Role of ‘green knowledge’ in the environmental transformation of the supply chain: the case of Greek manufacturing

Andreas C.R. Baresel-Bofinger*
SEERC-South East European Research Centre, 24 Proxeniou Koromila Street, 54622 Thessaloniki, Greece
E-mail: abofinger@seerc.org
*Corresponding author

Panayiotis H. Ketikidis
SEERC-South East European Research Centre, 24 Proxeniou Koromila Street, 54622 Thessaloniki, Greece and CITY College – International Faculty of the University of Sheffield, 13 Tsimiski Street, 54624 Thessaloniki, Greece
E-mail: ketikidis@city.academic.gr
E-mail: pketikidis@seerc.org

S.C. Lenny Koh and John Cullen
Logistics and Supply Chain Management (LSCM) Research Centre, Management School, University of Sheffield, 9 Mappin Street, Sheffield S1 4DT, UK
E-mail: S.C.L.Koh@sheffield.ac.uk
E-mail: john.cullen@sheffield.ac.uk

Abstract: This paper examines the role that the management of green knowledge and the use of environmental intellectual capital play in the implementation process of green supply chain management (GSCM) practices in Greek manufacturing companies. Greece is one of the economies with low perceptions of environmental friendliness within the business community. One of the crucial criteria for a company to commit itself seriously to green supply chain management practices is the question of how such an approach affects performance and how much added value can be created through such commitment. Based on a literature review the data for this research were collected through multiple in-depth case studies. The results illustrate that while good management of green knowledge can lead to added value, the definition and implementation of relevant measure items and targets seem indispensable for the improvement of green knowledge quality and as an important driver for implementation of GSCM practices.
Keywords: green supply chain management; GSCM; environmental supply chain management; green knowledge; environmental knowledge; green knowledge management; environmental intellectual capital; EIC; sustainability; Greece; South East Europe.


Biographical notes: Andreas C.R. Baresel-Bofinger has studied Law and Philosophy at the Universities of Tübingen, Munich and Harvard as well as Business Administration and Economics at CITY College – An International Faculty of the University of Sheffield in Thessaloniki, Greece, where he also received his MSc in Information Systems. Currently, he is carrying out his Doctoral studies at SEERC, the South East European Research Centre in Thessaloniki, in the area of green supply chain. He has been working for many years at SEPVE, the Association of ICT companies of Northern Greece, in the management of European projects, and more recently, as a Consultant for the Incubator of Technopolis Thessaloniki ICT Business Park, the first private business park in Greece for high-tech and knowledge-intensive enterprises.

Panayiotis H. Ketikidis is the Vice Principal for Research, Innovation and External Relations of CITY College – An International Faculty of the University of Sheffield, and the Chairman of the Management Committee and Academic Director of the Doctoral Programme at the South East European Research Centre (SEERC). He is the President of the Greek Computer Society (EPY) – Macedonia-Thrace chapter (elected 2008–2010). He has been elected as the President of the International Society of Logistics – Chapter Thessaloniki (1999–2005) and from 2006 he is Emeritus President of the International Society of Logistics. He is the Chief-Editor of the International Journal of Innovation and Regional Development (IJIRD), Associate Editor of the International Journal of Logistics Economics and Globalisation (IJLEG), and a member of organising and scientific committees in various national/international conferences and workshops.

S.C. Lenny Koh is the Associate Dean for Alumni Affairs in the University of Sheffield Management School, Chair Professor in Operations Management, Director of the Logistics and Supply Chain Management Research Centre and Head of the Operations Management Group. She is the co-founder of the Supply Chain Management and Information Systems Consortium. She leads several large-scale initiatives and projects. She is also an Advisor to the National Development and Reform Commission of China and the UK Government. She has over 244 publications. Her work appears in top quality journals. She is the Editor-in-Chief and Associate Editor of several international journals.

John Cullen is Professor of Management Accounting in the Management School of the University of Sheffield. His research interests include supply chain management, supply chain accounting, management control and corporate governance. He is currently undertaking a major project on reverse logistics in the UK retail sector (in collaboration with the University of Cranfield) funded by the Department for Transport. He is a member of the editorial board of the Journal of Contemporary Accounting and Organisational Change and has reviewed for journals such as British Accounting Review and Management Accounting Research. He is the Vice Chairman of the Committee
of Heads of Accounting and also a member of the Freight Logistics Research Group at the Department for Transport. He is also on the steering group of a regional innovative supply chain and networks group. He has undertaken supply chain consultancy projects in a number of organisations.

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1 Introduction

Due to increasing regulatory, competitive and marketing pressures for environmental sustainability, enterprises face the necessity to implement strategies to reduce their environmental impact. Green supply chain management (GSCM) is a modern concept of management practices attempting to integrate environmental thinking into all stages up and down the supply chain. In a globalised market, the environmental performance criteria extend beyond the single firm to its entire supply chain across national borders (Zhu et al., 2005). One of the crucial criteria for a company to commit itself seriously to GSCM practices is the question of how such an approach affects organisational performance and how much added value can be created through it (Bowen et al., 2001).

A company’s value is based on tangible and intangible assets (Russo and Fouts, 1997). According to Canibano et al. (2000), the benefits of both tangible and intangible assets seem to be gaining increasing acceptance in the accounting, economic and strategic management literature, following positive results of linkages between firms’ resources and measures of performance. Godfrey and Hill (1995) highlight that the inclusion of intangible assets derives from their ability to possess all of the characteristics of strategic assets. The intangible assets entail also the intellectual capital of the company (Guthrie, 2001). Environmental intellectual capital (EIC), as the sum of all green knowledge within a company, constitutes a part of this intellectual capital (Claver-Cortes et al., 2007).

The motivation for this research, which forms part of a bigger empirical research about GSCM implementation in Greek manufacturing companies, comes from the fact that the GSCM approach is still rather new in the countries of South East Europe and there is a gap of theoretical and empirical research for this region. Countries, such as Greece, with an emerging environmental sensitivity are characterised by a more relaxed implementation of environmental legislation and regulations, less advanced clean technologies and less sophisticated GSCM practices compared to countries with a more advanced environmental sensitivity (Park et al., 2007). Within this context, this study investigates the practices of Greek manufacturers in accumulating, administering and diffusing green knowledge in the process of GSCM implementation and how these two management approaches interact with each other. EIC can enable a company to implement environmental actions along its supply chain, such as close cooperation style with its suppliers, which in its turn can help the company to create new green knowledge and increase the company value (González-Benito and González-Benito, 2005). Although there is plenty of research regarding each of the topics of intellectual capital and GSCM...
separately, not many researchers have explored the relation between the two fields. This empirical study intends to contribute to closing this gap.

The paper is organised as follows: Section 2 reviews some of the key theoretical issues relating to GSCM, green knowledge and green intellectual capital, green measures and business performance. Also, green policies in Greece are outlined. Section 3 presents the research methodology. Section 4 offers the results of the case studies, which are further discussed in Section 5. Section 6 concludes with suggestions for future research.

2 Research context

2.1 Green supply chain management

Although its beginnings go back to the 1970s, research literature in the fields related to greening the supply chain started about the beginnings of the 1990s. While the concept of GCSM, which is also denoted by some researchers as environmental supply chain management or sustainable supply chain management, is based on two fields, namely environment management and supply chain management, there is a variety of definitions of GSCM depending on the research subject under consideration. So can GSCM primarily comprise the aspect of green purchasing (Preuss, 2005) or in a more comprehensive sense, it encompasses the integration of environmental consciousness into all the aspects of the forward and reverse flow of goods and information in the supply chain (Zhu et al., 2005). Generally, the concept can be described as a management approach to link environmental concerns with all stages of the supply chain comprising purchasing material, managing material, product and process design, inbound logistics, production, outbound logistics and reverse logistics.

Figure 1 depicts the scheme of GSCM according to Hervani et al. (2005), who characterise GSCM as a composition of green purchasing, green manufacturing/green materials management, green distribution/marketing and reverse logistics. According to Zsidisin and Siferd (2001), GSCM can be defined as “the set of supply chain management policies held, actions taken, and relationships formed in response to concerns related to the natural environment with regard to the design, acquisition, production, distribution, use, reuse, and disposal of the firm’s goods and services”. Other researchers focus more on individual aspects of GSCM, such as green marketing (Stafford, 2003), environment friendly product design (Madu et al., 2002) and the issues of reverse logistics (Bernon and Cullen, 2007) and the closed-loop supply chain (Defee et al., 2009). As shown in Figure 2, Srivastava (2007) tries to give a rather comprehensive overview classification of the GSCM elements but blends out some important areas such as green purchasing, industrial ecology and industrial ecosystems, and does not show the various interrelations and interactions between the different aspects. The positive effects of greening management practices were laid out in detail by Porter and Van der Linde (1995). Van Hoek (1999) discusses the value-seeking approach of a corporate strategy by a company taking responsibility of its ecological footprint. Research has also been aiming at such topics as performance measurement of GSCM (Zhu and Sarkis, 2004).
Role of ‘green knowledge’ in the environmental transformation

Figure 1  Scheme of GSCM

![Scheme of GSCM](source)

Source: Hervani et al. (2005)

Figure 2  Classification of major GSCM topics

![Classification of major GSCM topics](source)

Source: Srivastava (2007)
2.2 Green knowledge and green intellectual capital

In order to adopt a more environment friendly strategy, companies need to gain the relevant knowledge of how to implement the appropriate possibilities for product and process alteration (Chen, 2008). Knowledge can be defined as a combination of various ingredients such as experience, expert insight, values, and contextual information, which sets a base for assessing and integrating new information and experiences (Davenport and Prusak, 1998). Intellectual capital results from the management of knowledge flows. So can Stewart (1997) define intellectual capital as the mixture of knowledge, information, intellectual property and experience, which can be exploited in order to generate wealth. Environmental capital is part of intellectual capital (Claver-Cortes et al., 2007). According to Chen (2008, p.277), green intellectual capital is the “total stocks of all kinds of intangible assets, knowledge, capabilities, and relationships, etc. about environmental protection or green innovation in the individual level and the organisation level within a company”. According to the most common classification of intellectual capital also green intellectual capital can be subdivided into green human capital, green structural capital, and green relational capital (López-Gamero et al., 2010). Human environmental capital refers to the ecology-concerned knowledge and skills of a company’s employees relating to either operational capabilities or emotional commitment (Claver-Cortes, 2007).

Structural environmental capital is formed by organisational capabilities developing the company’s environmental management and technological capabilities concerning the development and implementation of environment friendly products and processes. The third dimension, relational environmental capital, refers to the company’s relationships with its stakeholders and the market in which it operates, regarding environmental issues.

2.3 Green measures and business performance

Research of the relationship between GSCM and organisational performance has so far produced non-conclusive results (Green et al., 1998). There exist two contrasting views about the relationship between environmental practices and organisational performance. The first viewpoint argues that many managers believe that environmental management consists simply of compliance with regulations, and that a trade-off exists where increased level of environmental management results in increased cost (Walley and Whitehead, 1994). Based on the basic premise of competitive advantage according to Porter (1985), firms can improve their environmental performance only at the cost of some profit-enabling capability or resource. Nevertheless, the ongoing ecological deterioration of the environment seems to make it an imperative for companies to define competitive advantage within a broader scope of social legitimacy and to adopt a wider understanding of the coexistence and interrelationships between the conflicting factors (Lewis, 2000).

There is also a body of research that suggests a positive relationship between environmental practices and organisational performance. It has been argued that the ability to successfully address environmental issues provide the organisations with new opportunities to sustain their competitive advantage (Hansmann and Kröger, 2001). Evidence also suggests that proactive initiatives could help the organisations to achieve superior benefits in the long-run through improved management of environmental risks and development of capabilities for sustained environmental improvement (Zhu and Sarkis, 2004). More specifically, competitive advantage could be achieved through the
Role of ‘green knowledge’ in the environmental transformation

...increase in environmental liability, the reduction in material waste and the identification and reduction of inefficient processes (Carter et al., 2000). Rao and Holt (2005) hold the view that a company can achieve competitive advantage through its ability to improve efficiency, quality and productivity, and to realise cost savings. Sharma and Vredenburg (1998) highlight three competitive capabilities derived specifically from an environmental commitment: stakeholder integration (the ability to involve external stakeholders in finding solutions to environmental problems), higher-order learning from having a different perspective on existing procedures, and continuous innovation because of a richer learning process.

Researchers have argued that knowledge management and intellectual capital can provide companies with a competitive advantage (Ho, 2009; Carlucci and Schiuma, 2007). Latest studies acknowledging the trend of companies’ proactive engagement in environmental management and green innovation indicate a positive relationship of green intellectual capital and firms’ competitive advantage (Chen, 2008). Nevertheless, the appropriate approaches to manage intellectual capital in order to enhance this positive relationship in an efficient way still needs further examination (Schiuma and Lerro, 2008).

2.3.1 Environmental performance

Sharma and Vredenburg (1998) define environmental performance as the environmental impact that a corporation’s activity has on the natural surroundings. While the importance of taking environmental performance into account when assessing a company’s strategy and competitive stand has been increasingly recognised by researchers, the question about the right way of measuring environmental performance is still an open one (Banerjee, 2002). Veleva et al. (2001) put forward five indicators: facility compliance/conformance, facility material use and performance, facility effects, supply chain and product life-cycle and sustainable systems. While these types of indicators mostly focus on measuring the degree of negative impact of a company’s activities, Nunes and Bennett (2007) go a slightly different way by proposing a system of indicators measuring the environmental benefits resulting from a company’s green activities. The tools and methods used for environmental performance evaluation could entail such systems as ‘environmental management accounting’, ‘environmental management system’ (EMS), ‘life cycle analysis’ and ‘eco-labelling’. Chien and Shih (2007) include in their research framework for studying relationships between environmental regulations, external stakeholders, GSCM practices, environmental performance and financial performance in manufacturing companies in the electrical and electronic industry in Taiwan two aspects in environmental performance, namely management performance and operational performance. Management performance refers to environmental policies and measures, the approval rate of the management system, and the improvement in community relations and corporation image. Operational performance entails the performance in using energy and resources, the reduction of emission, and waste disposal.

Through effective management of its suppliers, a firm can achieve a decrease of transaction costs, a reduced production of waste and hazardous materials, as well as a better rate of reuse and recycling of raw material (Chien and Shih, 2007). Harvey and Schaefer (2001) discover that external reporting serves as pressure for better performance results.
2.3.2 Economic performance

Although it is generally accepted that more stringent environmental standards have to be met and many organisations have to devote increasing resources to develop and implement corresponding measures, there is no clear answer to the question if a better environmental performance results also in better economic performance (Wagner et al., 2002). While some researchers find lower costs and positive effect on value resulting from implementation of environmental-friendly processes (Rao and Holt, 2005; Florida, 1996), other authors argue that implementing environmental practices always results in a trade-off with poorer economic performance (Walley and Whitehead, 1994). Chien and Shih (2007) define financial performance as cost reduction, market share growth and profit increase. Alvarez et al. (2001) discover a positive effect of greening the supply chain on a firm’s economic performance.

GSCM can cut the cost of materials purchasing and energy consumption, can reduce the cost of waste treatment and discharge, and avoid a fine in the case of environmental accidents (Zhu and Sarkis, 2004). A sustainable approach can lead to internal cost saving, open new markets and to beneficial uses for waste (Tsoulfas and Pappis, 2006). According to Fuentes-Fuentes et al. (2004), green practices have a positive effect on a company’s growth in profits, sales and market share. Klassen and McLaughlin (1996) show that organisations minimising the negative environmental impacts of their products and processes, recycling post-consumer waste and establishing EMSs are very likely to expand their markets or displace competitors that fail to promote strong environmental performance. Revenues can be positively impacted when customers prefer the products of environmentally friendly firms (Winsemius and Guntram, 1992). Costs may be reduced through proactively managing environmental regulations, which may create barriers and first-mover advantages that are difficult for competitors to imitate (Dean and Brown, 1995).

Porter and Van de Linde (1995) argue that throughout a product’s life cycle, pollution reflects hidden costs in the form of wasted resources and effort. By adopting GSCM practices, these costs can be reduced. Orlitzky et al. (2003) show based on a meta-analysis, that there is a positive association between corporate social performance and corporate financial performance across industries. Contrary to that, Bowen et al. (2001) warn that economic performance cannot be expected to be seen in boosted profitability or sales performance, at least not in the short-term. In a study on Chinese enterprises, Zhu et al. (2005) confirm that there is no improved economic performance through implementation of GSCM.

2.4 Green policies in Greece

Supply chains have become complex networks of multi-layered activities and a multitude of players around the globe to an extent that responsibility for environmental concerns may be attributed to any member of the chain. The region of South East Europe, in spite of its good geographical position, faces severe hindrances to become a competitive player in the global supply chain networks (Ketikidis et al., 2008). Greece, an EU member since 1981, is under direct influence of the growing EU environmental legislation that affects virtually all products at all levels of the supply chain. Greece is usually seen as a latecomer on the environmental scene, where compliance with environmental regulations
is rather on a voluntary and incentive-based level than on a mandatory one (Kassolis, 2007).

A country’s social and institutional capacity for environmental sustainability refers to the extent that a country has in place institutions and underlying social patterns of skills, attitudes, networks that foster effective responses to environmental challenges (Husted, 2005). Besides a nation’s capacities for scientific research, production of environmental information, debate, environmental regulation and enforcement it also includes the private sector’s responsiveness to environmental problems. Katz et al. (2001) conclude that the will and ability to protect the environment are influenced by intra-country socio-cultural factors. If people are more culturally conscious of environmental conditions, a higher level of environmental sustainability can be maintained. National culture is expected to influence how people utilise their natural resources and environments by shaping their attitudes and perceptions (Hoon et al., 2007).

Psychogios and Priporas (2007) report that all of the Greek managers interviewed by them see the need to modernise the Greek economy, in general, and the management system, in particular, in order to match the demands of EU membership as well as the pressure from increased international market competition. In a study about the implementation of EMSs in the Greek industry, Georgiadou and Tsiotras (1998) found out that the Greek companies consider the implementation of environmental management standards, such as ISO 14001, the most important factors in improving an organisation’s image, reducing production cost and improving quality, and showing care for the environment, whereas factors, such as facilitating management of environmental aspects and satisfying customer environmental expectations, are considered less important.

According to latest research from the Grant Thornton International Business Report (IBR, 2009), Greece is characterised as one of the economies with low perceptions of environmental friendliness within the business community. Watson and Emery (2004) characterise environmental policy in Greece as incapable of making a difference in organisations’ economic and social behaviour. This may be exemplified by the implementation of EMSs and ISO 14001 certifications in Greece. For December 2006, Greece shows for EMAS sites a total number of 54 and for ISO 14001 a number of 300, based on the data from the German Federal Environment Agency (2007), demonstrating a rather weak position of 43 in international ranking of 146 countries.

The implementation of the eco-management and audit scheme (EMAS) regulation and the ISO 14001 standard has been easily integrated into the national framework of environmental management policies. Although this has been a positive change for environmental management practices in Greece, ISO 14001 has not gained much in terms of its environmental dimension in the country, because awareness, interest and knowledge in environmental management remain rather low.

There exist strategic, structural and procedural impediments in implementing environmental management practices (Baresel-Bofinger et al., 2007). Partly due to the lack of conceptual perception of environmental management practices and sustainable development, there is a general lack in specific content as to how environmental management practices are to be attained or who is responsible for achieving them (Kassolis, 2007). There is also a lack of organised efforts to inform the public on such issues. Although stricter procedures in particular stages of environmental management have been enacted, practices are generally lagging behind and are vague. Kassolis (2007) claims that significant actions, policies and tools are missing in Greece due to low
priority setting and lack of political will, as well as due to the fact that the institutional context together with the necessary chain of regulatory framework has not been clearly defined.

3 Methodology

This study forms part of a larger empirical research investigating the circumstances under which GSCM practices are currently adopted in manufacturing companies in Greece and how they impact organisational performance. The manufacturing industry has been chosen for its distinctive position in the context of environmental sustainable development. It is often related to being one of the main causes of many environmental damages (Baldwin et al., 2005). The manufacturing sector is characterised by big consumptions of energy and by large quantities of waste production. Thus, it has a distinctive impact on the environment. At the same time, manufacturers are also exposed to a high degree to changes in environmental regulations and market attitude. Supply chain management plays an eminent strategic role in that industry sector (Preuss, 2005).

This exploratory research applies a multiple case study approach. The adoption of a single case or a one firm perspective would present too narrow a view. The in-depth case studies allow the collection of rich empirical data. Nevertheless, this approach is not intended to be a macroscopic study and can be generalised only to a limited extent.

3.1 Sample

Mixed purposeful sampling was selected for in-depth study (Patton, 1990). Case selection was driven by the need to ensure a certain degree of variety of cases but still sharing some common criterion. Companies should be from different fields of the manufacturing sector and represent different company sizes but their supply chain should extend into the region of South East Europe. Identification of product classes was undertaken, and following these selection criteria, actual companies were selected from the Greek Financial Directory of ICAP Group, comprising 20,000 companies of all domains of the Greek economy, and from chamber of commerce lists. Nevertheless, the case selection process involved also a certain degree of ‘planned opportunism’, as Pettigrew (1990) calls it referring to the practicalities of overcoming the limitations and difficulties of gaining access to research sites. Company sizes range from small companies with fewer than 50 employees, through medium-sized companies with up to 500 employees, to large corporations with international presence. From the bigger sample for the underlying empirical study, two case studies are included in this present paper. Company A is a manufacturer of electronic and electrical devices, specialised in emergency illumination and security systems with a 120 employees. Company B is a manufacturer of building chemicals and pre-mixed mortars with 250 employees. Both companies have their own R&D department, have trading subsidiaries in the neighbouring Balkan countries and have international suppliers and clients.

3.2 Data collection

Data were collected from semi-structured interviewees on a face-to-face basis. Based on a substantial literature review a semi-structured interview guide was developed giving the
respondent and the interviewer opportunity enough to extend on various topics of interest. For finalisation, this guide underwent a test phase through discussions with academics and business people. The same interview guide was used for persons in various positions in one organisation, depending on the particular focal company, ranging from CEO, financial officer, executives in procurement, sales, customer relations, supply chain, logistics, manufacturing, operations, product, marketing and/or head of environmental issues. To all interviewees, the interview guide was made available prior to the interview together with some introductory note and relevant background information. The interview guide included, among others, questions referring to the company’s environmental strategy, the driving forces for engagement in GSCM, the environmental management practices inside the organisation including management of intellectual capital, the green practices beyond the company’s boundaries including management of environmental knowledge, environmental performance, and value creation.

The utilisation of this interview method was essential for gaining insights into the participants’ perceptions, opinions, and views of the GSCM system and their day-to-day practices. Interviewees were allowed a degree of freedom to explain their views, as well as to enable certain responses to be questioned in greater depth (Bryman, 2004). In order to increase the reliability of the case study by guiding the researcher in carrying out the data collection, a case study protocol was developed (Yin, 2009). In all the cases, the whole conversation was audio taped in order to improve validation of data. In order to ensure ethically correct conduct of the research, the respondents’ consent was asked for prior to the start of the interview (Robson, 1991). The respondents were fully informed about the true purpose of the research and all people who would have access to the recording (Malhotra and Peterson, 2001). All data collected protected the privacy and confidentiality of the individual respondents. This was declared prior to interview and maintained by good records management after the interview. Hand written notes were also taken during the discussions. The interviews were transcribed and the obtained data were coded. The data from the interviews was supplemented by further sources of evidence, such as in-house documentation, media coverage and direct observation through visits to the facilities and contact with employees. Given the qualitative nature of most of the data sought, triangulation technique provides a stronger validation of the results (Yin, 2009).

3.3 Data analysis

A method suggested by Miles and Huberman (1994) for building theory from case study data which is close to the social constructionism paradigm was used for the data analysis. The main research objective was to identify issues in the areas of GSCM implementation. This was the basis for a within-case and a cross-case analysis. Each interview had as its main objective to identify issues that should be considered in the implementation process of GSCM. One subcategory of issues was related to the collection, administration, usage and diffusion of knowledge relevant to this implementation process. First, a detailed case study write-up was produced after each company visit to allow data analysis within each case. The interviews were transcribed verbatim. The hand written notes were examined. Case notes were written-up. Units of general meaning were outlined. Units of meaning relevant to the GSCM issues raised in the research questions and based on the literature
and on actual terms used by interviewees were delineated. Units of relevant meaning according to the GSCM practices were clustered. Themes from clusters of meaning, and the identification of general and unique themes from the interviews were determined. Quotes were integrated to illustrate key points. Cross-case patterns were examined.

4 Case study results

As mentioned above, the intention of this research is to examine the role that the management of green knowledge plays in the implementation process of GSCM practices in Greek manufacturing companies and the interaction between GSCM and green intellectual capital. Both have an effect on organisational performance, as depicted in Figure 3.

Figure 3 Interactions of GSCM, green intellectual capital and company performance

4.1 Green human intellectual capital

According to the aforementioned classification of green intellectual capital, there are a number of characteristics that were identified in the two companies under study. Table 1 shows the companies’ human intellectual capital, relating to the capabilities and commitment of the people in the organisation. Company A showed a philosophy of innovation that was embedded in top management and that was directing any efforts towards green practices. Responsible for applying for ISO 14001:2004 certification is the head of quality assurance. For implementation of ISO guidelines, an external consultant has been hired lately. The main pooling of information concerning greening products in Company A happens in the R&D department. The company does not present a written environmental mission paper. There is a general understanding of environmental issues among the employees of the company. Internal e-mails update the employees about latest measures implemented. In Company B, top management shows a heightened awareness
Role of ‘green knowledge’ in the environmental transformation

of corporate social responsibility and environmental concerns which triggers down to all employees. As the administrative manager describes: “We do these things because we feel it is the right thing to do them.” Regular e-mails and announcements concerning multiple environmental topics and latest measures in the company are distributed to all employees. Nevertheless, there is no written environmental mission statement present in the company. Motivation for environmental measures are restricted by the logic that first of all any measure has to make economic sense. As one production manager puts it: “First of all I think as a business man. If it does not save or make money, I hesitate to do it.”

Table 1  Green human intellectual capital

<table>
<thead>
<tr>
<th>Human IC</th>
<th>Company A</th>
<th>Company B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive aspects</td>
<td>Negative aspects</td>
<td>Positive aspects</td>
</tr>
<tr>
<td>Managers’ values/example</td>
<td>No written environmental mission statement</td>
<td>Managers’ values/example</td>
</tr>
<tr>
<td>Spirit of innovation</td>
<td>Not yet implementation of EMS</td>
<td>Internal e-mails</td>
</tr>
<tr>
<td>General familiarity with environmental issues</td>
<td>Motivated employees</td>
<td></td>
</tr>
<tr>
<td>Outsourcing implementation of EMS</td>
<td></td>
<td></td>
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<tr>
<td>Internal e-mails, instruction for environmental behaviour</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2  GSCM practices for technological and organisational development

Both companies undertake a number of GSCM practices. Tables 2 and 3 show the companies’ actions in the areas of technological and organisational development. These practices can be divided into pollution control and pollution prevention actions (Klassen and Whybark, 1999). Control actions follow the objective to correct environmental impact through end-of-pipe measures. Pollution prevention actions have the objective to eliminate or reduce the environmental impact from the source (López-Gamero et al., 2010). Both companies practice selective waste collection. They pay a third party to collect recyclable and to dispose hazardous waste. These measures are required by state law but the implementation of the law is not controlled and violators are rarely pursued. Company B considers plans to build its own water treatment installation but until now the cost-benefit analysis with regard to the amount of waste water to be treated favours the solution of collection through a third party for disposal at the public water treatment plant. An effort is made to make waste water collection more efficient by diluting the waste water enriched with chemical substances with the less aggressive sewage water from regular office usage. Company B uses air filters which are again required by law but not the standard for all, particularly smaller, companies. Computer and
telecommunication equipment that is outdated or replaced by new one is given to
second-hand users.

**Table 2** GSCM practices of Company A

<table>
<thead>
<tr>
<th>Control actions</th>
<th>Prevention actions</th>
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<tbody>
<tr>
<td>Selective waste collection</td>
<td>Introduction of materials with lower environmental</td>
</tr>
<tr>
<td></td>
<td>impact (e.g., LED)</td>
</tr>
<tr>
<td>Toxic/dangerous waste disposal</td>
<td>Use of extra heat from cooling aggregate to warm</td>
</tr>
<tr>
<td></td>
<td>factory premises</td>
</tr>
<tr>
<td>Collection of machinery oil to give to</td>
<td>Change of container material for longer duration of</td>
</tr>
<tr>
<td>recycling</td>
<td>usage</td>
</tr>
<tr>
<td>Payment of third party to collect recycle material</td>
<td>On site recycling programme</td>
</tr>
<tr>
<td>(paper, copper and oil)</td>
<td>use of recycled materials</td>
</tr>
<tr>
<td></td>
<td>ISO application</td>
</tr>
<tr>
<td></td>
<td>Preparation of EMS implementation</td>
</tr>
<tr>
<td></td>
<td>Research for use of less hazardous materials</td>
</tr>
</tbody>
</table>

**Table 3** GSCM practices of Company B

<table>
<thead>
<tr>
<th>Control actions</th>
<th>Prevention actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selective waste collection</td>
<td>Use of battery driven forklift vehicles within</td>
</tr>
<tr>
<td></td>
<td>warehouse</td>
</tr>
<tr>
<td>Toxic/dangerous waste disposal</td>
<td>Recycling programme</td>
</tr>
<tr>
<td>Plans for own waste water treatment plant</td>
<td>Changes in product and material specifications</td>
</tr>
<tr>
<td>Collection of machinery oil to give to</td>
<td>Reuse of material</td>
</tr>
<tr>
<td>recycling</td>
<td></td>
</tr>
<tr>
<td>Payment of third party to collect recycle material</td>
<td>Installation of more energy efficient production</td>
</tr>
<tr>
<td>(paper, steel, plastic, oil, office equipment)</td>
<td>line machinery</td>
</tr>
<tr>
<td>Giving out dated material to further user</td>
<td>Firm staff training and awareness campaign</td>
</tr>
<tr>
<td>Usage of air filters</td>
<td>Efficient usage of equipment to avoid unnecessary</td>
</tr>
<tr>
<td></td>
<td>toxic waste</td>
</tr>
<tr>
<td>Waste water collection</td>
<td>Efficient usage of detergents for cleaning machines</td>
</tr>
<tr>
<td>Improvement of efficiency of waste water collection</td>
<td>Modernisation of equipment to minimise scrap</td>
</tr>
<tr>
<td></td>
<td>Modern energy efficient office building construction</td>
</tr>
<tr>
<td></td>
<td>Search for package material with less environmental</td>
</tr>
<tr>
<td></td>
<td>impact</td>
</tr>
</tbody>
</table>

With regard to GSCM practices aiming at preventing harm to the environment
Company A makes an effort to use in its products energy conserving light sources, such
as LED. The company also uses heat caused by the operation of a cooling unit that would
Role of ‘green knowledge’ in the environmental transformation

4.3 Management of green knowledge in relation with stakeholders and markets

The two companies take a number of measures regarding the management of green knowledge in relation with their stakeholders and markets, as shown in Table 4.

Company A entertains a website giving some but very limited reference to its attitude regarding environmental responsibility. In spite of holding an ISO 14001:2004 certificate the company does not promote it prominently on its website but gives only some reference in its product catalogue. In product descriptions some reference is made to concordance with EC standards and to such regulations as disposing batteries in an appropriate way. Company A does not publish any environmental reporting. The company distributes a regular newsletter in which it also refers occasionally to environmental issues. In-house communication regarding environmental topics is done via e-mails, personal conversations on top, senior middle management level. The small size and the low hierarchy structure of the company allow short communication ways. While officially the responsibility for environmental issues lies in the hands of quality control, marketing plays a vital role in taking up new topics, while the R&D department...
is taking responsibility of technical exchange with suppliers. Big foreign suppliers make suggestions for the use of new material and product design which are taken up by the company if they seem to conform to other factors such as cost control and market demand. Supplier selection is not primarily defined by environmental criteria. The vital influence on integrating green measures in the supply chain derives from foreign markets and clients. The exports to retail customers in North European countries, such as Sweden, with their high environmental standards put pressure on Company A to change their products in order to conform to those standards. Big (potential) customers also conduct an environmental audit with Company A as part of a general company audit and suggest or require the implementation of certain green practices along the supply chain. If such environmental audits are not satisfactory Company A can lose the order to competitors. The company attempted to initiate with government agencies and business associations some green measures concerning green product design and waste management but no results have been achieved yet. Considerations to initiate together with national competitors some voluntary agreements regarding the implementation of GSCM practices have failed due to their lack of interest. Company A has successfully achieved ISO 14001:2004 certification but has fallen short so far to implement all the necessary foreseen measures. An EMS has still to be implemented environmental measures and targets still to be defined and established. Lately, Company A has decided to hire an external consultant to support the implementation process.

**Table 4** Green knowledge management in relation with stakeholders and markets

<table>
<thead>
<tr>
<th>Relational IC</th>
<th>Company A</th>
<th>Company B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive aspects</td>
<td>Negative aspects</td>
<td>Positive aspects</td>
</tr>
<tr>
<td>Website</td>
<td>Little information on website regarding green practices</td>
<td>Annual meeting</td>
</tr>
<tr>
<td>Newsletters</td>
<td>No green reporting</td>
<td>Newsletters</td>
</tr>
<tr>
<td>(Environment) audit big customers</td>
<td>Competitors not interested in cooperation in green issues</td>
<td>Cooperation with suppliers</td>
</tr>
<tr>
<td>ISO 14001: 2004 certification</td>
<td>Government agency and business association slow in supporting initiatives</td>
<td>Attempt to influence smaller size suppliers for increase of environmental measures</td>
</tr>
<tr>
<td>Initiatives with government agencies and chamber of commerce</td>
<td>Combining environment friendly actions with social actions in community</td>
<td>No green reporting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Company B does not have a written environmental statement. Although there are some thoughts to apply for ISO 14001 certification the process has not been started yet. There is no publishing of environmental reports. The company does not promote its environmental approaches and practices on its website. The reason for that omission is a general conviction that the company wants to avoid any impression of ‘green washing’. As the head of marketing explains: “I am cautious to promote our company as an environmental friendly one while we still have a number of environmental issues that would need improvement. We do not want to give an impression that we cannot uphold.” While e.g., some product design has been improved in terms of eliminating hazardous material, the company does not have the market power to tell their main suppliers to introduce green changes. On the other hand, the company is big enough to achieve through the close cooperation of their R&D department with smaller suppliers environmental friendly changes in product design. The flow of green information inside Company B is pooled in the marketing department that gathers throughout the year suggestions and useful comments from all parts of the supply chain to discuss them in an annual meeting in order to come up with new ideas and implications for strategic decision-making. The company’s products are price sensitive, and the product prize is one of the main factors determining product and process design within the company. Company B competes with many smaller manufacturers that put pressure on prices. As the head of marketing describes: “The market for our products is not very sensitive for environmental needs, in particular the markets in the region of South East Europe.” Cooperation with competitors for voluntary agreement regarding GSCM practices are not seen feasible at this moment. As the head of production puts it: “Many of our competitors tend to circumvent environmental regulations and do get through with this behaviour due to lack of enforcement.”

5 Discussion

The various GSCM practices implemented by the companies under study and the accumulation of EIC have an impact on the companies’ organisational performance and their value. End-of-pipe green measures that control environmental impact but do not remove it create costs for the companies but do not generate value (Claver-Cortes et al., 2007). On the other hand, also these measures can help generate business as in the example of Company A attracting a major foreign client due to the fulfilment of the environmental audit. Company B realises cost savings through GSCM measures that reduce energy consumption. Operational performance of Company B is increased through the minimisation of scrap rate and the improved utilisation of machinery. Company A can promote its product of greener design to new clients and markets. As Vachon and Klassen (2006) describe in their research, the successful integration of a firm’s suppliers into its supply chain management can result in the company’s improved environmental performance. The creation of a trustful relationship is necessary for green knowledge sharing (Cheng et al., 2008). In the present case study of Company B, this statement holds true with the limitation that a firm’s market power has to be adequately big to make big suppliers participate in the process. But where this network of knowledge exchange can be established, the cooperation regarding green issues with suppliers and clients lead in both companies to an increase of EIC.
In terms of management of green knowledge both companies could improve their existing mechanisms in several ways. An emphasis on a higher quantity and higher frequency in disclosure of GSCM practices on the company website and in newsletters would have a positive effect on the transparency of business actions of the companies and would increase trust and support from other stakeholders. According to Bowen (2000), the degree of a company’s environmental visibility can be seen as often positively related to the amount of pressure they face to adopt green practices. Besides legislation, such pressure could be put on by a firm’s competitors, as Zhu et al. (2005) argue, customers according to Green et al. (1998), or other stakeholders. In the present case studies, the pressure from competitors and the public may still be not strong enough. The presence of an environmental mission statement and a written environmental strategy would strengthen the companies’ focus on environmental measures. The mechanism of Company B to primarily discuss environmental initiatives once a year under the guidance of the marketing department appears rather restrictive for a process that should be a continuous one. In Company A, the eminent role of the R&D department regarding the management of green knowledge with suppliers neglects the potential of other departments such as procurement and logistics to contribute to that cooperation. Together they could create a supplier evaluation process in regard to ecological issues.

In both companies, the definition and implementation of measure items and targets as well as appropriate measurement tools for GSCM and green intellectual capital could be enforced together with the implementation of an EMS in order to facilitate a more efficient management of green knowledge and enable a performance measurement regarding the impact of green practices along the supply chain. Both companies have improved their environmental performance over the past through the implementation of preventive GSCM practices and have increased their EIC. Various measures have increased the efficiency of energy consumption, have reduced the scrap rate and increased recycling and the use of recycled material. To a certain extent products and processes have become more environmental friendly. In both companies, the notion of environmental concern exists.

Hindrance for implementation of green practices can be seen in partially low market sensitivity for green products, particularly in the markets of neighbouring countries of South-East Europe. The commitment to a clear environmental strategy and raising its importance in the general corporate strategy would need some enforcement in both companies. In Company A, an environmental strategy appears to be only a subcategory of the company’s prevalent innovation strategy. In Company B, a general strategy of ensuring reliable product quality at cost efficiency is prevalent and within this strategy green measures that contribute to these set goals are welcome.

6 Conclusions and further research direction

The research examined the relation between efficient green knowledge management and the successful implementation of GSCM practices. In the presented two case studies of Greek manufacturers, it was exemplified that EIC can have a positive effect on a company’s ability to implement green practices along its supply chain. Good cooperation and information flow with suppliers and clients can support and also initiate a company’s effort to make environmental friendly changes in its products and processes. Nevertheless, these efforts are restricted by a lack of market awareness and appreciation
Role of ‘green knowledge’ in the environmental transformation

of environmental friendly products. As long as markets focus primarily on price and quality relation without including ecological aspects in the definition of quality the impediments for a company may be too high to dedicate itself to greening its supply chain. A lack of governmental support or enforcement of existing regulations can hinder a company’s green aspirations. So can the unwillingness for voluntary cooperation among competitors. Within a company, although an environmental strategy and the company’s philosophy regarding environmental responsibility may be tacit knowledge, a written statement appears to be necessary in order to make sure that this knowledge is properly understood and used in an efficient way. The definition and implementation of measure items and targets seems indispensable for the improvement of information quality. In the absence of such measures, the impact on organisational performance as a company’s value can be hard to determine and an important driver for implementation of green measures is missing.

This research is limited by the small number of case studies. Hence, its results can only be generalised to a restricted extent. Further research which incorporates a broader industry survey, also across different sectors, would be useful for practice. The aspect of cultural factors influencing the way green knowledge is managed could be more emphasised in a comparative study across different countries.

References


Role of ‘green knowledge’ in the environmental transformation


