Supply Networks for Cleaner Production: framework for environmental improvement of small and medium sized firms in emerging markets

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Supply Networks for Cleaner Production:
framework for environmental improvement of small and medium sized firms in emerging markets

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Netwerken van toeleveranciers voor schoner produceren: een kader om te komen tot verbeteringen in kleine en middelgrote ondernemingen in ontwikkelingslanden

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Thesis

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This thesis is addressed to professionals, managers, academics, and students interested in structural development challenges, such as the environmental performance of small and medium-size firms in emerging markets. The aim of this thesis is to inspire them to think beyond traditional knowledge and value bottom-up experiences as sources of change and academic enquiry.

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Summary

Cleaner Production was heralded as a promising paradigm for improving the environmental performance of companies; however it has largely focused on technical aspects, which has limited its expected implementation. This research proposes to bridge the existing fields of CP and Sustainable Supply Chain Management (SSCM), and contribute to new thinking for disseminating preventative environmental practices. By doing so, it proposes a framework for environmental improvement of small and medium sized firms.

An underlying assumption of this thesis is that SMEs are cornerstones of sustainable development because they represent about ninety-nine percent of all enterprises worldwide, and are known to be a significant source of environmental contamination. Improving SME environmental performance is clearly in the public interest, and in the interest of small business owners and managers who seek ways for their firms to remain competitive.

Another consideration relates to the limited impact of the many public and private initiatives undertaken throughout the world to improve SME environmental performance. Research has identified the main challenges to be overcome as a lack of knowledge, resources, and vision, as well as an absence of market pressures. Addressing these challenges, with data drawn from this research, would reduce the environmental load stemming from inefficient resource use and less than optimal processes employed by SMEs.

The experience of the Mexican Sustainable Supply Programme (MSSP) serves as the object of analysis. Programme design features, combined with methods employed by CP and SSCM, enabled MSSP to reach out to a significant group of SMEs and motivate dissemination of preventive environmental practices. Moreover, a significant number of anchor firms and suppliers characterized as SMEs are, to this day, involved in the programme.

The author's privileged access to the MSSP, together with his prior knowledge of CP programme design and dynamics, rendered the MSSP ideally suited for his research. An abductive research strategy, he reasoned, would allow developing contributions to theory for understanding dissemination of preventive environmental practices in small firms in emerging markets.

Three questions were formulated to assess the underlying dynamics-taking place in the MSSP, as follows:

1. How can differential performance outcomes among SMEs in the implementation of preventive environmental practices be explained?
2. How to explain differential dissemination-performance of firms participating in public environmental voluntary initiatives aimed at sustainable supply management?

3. How can initiatives combining CP and SSCM contribute to dissemination of preventive environmental practices in SMEs?

A multidisciplinary approach was used to probe these research questions in relation to the MSSP. Selected concepts drawn from management theory were combined with CP and SSCM literature in management frameworks. Each centred on a particular element of organizational and inter-organizational dynamics, such as (i) cost-benefit of CP best practices, (ii) organizational learning involved in the implementation of preventive environmental practices, (iii) role of anchor companies in supply networks, and (iv) the collaboration capacity of suppliers. These independent concepts were integrated into a higher order multi-disciplinary and multi-level framework.

Both quantitative and qualitative research tools were employed to collect data. Quantitative data includes information on organizational characteristics and CP projects for fourteen supply groups totalling 177 suppliers. Statistical analyses include descriptive statistics, cluster analyses and regression analyses. Qualitative data draws on semi-structured interviews with managers of participating firms. Several site visits and two stakeholder workshops were held to verify reported data. The research findings provided answers to the research questions as follows:

Explanations of differential performance outcomes in the implementation of preventive environmental practices in SMEs:

Implementation of CP projects in firms was measured in terms of learning levels. Findings show how organizational characteristics such as supply sector and type of supplier influence implementation of preventive environmental practices in small firms. Suppliers of raw materials, parts, and packaging materials feature higher learning levels as compared to service suppliers. Firm size appears to influence likelihood of organizational learning. Medium-size firms reveal a significantly higher propensity to learn than small-sized firms. Research findings also record significant relationships with respect to participants' professional profiles; managers with both a technical and administrative background attain higher learning levels than those with either a single technical or administrative profile, the latter showing a propensity for limited learning.

Cost-benefit assessment shows that, on average, waste recycling and waste prevention projects yield higher economic and environmental value than energy efficiency and water conservation projects. Waste reduction applications also produce more attractive net present values than technology innovations or best practices. Projects classified as technology innovations feature higher economic and environmental benefits than projects identified as best practices. Economic and environmental benefits of cleaner production are positively related to firm size.

Explanations of differential dissemination-performance in contributions to public voluntary environmental initiatives (PVEI) aimed at SSCM:

Differential performance of supply chain groups participating in MSSP was assessed by gauging the expectations of anchor company managers and their contribution to dissemination of preventive environmental practices among suppliers. The findings uncovered a variety of reasons for anchor companies wishing to participate in PVEI aimed at SSCM. Also, the perceived benefits following participation varied widely.

Thesis findings suggested that anchor companies with prior supply chain programme experience contributed positively to dissemination of CP practices among suppliers. Anchor company teams comprised of 'purchasing', and 'health and safety' (EHS) managers obtained poorer results in CP dissemination among suppliers than companies represented by a single manager. Similarly, thesis findings show that supplier dropout during a series of programme workshops was significantly lower among supplier groups attached to anchor companies represented in the programme exclusively by EHS managers.

Other explanations for the differential performance of supply chain groups may be found in supplier characteristics and their capacity for collaboration in devising sustainability initiatives. Collaboration capacity of supplier firms is defined as a multidimensional organizational construct measuring operational, communicative, and cooperative routines required for dissemination in supply networks. Suppliers of materials, excepting printers, performed better than service suppliers. Supplier participants with technical profiles showed a significant negative relationship with communicative routines; administration managers showed significant negative relationships vis-à-vis operational routines; and firms represented by two or more representatives scored highest on all routines of collaboration capacity required for high performance.

Explanations of why combining CP and SSCM contributes to improvement of environmental performance of small firms in emerging markets:

Integrating CP and SSCM offered a strategy to scale initiatives aimed at small firms in emerging markets. Supply chain relationships emerging from SSCM compensated for the often weak institutional capacity of environmental agencies in emerging markets, thus influencing transaction costs entailed in addressing a large group of SMEs. Similarly, CP- fed innovation for process efficiency and waste reduction, with cost-benefit outcomes that appealed to small firms. CP generally implies organizational learning and capacity building, thus upgrading intra-organizational capacity and strengthening network relationships and competitiveness. Findings showed CP and SSCM to be mutually beneficial. Accordingly, their combined approach is recommended as a conceptual framework for disseminating and implementing preventive environmental practices in small firms in emerging markets.

Thesis findings showed organizational aspects of small firms, as opposed to the technical and economic aspects, as the most likely determinants of CP and SSCM outcomes. Implications of this proposition suggested focusing on the organizational learning and change process of environmental improvement in small firms. Anchor companies might be involved by emphasizing market differentiation, such as environmental leadership, the need for cost reductions, and an interest in collaborating with environmental agencies, which encourage firms to join initiatives aimed at improvement of environmental performance.

The chief contribution of this thesis is perhaps the introduction of new thinking, addressed to the improvement of environmental performance of small firms in emerging markets, by proposing a multi-level and multidisciplinary research framework. This approach is based on the proposition that implementation of preventive environmental practices in supply networks does not hinge only cost-benefit outcomes, but should consider organizational learning as a mayor emphasis. Therefore it refutes existing knowledge that assumes cost-benefit considerations as the overriding reason for firms to adopt preventive environmental measures.

Other findings showed that an organization's capacities, together with the characteristics of managers, significantly influenced implementation and dissemination of preventive environmental practices. Accordingly, this thesis provides an empirical foundation for propositions that include social science frameworks comprised of organizational learning in the study of environmental improvement of SMEs in emerging markets.

Recommendations for further research included, first, follow-up experience with the MSSP beyond the pilot stage examined for this thesis. The MSSP has become one of the largest programmes of its kind in the world, involving approximately 300 anchor companies, 500 supply groups, 6,000 suppliers, 10,000 CP project designs, and nine service providers. Second, broaden the research methodology to include in-depth case studies detailing the role of participating stakeholders. Deeper study of outliers and supplier withdrawals should reveal an improved understanding of the reasoning, perceived benefits, and underlying dynamics explaining firms' behaviour in the dissemination process of preventive environmental practices.

Lastly, the scope of further research should be expanded. The role of MSSP convener organizations should be assessed, including that of service providers that offer training workshops. Also the inclusion of a control group would yield important additional insights, such as are required to scale up multi-stakeholder efforts in programmes, such as the MSSP, in other emerging economies.

Samenvatting

Schoner produceren is gepresenteerd als een effectieve aanpak voor het introduceren van milieuverbeteringen in bedrijven in de jaren 80 en 90 van de vorige eeuw. De nadruk op de technische implementatie heeft de hoge verwachtingen voor milieuverbeteringen nog niet waar kunnen maken. Dit onderzoek presenteert een kader dat schoner produceren analyseert door middel van productieketens en andere bedrijfskundige concepten. Zo wordt nieuwe kennis gepresenteerd voor het verbreiden van preventieve milieu verbeteringen in Middelgrote en Kleine Bedrijven (MKB), met name in ontwikkelingslanden.

Het eerste deel van deze studie bekijkt MKB als onderdeel van duurzame ontwikkeling. Deze bedrijven veroorzaken milieu vervuiling vanwege vaak verouderde toegepaste technologie. Daarbij komt, dat overheden in zich ontwikkelings landen meestal weinig of geen controle uitoefenen op het MKB. Hierdoor wordt er geen druk uitgeoefend op bedrijven om schoner te produceren wat bijdraagt aan de achterstand met betrekking tot het implementeren van milieu verbeteringen.

Helaas hebben de vele initiatieven om milieuverbeteringen door te voeren de afgelopen twintig jaar weinig effect opgeleverd. Wetenschappelijk onderzoek heeft aangetoond dat gebrek aan kennis, middelen, visie, en het ontbreken van een marktvraag, belemmeringen zijn voor het toepassen van milieu verbeteringen. Er zijn tot nu toe weinig alternatieve methoden bekend om milieuverbeteringen in het MKB in ontwikkelingslanden te verbreiden. Het hier gepresenteerde onderzoek draagt bij aan een nieuwe denkwijze voor het reduceren van milieuvervuiling en het verbeteren van de productieprocessen van MKB in ontwikkelingslanden.

Een Mexicaans milieuprogramma is geselecteerd als empirische context om dit onderzoek uit te voeren. De opzet van dit programma combineerde een productieketen aanpak met het schoner produceren perspectief om zo een grote groep Middelgrote en Kleine Bedrijven te bereiken en deze te overtuigen om hun productie processen aan te passen. Het Mexicaanse programma bestreek een groep van grote en kleine bedrijven, en wordt tot op de dag van vandaag nog steeds verspreid. De onderzoeker had toegang tot informatie over het programma, omdat hij als consultant verantwoordelijk was geweest voor de opzet en uitvoer. Dit geeft de onderzoeker de mogelijkheid om van binnen uit het programma te analyseren en kennis te ontwikkelen die bijdroeg aan het begrijpen van de dynamiek van schoner produceren in MKB.

De onderzoeksvragen voor dit onderzoek zijn als volgt geformuleerd:

1. Hoe kunnen we verschillen in toepassing van milieuvriendelijke technieken in Middelgrote en Kleine Ondernemingen verklaren?

2. Hoe kunnen we verschillen in verbreiding van milieupreventie technieken door middel van publieke programma's gebaseerd op productie ketens, verklaren?
3. Hoe kan de integratie van productieketens en schoner produceren bijdragen aan de verbreiding van preventieve technieken in midden en klein bedrijf?

Een multidisciplinaire aanpak werd gebruikt om met behulp van de onderzoeksgegevens van het Mexicaanse programma de onderzoeksvragen te beantwoorden. Literatuur uit de bedrijfskunde en het vakgebied schoner produceren is gecombineerd in een theoretisch kader. In eerste instantie is een kosten- en baten-analyse gebruikt om verschillende projecten van schoner produceren te kunnen beoordelen. In tweede instantie is een model van lerende organisaties gebruikt om implementatie van schoner produceren binnen bedrijven te bestuderen. Daarnaast is de rol van grote leidende bedrijven binnen de productieketen bestudeerd met betrekking tot hun invloed op het verbreiden van schoner produceren binnen productieketens. Verder is de capaciteit van het MKB om samen te werken in de productieketen geanalyseerd. Deze vier kaders zijn geïntegreerd in een multidisciplinair en multi-niveau raamwerk voor verbreiding van schoner produceren in MKB.

Kwantitatieve en kwalitatieve onderzoeksmethodes zijn gebruikt om onderzoeksgegevens te verzamelen en te analyseren. Kwantitatieve informatie is gebaseerd op karakteristieken van veertien productieketens die in totaal 177 toeleveranciers omvatten. In de statistische analyse is gebruik gemaakt van beschrijvende indicatoren, cluster analyse en regressie modellen. Het kwalitatieve onderzoek is gebaseerd op interviews met managers van deelnemende bedrijven en observatietechnieken bij bedrijfsbezoeken. Twee workshops met stakeholders van het Mexicaanse programma zijn gebruikt om de uitkomsten van informatieanalyse te valideren. Gebaseerd op deze onderzoeksmethode zijn de volgende antwoorden op de onderzoeksvragen naar boven gekomen:

Redenen waarom sommige Middelgrote en Kleine Bedrijven preventieve technieken implementeren en andere niet.

Dit onderzoek meet de implementatie van schoner produceren aan de hand van verschillende niveaus van organisatieveranderingen die kunnen variëren van; (i) het verwerven van informatie, (ii) het toepassen van informatie tot (iii) het verbreiden van informatie binnen en buiten het bedrijf. De resultaten tonen aan hoe eigenschappen van bedrijven zoals de sector waar ze toe behoren, de aard van de toegeleverde producten en de implementatie van schoner produceren in de deelnemende bedrijven beïnvloeden. Bijvoorbeeld, toeleveranciers van verpakkingsmaterialen ondergaan meer diepgaande organisatieveranderingen dan toeleveranciers van de schoonmaaksector. De omvang van het bedrijf blijkt ook relevant te zijn; grotere bedrijven tonen meer diepgaande veranderingen dan kleinere bedrijven. Ook de ervaring en opleiding van de vertegenwoordigende deelnemers beïnvloeden het implementatieniveau van schoner produceren. Deelnemers met een gecombineerde technische en bestuurlijke achtergrond dragen bij aan meer diepgaande organisatieveranderingen dan deelnemers met een eenzijdige ervaring.

Kosten- en opbrengsten-analyses bewijzen op recycling georiënteerde projecten hogere milieurendementen hadden en economisch aantrekkelijker zijn in vergelijking met energie-efficiëntie projecten en waterbesparende toepassingen. Afvalbesparende projecten leiden tot hogere milieuwinsten en kostenreductie dan technologische en procesaanpassingen. Bovendien worden milieuwinsten en kostenreducties ook beïnvloed door de omvang van het bedrijf. Grotere bedrijven maken gemiddeld hogere winsten.

Redenen waarom sommigen productieketens meer bijdragen aan de verbreiding van schoner produceren tussen hun toeleveranciers dan anderen.

Verschillen in de toepassing van schoner produceren binnen groepen van toeleveranciers werd gemeten aan de hand van verwachtingen van managers van grote invloedrijke bedrijven. Dat werd gedaan door hun bijdrage aan het uitnodigen, voltooien, en implementeren van preventieve projecten door hun toeleveranciers te achterhalen. Resultaten van het onderzoek gaven aan dat de grote leidinggevende bedrijven geen eenduidige verwachtingen veronderstelden om aan het Mexicaanse programma deel te nemen. Ook hun mening over waargenomen bijdrages van hun programma deelname, liepen sterk uiteen.

Verdere resultaten lieten ook zien hoe voorafgaande productieketen ervaring van grote leidinggevende bedrijven, schoner produceren in het Mexicaanse programma versterkt. Een opmerkelijk resultaat is dat bedrijven die vertegenwoordigd werden door een team van milieu- en inkoopmanagers, minder verbreiding tonen dan bedrijven vertegenwoordigd door alleen een milieu manager. Ook geven de resultaten aan dat juist bij deze laatste groepen ook de uitval van toeleveranciers in programma kleiner was.

Verdere verklaringen omtrent verschillen in verbreiding van schoner produceren kunnen worden verklaard door de eigenschappen van de toeleveranciers die onderdeel zijn van de groepen. Sommigen beschikten over eigenschappen voor samenwerking die positief bijdragen aan het formuleren, communiceren en uitvoeren van schoner produceren projecten. Zo droegen toeleveranciers van materialen in hogere mate bij aan het toepassen van schoner produceren dan toeleveranciers van diensten zoals schoonmaak activiteiten, voedselvoorziening en consultancy.

Toeleveranciers die vertegenwoordigd werden door managers met een gemengd technisch en administratief profiel lieten hogere toepassingniveaus zien dan managers met een gespecialiseerde opleiding. Zo gaven technisch georiënteerde managers aan moeite te hebben met de communicatie van de resultaten van de door hen geformuleerde projecten, terwijl bestuurlijk georiënteerde managers meer moeite hadden met het formuleren van geavanceerde schoner produceren projecten. Bedrijven vertegenwoordigd in het Mexicaanse programma door twee of meer managers lieten in alle gevallen betere resultaten zien met betrekking tot implementatie

van schoner produceren, dan managers die als enige vertegenwoordigers van hun bedrijf aan het programma deelnamen.

Redenen waarom een gecombineerde aanpak van schoner produceren en duurzame productieketens bijdraagt aan de milieuverbeteringen binnen midden en kleine bedrijven in zich ontwikkelende landen.

Binnen de gecombineerde aanpak zorgt het duurzame productieketen perspectief ervoor dat groepen Middelgrote en Kleine Bedrijven bereikt kunnen worden, zonder dat de vaak gelimiteerde milieuoverheid een directe rol hoeft te spelen. Daarnaast zorgt het schoner produceren perspectief ervoor dat de bedrijven zelf ontdekken hoe milieuverbeteringen ook kostenbesparingen met zich mee brengen. Bovendien komen ze er achter dat samenwerking in groepen van toeleveranciers hun capaciteiten voor innovatie, het leggen van relaties en uiteindelijk hun concurrentiepositie versterkt. De uitkomsten van het onderzoek tonen verder aan dat schoner produceren en duurzame productieketens elkaar versterken. Daarom raadt dit onderzoek, met name in ontwikkelingslanden, een gecombineerde aanpak van beide perspectieven aan als kader voor het verbreiden van milieuverbeteringen in MKB's en kleine bedrijven.

Binnen dit kader spelen organisatorische kwaliteiten van bedrijven een centrale rol, naast technische en economische mogelijkheden. Daarom wordt aangeraden om bij milieuverbetering bij Middelgrote en Kleine Bedrijven nadruk te leggen op het versterken van capaciteiten en leerervaringen van bedrijven. Verder kunnen grotere leidinggevende bedrijven bij verbreidingsprogramma's´ betrokken worden door nadruk te leggen op proactief leiderschap, samenwerking met milieuoverheden, kostenbesparingen bij en integratie van toeleveranciers.

Dit onderzoek introduceert een nieuwe manier van denken over hoe milieuverbeteringen verbreid kunnen worden in Middelgrote en Kleine Bedrijven. Het gepresenteerde kader stelt een aanpak voor die verschillende niveaus en disciplines van een industriële productie keten beschouwt. Deze bijdrage is gebaseerd op de aanname dat niet alleen kostenoverwegingen, maar ook het lerend vermogen van organisaties een doorslag gevende rol speelt in de implementatie van schoner produceren in bedrijven. Deze aanname breekt met de traditionele gedachte binnen de schoner produceren literatuur die veronderstelt dat het belangrijkste argument om preventieve milieu verbeteringen door te voeren kostenbesparingen zijn.

Een verdere bijdrage is de constatering dat eigenschappen van bedrijven en managers implementatie van schoner produceren beïnvloeden. Hierdoor kan een zorgvuldige selectie van bedrijven en deelnemers de resultaten voor verbreidingsprogramma´s positief beïnvloeden. Gebaseerd op empirisch bewijs, toont dit onderzoek aan waarom het belangrijk is om bedrifskundige theorieën te overwegen in het verbreiden van milieuverbeteringen in Middelgrote en Kleine Bedrijven in zich ontwikkelende landen.

Aanbevelingen voor verder onderzoek omvatten in eerste instantie de mogelijkheid van het analyseren van de verbreiding van schoner produceren in latere fases van het Mexicaanse programma. In de periode na 2008 tot op heden is het programma

uitgegroeid tot één van de omvangrijkste initiatieven die milieuverbeteringen in het MKB nastreven. Aan het programa werkten mee, meer dan 300 betrokken grote leidinggevende bedrijven, 500 groepen van toeleveranciers en 6.000 toeleveranciers die gezamenlijk meer dan 10.000 projecten geformuleerd hebben gebaseerd op het schoner produceren perspectief. Daarnaast kan het van belang zijn om de bedrijven die zich uit het programma teruggetrokken hebben verder te analyseren. Kennis gebaseerd op hun overwegingen kan verdere informatie opleveren voor het begrijpen van bedrijfsprocessen die te maken hebben met het doorvoeren van milieuverbeteringen.

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Acronyms and Abbreviations

CEC	Commission for Environmental Cooperation of North American
CP	Cleaner Production
ECLAC	Economic Commission for Latina America and the Caribbean
EHS	Environmental, Health and Safety
GEMI	Global Environmental Management Initiative
IADB	Inter American Development Bank
IE	Industrial Ecology
MSSP	Mexican Sustainable Supply Programme
NAAEC	North American Agreement on Environmental Cooperation
NPV	Net Present Value
OECD	Organization for Economic Co-operation and Development
PROFEPA	Procuradoria Ferderal Para el Ambiente [Federal Environmental Attorney]
PVEI	Public voluntary environmental initiative
SEDESU	Secretaria del Desarrollo Sostentable del Estado de Queretaro [Secretary of Sustainable Development of the Queretaro State]
SEMARNAT	Secretaria de Medio Ambiente y Recursos Naturales [Secretary of Environmental Affairs and Natural Resources]
SME	Small and Medium-sized Enterprise
SSCM	Sustainable Supply Chain Management

1. Introduction

This research is about small- and medium-sized enterprises (SME) and their differential performance in the dissemination of preventive environmental practices. It was designed to gain an understanding of why some SMEs improve their environmental standards and others fail to do so. New thinking is proposed, based on a managerial perspective of cleaner production and sustainable supply chain concepts, as well as their interaction. Outcomes of a Mexican sustainable-supply programme for dissemination of preventive environmental practices served as the setting. To introduce the topic, this author begins by describing what led him to develop the thesis, followed by a statement of the theoretical problem, the research questions posed, overall relevance of the study, and the thesis outline.

1.1 Motivation for developing this thesis

SMEs[1] are considered cornerstones of sustainable development (Blackman, 2006). Because they represent about ninety-nine percent of all enterprises worldwide, they embody an important source of employment generation in scores of countries (Newberry, 2006). SMEs are also known to be an important source of environmental contamination; Hillary (2000) estimates they are responsible for about 30 percent of the environmental load discharged by industry.

Efforts to improve SME's environmental performance have been under way in most Latin American countries from the mid- to late nineties (Fernández-Viñé et al., 2010; Blackman et al., 2013). These efforts included developing regulatory mechanisms related to standards for sewage, airborne emissions, waste disposal, and more recently, producer responsibility (Espinosa and Rodriguez, 2003; Milanez and Buhrs, 2009; Lindhqvist et al., 2008). Economic incentives, such as tax reductions for acquisition, installation and usage of environmentally friendly technologies, have also been implemented (Herrera, 2005; Romo, 2005); some countries offer subsidies for clean technology implementation (Grutter and Egler, 2004; Blackman, 2000). Despite these efforts, improving the environmental performance of Latin American SMEs remains challenging; Vives, et al. (2005) showed that only about 30 percent of a sample of 1,300 SMEs in five Latin American countries undertook environmental protection practices.

- *Conventional drivers for environmental improvement fail to reach SMEs*

Several reasons explain why improvement of environmental performance of SMEs is challenging. SMEs are short on resources and organizational capability when compared to larger firms (Jenkins, 2004). Smaller companies generally have less financial slack, and retained earnings with which to deploy environmental improvement programmes or to invest in cleaner technologies (Mitchell, 2005). Additionally, their human resources are typically less well trained and less specialized, which explains why most technical assistance programmes rely for improvement on (costly) external consultants (Parker and Redmond, 2009; Batra and Mahmood, 2003; OECD, 1997). Some SMEs are more flexible with respect to change and innovation (Moore and Marning, 2008), but they are the exceptions.

Other drivers of environmental improvement – e.g., complying with environmental regulations, fulfilling market or neighbourhood community expectations – seldom apply to SMEs. In emerging economies, environmental authorities find it burdensome to oversee these firms (Blackman et al., 2010; 2006; 1997; Leal, 2005), blunting one of the traditional drivers for environmental improvement (Boons and Baas, 2004; Baas, 2005). Even worse, imposing environmental demands on these firms is not generally

[1] Official definitions of small- and medium-sized enterprises differ widely; generally in developed countries, employment reaches up to 500 and annual turnover up to USD 20 million (Ayyagari et al., 2007). In emerging economies, as in most Latin American countries, official SME statistics define smaller firms as up to 250 employees, and annual turnover of about USD 2 million (Vives et al., 2005; Zevallos, 2003).

politically acceptable. For SMEs in Latin America, the traditional driver of regulatory enforcement is almost non-existent (Maranto-Vargas and Gomez, 2007; Wells and Galbraith, 1999).

Moreover, in most emerging economies, SMEs tend to serve local markets where environmental advocacy or pressure from local customers is lacking (Fundes, 2003; Grotz and Braun, 1993). Also, non-governmental organizations (NGOs) and communities are often too weak to impose meaningful pressure on SMEs (Blackman, 2006; Londoño Toro, 2008). Compounding matters, transparency and availability of environmental information is often scarce in developing countries (Ehrenfeld et al., 2002). In light of these challenges, SMEs in emerging markets are virtually untouched by traditional drivers of environmental improvement of local companies.

- *Cleaner Production as a viable alternative*

Cleaner production (CP) has been heralded as a powerful strategy to improve environmental performance of firms (Baas, 2006), insofar as CP almost always generates economic benefits along with environmental improvements (Baas, 1998). Hence CP is a potentially attractive strategy for companies wishing to spur continuous improvement. Examples of CP include changes in management or operational procedures that spawn improved efficiency in the use of raw materials, energy, and water, by recycling waste and installing cleaner technologies. CP relates to Industrial Ecology (IE); an emerging field where innovation produces tools and perspectives related to industrially-oriented human activities and the environment (Erkman, 1997; Geardel and Allenby, 2002). As with CP, IE aims at preventive practices by closing material cycles, and stimulating symbiosis between/among industries and stakeholders (Ehrenfeldt, 2004; Boons and Howard-Grenville, 2009).

Developing CP implies design and implementation of new projects. Implicit in such implementation is a process of organizational change, whereby management and key staff develop, apply, and monitor improvements stemming from new operational routines (Vickers and Cordey-Hayes, 1999). This triggers breakthroughs in existing routines, learning processes, and prevailing paradigms (Baas, 2006). CP dissemination occurs when firms participate in programmes aimed at the design and implementation of preventive measures within their production activities (Baas, 2006).

Numerous countries and international organizations have recognized the CP promise as a strategy for complementing environmental regulatory instruments (UNEP, 2004). Accordingly, a number of national and regional authorities have adopted CP policies (Leal, 2006), and a global network of CP centres links multilateral organizations and development banks in over 100 countries (Ehrenfeldt et al., 2002). These national and international initiatives were designed to disseminate CP by persuading firms to adopt the strategy on a voluntary basis.

Traditional CP dissemination schemes generally feature external consultancy services and dissemination of information (Baas, 2006). Typical services include information

diffusion by means of workshops and seminars for managers and plant personnel, training local consultants, and developing demonstration projects. The United Nations Environmental Programme offers a 5-step CP intervention process entitled "How to establish and operate cleaner production centres" (UNEP, 2004). The method involves planning and organizing the CP intervention, a pre-review of production facilities followed by detailed assessment, a feasibility analysis of proposed projects, and follow-up visits to verify implementation and enhance continuous improvement UNEP, 2004: 116). Tools employed include eco-maps, eco-balances, cost and risk assessment, and environmental indicators.[2]

An assumption of traditional dissemination is that CP implementation requires specialized knowledge on how to organize, assess and propose projects. External specialized consultants carry out pre-assessments, gauge viability, and propose project-based interventions. Consultants are advised to collaborate closely with plant staff and estimate "appropriateness" (UNEP, 2004). Other assumptions of traditional methods are that economic and environmental benefits resulting from CP interventions suffice to motivate management decision-making; hence disseminating success stories of firms adopting CP practices are viewed as key mechanisms to spread the CP promise (Baas, 2006). Complementary strategies, such as knowledge management, policy advice, interfacing with financial institutions and matchmaking for networking, are proposed as secondary approaches for CP dissemination (UNEP, 2004).

Reviews of programmes that follow traditional dissemination schemes reveal modest outcomes: Dieleman (2007) found that less than 40 percent of firms receiving CP technical assistance improved performance; Stone (2006a) and Sage (2000) found even lower success rates. Yet impact assessments of CP dissemination programmes and mechanisms are scarce (Van Berkel, 2006; Dieleman, 2007; Baas; 2006; Stone, 2006a). Indicators generally include firms assisted, number of people trained, and number of guides published; quantitative environmental and economic feedback have seldom been obtained, nor have there been many studies that evaluated levels of CP implementation. The latter are indispensable to understand CP intervention effectiveness and efficiency.

Several reasons are offered for the gap between CP dissemination rates and the potential improvement levels gleaned from theoretical and practical possibilities (Zilahy, 2004). Some note context constraints, such as lack of incentives (Hitchens et al., 2003), or the ineffectiveness of traditional dissemination mechanisms that rely on technical tools, downplaying organizational capabilities and change processes (Dieleman, 2007; Stone, 2006a, 2006b; Baas, 2006, 2005). Other reasons for the gap in CP dissemination range from firm- or manager-related shortcomings to limited financial resources or time to enact CP measures (Mitchell, 2005; Hitchens et al., 2005; Frijns and Van Vliet, 1999), competing options for management decision-making

[2] Eco-mapping is a CP tool for identifying and prioritizing environmental impacts and resource consumption in a geographic area; eco-balance, or mass and energy balance, is another CP tool used to estimate efficiency of specific processes; inefficiency costing is an accounting technique that values the cost of waste and inefficiencies that occur in production processes (Van Hoof et al., 2008).

(Vives, 2006:39), unawareness of CP benefits and methods, and poor staff motivation (Stone, 2006b; Baas, 2006).

Reflecting on these constraints to the presumed drivers yields little insight into understanding the dynamics and explanatory variables of why some firms improve their environmental performance and others do not (Stone, 2006a; Baas, 2006). Numerous success stories show that preventive environmental practices help some firms improve environmental and economic performance, but we lack knowledge of the challenges entailed in disseminating these practices among a critical mass of SMEs.

1.2 Problem statement

This research was designed to provide a new understanding of why some SMEs adopt preventive environmental practices while others fail to do so, and to explore ways for improving the environmental performance of SMEs in the context of emerging markets. A managerial perspective was employed, which was built upon a comprehensive review of the relevant literature on CP dissemination (e.g. Baas, 2006; Stone, 2006a) and sustainable supply chain management (SSCM) (e.g. Carter and Rogers, 2008; Seuring and Müller, 2007).

Historically, CP, as an operational approach to sustainability, evolved from engineering and consultancy (Hirschhorn, 1995, 1997); while in firms and society, social science frameworks (Boons, 2009; Baas, 2006) and management theories (Vickers, 2000; Zilahy, 2004) have been used to explain CP development. Baas (2006) provided a theoretical framework that described the transition process of new concepts, such as CP. Building on a sociological perspective, he described how ideas permeate markets and change existing routines into new practices; he described dissemination as a process of breaking through existing routines to achieve novel learning processes and paradigm shifts. Constraints in the dissemination process include information processing, social dilemmas, stakeholder perceptions, power structures, and institutionalization (Baas, 2006). While technical assistance, demonstration projects, practitioner seminars, and information supply were identified as essential CP dissemination mechanisms (Baas, 2006).

Boons et al. (2011) introduced a comprehensive framework such as industrial ecology efforts by regional industrial systems for analyzing changes in CP-related approaches at a societal level. The literature provided a theoretical foundation for understanding the dynamics underlying changes in communication channels among actors, and how this reduces ecological impact (Boons et al., 2011). Social embeddedness was identified as a conditional factor influencing dissemination, whereas institutional capacity-building was proposed as a mechanism for the transmission of concepts related to CP. Outcomes included changes in social systems, as shown by diffusion of concepts, knowledge, relational and mobilization resources (Boons et al., 2011). Internal and external barriers were also identified as constraints in CP dissemination

practice, but the framework fell short on explaining the underlying dynamics of the drivers and barriers for SME implementation of CP.

Other authors, e.g., Dobes, (2012, 2001), Dieleman (2007), Stone (2006a, 2006b), Zilahy (2004), and Vickers (2000), recommended organizational theory for gaining an understanding of the dilemmas, barriers and drivers around CP dissemination in firms. Findings from these studies underscored the influence of organizational features, such as leadership, cultural awareness, organizational structure, information feedback loops, and empowerment. Insufficient organizational learning was found to explain limited outcomes of CP application (Clark and Roome, 1999; Stone, 2006a). Most of these studies were descriptive, and correctly proposed the need to integrate managerial frameworks into the CP literature; yet no author employed empirical validation in the development of new theory (Bacharach, 1989). Complementary studies of the relationships between organizational features and CP dissemination mechanisms have been scarce thus far (Stone, 2006a; Van Berkel, 2006).

Scholars have reviewed the CP-related field of sustainable supply chain management (SSCM) for over fifteen years (Gold et al., 2010). SSCM approaches have been found to be useful for improving environmental, social, and economic performance within a supply chain context (Carter and Rogers, 2008). The central idea of this approach refers to the role of supply chain management as a catalyst for generating inter-organizational value and sustainable inter-firm competitive advantage by means of collaboration between the focal organization and its market partners on the supply and distribution sides of the chain (Gold et al., 2010).

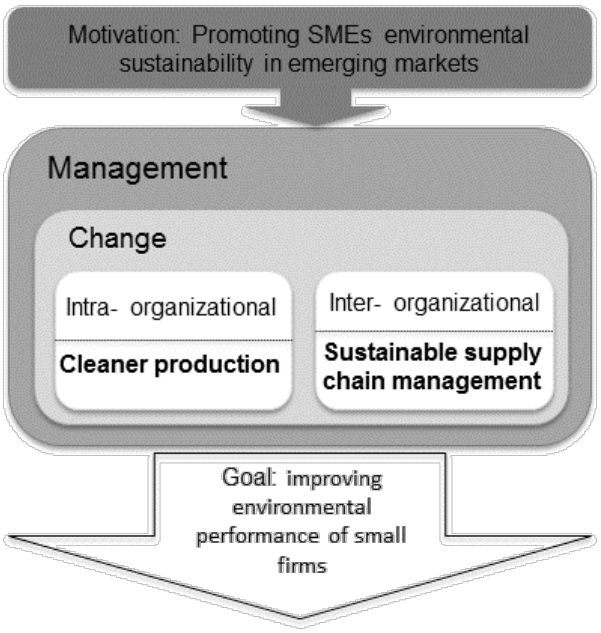
Suering and Müller (2008) proposed SSCM as a mechanism for disseminating environmentally friendly practices among firms. They described how incentives and pressures for improvement of sustainable performance transit from markets to anchor companies to suppliers (Seuring and Müller, 2008). In noting that supply chain professionals are uniquely placed to impact sustainable practices, Carter and Rogers (2008) proposed a framework that integrates sustainability with supply chain management. In charting new theory, they cited management strategy, organizational culture, transparency, and risk management as key tools for generating economic, social and environmental value along the entire supply chain (Carter and Rogers, 2008).

Other relevant research addressed such fields as sustainable supply practices (Mollenkopf et al., 2010; Andersen and Skjoett-Larsen, 2009; Srivastava, 2007; Welford and Frost, 2006), SSCM drivers and barriers (Hu and Hsu, 2010; Cai et al., 2010; Mont and Leire, 2009; Walker et al., 2008; Kovacs, 2008; Lee, 2008), decision-making in SSCM (Sarkis, 2002; Chen et al., 2004), and organizational resources influencing SSCM (Zhu et al., 2010; Vachon and Klassen, 2008, 2006a, 2006b; Bowen et al., 2001; Hines and Johns, 2001).

Most of this research, as well as advances in SSCM theory, focused largely on the anchor company, the internal dynamics of suppliers or other stakeholders. Moreover,

a clear link between the two fields of CP and SSCM has not yet been adequately researched. That being the case,, this thesis proposes to bridge the existing fields of CP and SSCM thereby contributing to new thinking for the dissemination of preventive environmental practices.

Accordingly, this thesis provides insights from an extensive review of the CP and SSCM literature. Each of the fields features its own management framework for understanding such organizational and inter-organizational dynamics as may contribute to improve environmental performance. Reviewing CP and SSCM in light of the management literature helped the author obtain new insights for disseminating preventive environmental practices within SMEs. Fortuitously, the managerial perspective provided a method for integrating the two fields. Figure 1.1 presents the problem statement, the theoretical means, and the new thinking proposed in this thesis.



Source: Author

Figure 1.1 The theoretical approaches used in this thesis

The Mexican Sustainable-Supply Programme (MSSP) was selected as the basis for this research. To improve the environmental performance of SMEs, the MSSP was designed to combine the CP and SSCM concepts. The programme was launched in 2005 by the Commission of Environmental Cooperation in North America (CEC), part of the North American Agreement on Environmental Cooperation (NAAEC). In 2008, Mexico's Secretariat of Natural Resources (SEMARNAT), a member of the CEC Board, and Federal Protection Agency (PROFEPA) undertook to promote the programme on a national scale, as part of the National Development Plan of President Felipe Calderon's government. CEC, and subsequently SEMARNAT and PROFEPA, sought to foster the dissemination of environmentally preventive practices among Mexican firms.

The MSSP can be seen as a "critical case" (Flybjerg, 2006), useful to provide logical deductions: MSSP objectives were comparable to those of other types of CP dissemination initiatives designed to build upon technical assistance methods described earlier. This characteristic enabled comparison of research findings and their construct validation as a criterion for the research design (Rowley, 2002).

From the start, the scale of MSSP was significant; a three-year pilot phase, led by CEC from August 2005 to May 2008, which featured fourteen anchor companies and 177 suppliers. Thereafter, SEMARNAT and PROFEPA continued the programme across Mexico, reaching out to some 400 different anchor companies and 6,000 suppliers by December 2012. The design remained the same throughout the programme. Detailed information on participating company characteristics provided a solid foundation for deploying a combination of quantitative and qualitative study methods. These multiple sources supported internal and external validity for the in-depth data analyses (Rowley, 2002).

Insights drawn by the thesis author from assumptions made in MSSP design as a tool for CP dissemination were an outcome of his participation in the planning and development of the programme. This first-hand experience provided the researcher privileged access to key information and facilitated interpretation of research outcomes, in a manner similar to an action researcher (Berg, 2008). This constructive view of research implies abstracted theory to be empirically valid (Eisenhardt, 1989).

1.3 Research questions

The central question of this study was:

How can improvement of environmental performance of SMEs in emerging markets be achieved?

Three sub-research questions were used to dig more deeply into the joint domain:

1. How can differential performance outcomes among SMEs in the implementation of preventive environmental practices be explained?
2. How to explain differential dissemination-performance of firms participating in public voluntary environmental initiatives aimed at sustainable supply chain management?
3. How can initiatives combining CP and SSCM contribute to dissemination of preventive environmental practices in SMEs?

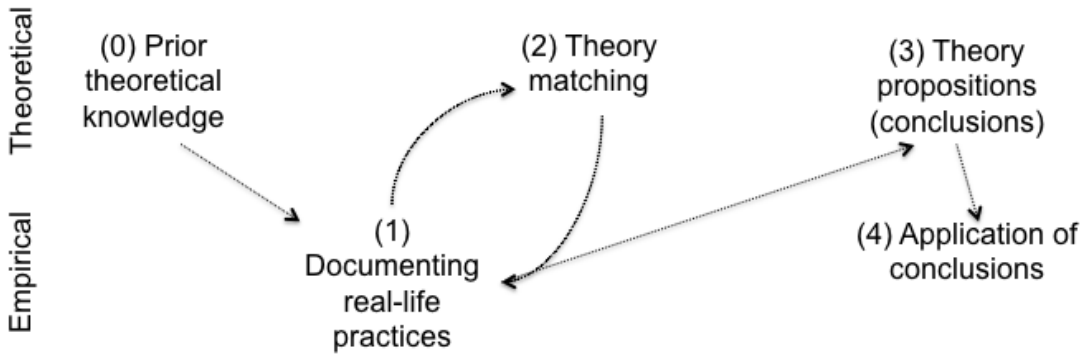
1.4 Research methodology

The central focus of this study is to identify what explains differential performance among firms participating in sustainable supply networks such as the MSSP. By understanding the underlying dynamics and explanatory variables influencing implementation of preventive environmental practices, this study proposes theoretical

underpinnings for improving environmental performance of small firms in supply networks.

Abductive reasoning was selected as a research strategy. This constructive research approach combines patterns of deduction and induction, and is useful for theory building in areas for which theory is lacking or existing theory is inadequate (Kirkeby, 1994). Both statements apply to CP through SSCM as an operational approach for a firm's sustainability.

Abductive reasoning emphasizes the search for suitable theories to track an unobvious empirical observation through "theory matching" or "systematic combining" (Dubois and Gadde, 2002). In this process, data collection and theory building take place simultaneously, which implies a learning loop. This interactive aspect between theory and empirical study is similar to methods used in action research, and is found in case-study research (Kovacs and Spens, 2005). The abductive process closes with the application of propositions in an empirical setting (Kovacs and Spens, 2005). The latter authors propose this reasoning for theory development in fields related to this study, such as logistics. Figure 1.2 presents the abductive research process applied in this research.



Source: adapted of Kovacs and Spens, 2005

Figure 1.2 The abductive research process used in this study.

- *Prior theoretical knowledge*

In this thesis's methodology, the starting point at which an empirical observation does not match prior theories derives from the researcher's participation in the planning and development of the MSSP. Previous theoretical knowledge resulting from ten years of experience as a consultant for CP implementation, and subsequently as a project director, influenced the author's intuitions, assumptions and contributions made as MSSP design was under way:

A first assumption of the MSSP design was that all staff involved in a firm's operational activities could propose CP options, and seek to learn how these could be designed and implemented. CP knowledge is thus viewed as complementary to other professions, not as a different field. Explicit knowledge of basic CP tools can be learned and applied by a plant's workforce. Although consultants were employed to lead programme workshops, they were not involved in CP implementation at participating firms.

A second assumption considered CP implementation as a progressive change process. Small, incremental CP adjustments can trigger transformational changes within companies. The most appropriate CP alternative is one that fits the specific situation of the firm at a certain point in time, and triggers support from plant management and staff. The best CP alternatives do not need to hinge on some advanced technical solution.

A third assumption related CP to the firm's competitive context. This implies that initial assessment must prioritize competitive forces and detect how CP can contribute to overcome them. Traditional assessment tools, such as eco-maps and eco-balances, are coupled with inefficiency cost estimates in identifying and selecting CP opportunities. Plant staff must be challenged to identify critical points where CP-added-value is most strategic.

A fourth assumption proposed that positive cost-benefit analysis alone does not suffice to make decisions on CP implementation. Complementary drivers based on supply chain relationships, references to supply chain peers, and network relationships are relevant factors to consider as decisions are made.

A fifth assumption considered CP implementation as a complex, integrated process, where social, organizational and technical aspects related to CP implementation constantly interact and influence motives for decision-making and capacity for action – a cyclic process, sensitive to guidance, that develops over time. Upfront management commitment, identified as a precondition in traditional mechanisms, does not necessarily ensure CP implementation; instead, management commitment evolves gradually.

A sixth assumption was that the dissemination mechanism for CP implementation had to be transferable and scalable, and reach out to a significant group of SMEs in the Mexico City-Queretaro region. A central intranet platform was used to transfer methodology and training materials, facilitating programme coordination and knowledge management among service providers.

Once MSSP was under way, the researcher noted early on that a significant group of firms achieved higher levels of commitment in comparison to earlier experiences based on traditional dissemination schemes. Accordingly, the researcher found the MSSP to be a rich context for undertaking multilevel and multidisciplinary research in CP dissemination among suppliers.

- *Documenting real-life practice*

Complementary quantitative and qualitative research strategies were used to document the real life experience of the MSSP. Data were gathered about independent and dependent variables at the individual level of participating managers, firms, supply groups, and the programme as a whole. A combination of research strategies provided insights into understanding quantitative outcomes (Berg, 2004), and in-depth understanding of CP dissemination as a complex and dynamic process (Senge et al., 1999). Accordingly, data gathering combined different sources in order to gather a rich overall picture (Eisenhardt, 1989):

1. ***Literature review***: an extensive literature review was undertaken to identify and match relevant CP and SSCM theory useful to explain dynamics observed. Discussion of the literature is presented as complementary conceptual frameworks in chapters 2, 3, 4 and 5. In this way, four different bodies of literature were reviewed. Academic journals featuring content used for analysis included the *Journal of Cleaner Production, Business Strategy and the Environment, Journal of Operations Management, Academy of Management, Journal of Business Ethics, Sustainable Development and Journal of Small Business Management*, among others. Complementary field reports published by organizations such as World Bank, Economic Commission for Latin America and the Caribbean (ECLAC), Inter American Development Bank (IADB), Organization for Economic Co-operation and Development (OECD), and specialized books, were reviewed.

2. ***Quantitative research***: several sources were used to construct a database featuring independent and dependent variables. MSSP data included information for 14 supply groups totaling 177 suppliers. Data were gathered as follows: all firms participating in the programme filled out an intake form, reporting main activity, industrial sector, number of employees, and number of participants taking part in the programme. Another source of information drew on the presentation of project(s) designed during the 10-session workshop-training programme, featuring detailed information about the type of CP to be implemented, estimated investment, and expected economic and environmental benefits.

   To obtain feedback on CP project implementation levels, follow-up questionnaires were mailed to all participating companies. Questionnaires were sent to an early group of participating firms in March-June 2007, and a second questionnaire to subsequently enrolled participants in August-September 2008. Follow-up calls and data collection were carried out free from any intervention on the part of participating anchor companies.

   An additional survey instrument was employed to measure participant perceptions regarding CP concepts and tools learned, skills acquired to apply them, factors influencing learning experience, and other professed outcomes of programme participation. Measures used to gauge perceived learning followed Likert-scales.

The questionnaire provided additional space for participants to express open-ended comments.

3. ***Qualitative research***: Qualitative data was gathered a posteriori by means of two complementary research instruments. Semi-structured interviews were employed to gauge perceptions and opinions of managers of participating anchor firms. Interviews focused on background information, reasons for participation, and perceived benefits; respondents included two directors general, two technical directors, one corporate sustainability director, and four environmental health and safety directors. Representatives of anchor companies participating twice in the pilot were interviewed once, following the second participation.

- *Theory matching*

Following the abductive research approach, a creative, iterative process of "theory matching", or "systematic combining", began with an attempt to find a new matching framework, thus extending theory used prior to observation; hence the aim was to understand the phenomena and suggest new theory (Kovacs and Spens, 2005). Four different management frameworks are developed to understand organizational and inter-organizational dynamics as they occurred in the MSSP:

Chapter 2 covers the cost-benefit analysis employed to examine differential performance and outcomes for different types of CP projects. Literature on CP typologies (Van Berkel, 2006; Dobes and De Palma, 2010), and cost-benefit analysis (Hong Nath, 2007; Nazer, 2006; Hedge et al., 2000) was cross-referenced in comparing CP typologies. Based on empirical evidence, additional relationships were established between organizational characteristics and typologies.

Chapter 3 builds on organizational learning theory used for sociological explanations of CP implementation in firms (Vickers and Cordey-Hayes, 1999; Vickers, 2000; Remmen and Lorentzen, 2000; Zilahy, 2004; Baas, 2006; Stone, 2006a, 2006b; Dieleman, 2007). Heretofore, this literature has focused largely on theoretical reflections on programme design and outcomes. Research presented in this chapter proposes a new approach that fully integrates organizational learning concepts within dissemination mechanisms such as the MSSP.

Chapter 4 focuses on the inter-organizational dynamics involved in dissemination efforts such as the MSSP. Literature on public voluntary environmental initiatives (PVEI) reviews reasons for firms participating in such initiatives (Lyon and Maxwell, 2007; Blackman et al., 2010; Jiménez, 2007; Rivera, 2004). Similarly, SSCM literature cites drivers that presumably influence anchor companies seeking sustainable supply (Zhu et al., 2010; Walker et al., 2008; Hu and Hsu, 2010; Lee, 2008; Seuring and Müller, 2008; Carter and Rogers, 2008; Sarkis, 2002). Yet little is known about companies joining PVEI designed as SSCM and aimed at disseminating preventive environmental practices in small firms.

Chapter 5 explores the collaborative capacity of small- and medium-sized firms as a newly proposed concept to gauge their capability to join sustainable supply chain initiatives. Heretofore, literature generally addresses the technical aspects of environmental improvements of individual firms, focusing on anchor companies, leaving out small suppliers, and overlooking inter-organizational dynamics (Baas, 2006; Stone, 2006; Mitchell, 2005; Boons and Baas, 1997; Vachon and Klassen, 2008; Suering and Müller, 2008; Carter and Rogers, 2008; Sarkis, 2002; Bowen et al., 2001).

- *Documenting real-life practices - data analysis*

Analysis of firms' iterative documentation practices provided deeper understanding of the MSSP by validating the complementary frameworks proposed. Econometric analyses were applied to assess the database and understand relationships between independent and dependent variables. As the database typically contains one data point per firm, analysis took a cross-sectional approach rather than a panel approach.

Various statistical methods were used in quantitative analyses: Linear regressions were applied to assess cost-benefits of CP interventions and supplier dropout; and probit models were applied to examine the fit of the database to a theoretical model. Also, cluster analysis was performed to distinguish differences in dissemination performance among supply groups. Respecting qualitative data collection, interview responses were transcribed and analyzed in light of the research framework selected, as recommended in the literature (Berg, 2004).

Lastly, the author's previous experience with CP dissemination, together with his participation in the design and development of the MSSP during 2005-2008, provided detailed insights and first-hand experience in programme dynamics. It also helped him in the process of validating the database and interpreting outcomes of quantitative and qualitative analyses.

- *Theory propositions*

Theoretical propositions were formed from logical deductions of study outcomes presented in chapters 2–5. Content of these chapters was submitted independently to academic journals. The propositions of this thesis, part of new theory, were validated by quantitative analysis based on the integration of the outcomes of the self-directed studies. Final conclusions were drawn by addressing the research questions that guided the overall study.

- *Application of conclusions*

This thesis presents an academic process and therefore the application of its conclusions in practice is beyond the scope of this document. Nonetheless, the recommendations of this thesis will be presented to SEMARNAT and PROFEPA, the governmental agencies in Mexico that continue to lead the MSSP.

1.5 Relevance

The outcomes of this study address two broadly defined audiences: first, practitioners interested in environmental improvement of SMEs; and second, scholars concerned with research. The following actors can be identified in the first group:

- *Policy makers*: findings demonstrate an innovative, scalable approach to improve SME performance to complement environmental regulation. A sustainable supply approach for CP implementation allows for efficacy and efficiency as a policy instrument.
- *Anchor company managers*: findings corroborate opportunities for efficiency improvements among suppliers, highlighting benefits of collaborative actions. Detailed guidelines are provided for anchor companies interested in the design of sustainable supply programmes.
- *SME managers*: findings point to areas of opportunity to implement cleaner production measures within firms. Also, detailed guidelines are provided on how to organize an internal CP strategy.
- *Consultants, service providers*: findings introduce an innovative strategy to scale the scope of consultancy services from a single client to groups of firms. Additionally, findings emphasize training services based on learning-by-doing, instead of technical assistance.

For an *academic audience* and future research the study provides:

- Theoretical underpinnings for CP implementation based on management literature.
- Frameworks for the assessment of learning and benefits of CP interventions.
- Empirical evidence for understanding variables influencing CP implementation in SMEs.
- Empirical evidence for understanding variables influencing sustainable supply chain management.

1.6 Scope and limitations

New thinking proposed by this thesis is abstracted from specific MSSP experience. Research design followed criteria for theory construction from case study research (Eisenhardt, 1989; Rowley, 2002; Flybjerg, 2006). Nonetheless, findings are subject to the following limitations:

- The research involves SMEs participating in global supply chains in Mexico. In general, each firm fulfilled selection criteria on reliability and quality audits required by anchor companies. These “best in class” firms differ from small companies that only serve local markets.
- The findings apply to the Mexican context, in particular to the Federal District and the state of Queretaro. Context drivers and barriers may vary in emerging markets even among regions within a country.

- The use of a control group was outside the scope of this research. Hence the findings only relate to participating firms.
- The role and differential performance of service providers and other MSSP stakeholders were not studied in this thesis, even when these might have influenced CP dissemination among participating firms.

1.7 Content

Chapter 1 introduces this thesis by reviewing the author's motivation for undertaking the research, outlining a statement of the problem, posing research questions, presenting research methodology, describing relevance and scope, and noting research limitations.

Chapter 2 assesses the environmental and economic costs and benefits of cleaner production projects formulated by SMEs participating in the MSSP. The programme is described as a public-private voluntary partnership to spur cleaner production dissemination in SMEs that are part of global supply chains. The chapter analyzes how project benefits varied as a function of different types of cleaner production applications, company characteristics, and participant profiles. CP literature was used as the framework of analysis.

Chapter 3 assesses organizational learning in cleaner production among suppliers participating in the MSSP. The chapter demonstrates how organizational double-loop learning was attained in a programme employing blended learning methods, with supply networks as a cleaner production dissemination vehicle. Insights were generated into how characteristics of participating supply firms and their managers influenced organizational learning in cleaner production. Concepts drawn from organizational learning theory were used as the framework of analysis.

Chapter 4 examines the reasoning that led anchor companies to participate in the MSSP, together with perceived benefits following completion. Additionally, anchor company differential contribution to CP dissemination among supply groups is examined. The research framework drew on literature for both voluntary environmental initiatives and sustainable supply chain management. Information used for outcome assessments combined responses to semi-structured interviews and statistical analysis of a consistently measured database.

Chapter 5 assesses the collaborative capacity that SMEs seeking to join sustainable supply chains serving global markets must develop. Supply chain and organizational literature were used to define the concept of collaborative capacity which measures a firm's capability to undertake operations, communications, and cooperative routines required for implementing CP initiatives.

Chapter 6 integrates the outcomes of chapters 2–5. The aim is to understand the relationship between two complementary fields, CP and SSCM, used to improve environmental performance of SMEs. Results provide evidence for cleaner production

as a strategy for sustainable supply, and sustainable supply as a mechanism for CP dissemination.

Chapter 7 presents the conclusions, with recommendations for future research. Research questions are reviewed in light of findings presented in earlier chapters, and a comprehensive contribution to knowledge is summarized. Table 1.1 presents the structure of this thesis in relation to the research questions.

Table 1.1 Thesis structure

Research questions		Chapter	Concepts
How can an improvement in the environmental performance of small firms in emerging markets be achieved?	1. How can differential performance outcomes among SMEs in the implementation of preventive environmental practices be explained?	2. Costs and benefits of cleaner production in small firms taking part in the Mexican Sustainable Supply Programme	• Cost-benefit
		3. Organizational learning in Cleaner Production among Mexican supply networks	• Organizational learning
	2. How to explain differential dissemination-performance of firms participating in public environmental voluntary initiatives aimed at sustainable supply chain management?	4. Dissemination of sustainable practices among suppliers – experience from in Mexico	• Supply chain management
		5. Collaborative capacity for sustainable supply: small firms in Mexico	• Collaboration capacity
	3. How can initiatives combining CP and SSCM contribute to dissemination of preventive environmental practices in SMEs?	6.Supply networks for cleaner production	• Integrated framework among cost-benefit, organizational learning, supply chain management, collaboration capacity

2. Costs and Benefits of Cleaner Production in Small Firms taking part in Mexico´s Sustainable Supplier Programme[3]

This chapter assesses the environmental and economic costs and benefits of cleaner production projects formulated by small- and medium-sized enterprises (SMEs) participating in a sustainable supply programme in Mexico. Cleaner Production literature and cost-benefit methods were used as frameworks for analysis. The findings present how project benefits varied as a function of different types of cleaner production applications, company characteristics and participant profiles.

[3] The text of this chapter is based on an article published with co-author Thomas Lyon, Dow Professor, Ross Business School, University of Michigan: Van Hoof B, Lyon TP. 2013. Cleaner production in small firms taking part in Mexico's Sustainable Supplier Programme. Journal of Cleaner Production, 41: 270-282. DOI: 10.1016/j.jclepro.2012.09.023

2.1 Introduction

Small and medium sized enterprises (SMEs) are considered cornerstones of sustainable development (Blackman, 2006). As they represent about ninety-nine percent of all enterprises, they are an important source of employment generation in many countries (Newberry, 2006). Likewise, they are identified as an important source of environmental contamination. Hillary (2000) estimates that SMEs are responsible for about 30% of all environmental load discharged by industry due to their outdated technology and limited capacity to implement environmentally friendly innovations. Moreover SMEs often appear invisible to environmental agencies, especially in emerging economies where the institutional capacity of environmental agencies is limited (Blackman, 2006). These conditions make dissemination of environmental improvements among SMEs challenging.

Cleaner production (CP) has been identified as a prevention-oriented strategy useful to reduce the environmental load associated with the processes and products of SMEs (Baas, 2006). Efforts to promote CP applications in SMEs have been put forward in Latin America (Leal, 2006) and throughout the world (Baas, 2006). Initiatives have involved technical assistance programmes offered by external consultants or cleaner production centers (Grutter and Egler, 2004), voluntary agreements (Jimenez, 2007; Blackman et al., 2009; Blackman et al., 2010), financial support for investments in clean technology (Blackman, 2000), and information dissemination through sectoral guides and CP manuals (Ehrenfeld et al., 2002).

Success of these programmes in terms of environmental improvements of SMEs has been limited, as few companies adopt CP practices after their participation in these types of programmes (Fernández-Viñé et al., 2010; Blackman et al., 2010; Parker et al., 2009; Stone, 2006a; Baas, 2006). In addition, the scope of these programmes was limited, reaching out to only a small proportion of this large group of firms (Blackman, 2006: 23). Accordingly, improving the environmental performance of Latin American SMEs remains challenging, as noted by Vives et al. (2005). Their study of some 1,300 SMEs in five Latin American countries showed that only about 30 percent of the firms in the sample undertook environmental protection practices.[4]

A number of constraints in disseminating CP concepts among SMEs have been identified: Vives (2006:39) cites “lack of resources, lack of knowledge, and the perception that they cause no environmental impact”. Other studies showed a lack of vision and knowledge on the part of business managers (Baas, 2006; Studer et al., 2005; Hilson, 2002); lack of internal resources such as investment capital (Mitchell, 2005; Hitchens et al., 2003; Frijns and Van Vliet, 1999); limited technical know-how and information about viable cleaner practices and technologies (Van Berkel, 2006; Grutter and Egler, 2004; Hilson, 2000); little staff motivation for development and implementation of CP alternatives (Stone, 2006b; Baas, 2006); and lack of availability

[4] Vives et al. (2005) did not specify whether or not any of the firms they studied had participated in any CP-related dissemination programmes.

of tailor-made tools and strategies for environmental improvement in SMEs (Jenkins, 2004).

These arguments explain the barriers to CP implementation in terms of capacities needed by firms, such as information availability, technical capabilities, and financial resources. Other reported barriers highlight motivational constraints of managers, such as lack of management interest, lack of market drivers, and lack of regulatory enforcement. These arguments do not give insights into company-specific characteristics influencing CP, nor do they provide understanding of the organizational features influencing the costs and benefits of CP applications (Dieleman, 2007; Vickers and Cordey-Hayes, 1999). To date, the influence of company characteristics such as size and industry sector on the benefits of CP in supply chain initiatives remains largely unknown.

Further complicating matters, CP is a broad concept that involves a range of different applications and benefits. The academic literature (Van Berkel, 2006; Dobes and De Palma, 2010) and CP manuals and guides (CPTS, 2005; CNPML&TA, 2009; CNPLH, 2009) distinguish different typologies of CP applications. Nevertheless, little is known about the comparability of these different typologies, because most academic research has studied the costs and benefits of particular applications or programmes (Hong Nath, 2007; Nazer, 2006; Hedge et al., 2000).

This study assessed the costs and benefits of cleaner production projects designed by small firms that participated in a sustainable supply programme in Mexico. The programme was designed as a public-private partnership to disseminate cleaner production among a significant group of SMEs throughout the country. Its database of 1,934 CP projects, the vast majority of which were designed by SMEs, provided an unusually rich and consistently measured empirical base for statistical research. The cumulative costs and benefits of the programme, as a whole, make a case for dissemination of CP among SMEs in emerging economies such as Mexico.

Two main research questions guided this study. First, what were the economic and environmental costs and benefits of CP applications designed in a large-scale sustainable supply programme targeted at SMEs? Second, what company and project characteristics influenced programme outcomes? By answering these questions, this study contributes to the literature by providing empirical evidence on how firm and project characteristics influence potential outcomes of CP applications. In addition, it provides new evidence on the potential economic and environmental benefits of sustainable supply efforts. The remainder of this chapter presents the conceptual framework, research design, findings, discussion of the outcomes and conclusions.

2.2 Framework for cleaner production and its applications

This section briefly reviews the literature on cleaner production, its diverse typologies of applications, and the different mechanisms that have been identified for CP promotion among SMEs. In so doing, it also sets the stage for the framework of analysis used in this chapter.

- Cleaner production

Cleaner Production (CP) is an environmental management concept that surged in the 1970s as a strategy for environmental improvement that is complementary to environmental regulation (WBCSD - UNEP, 1998). It advocates a voluntary approach for reducing environmental waste while also reducing costs. An early paper on the subject defines cleaner production as (Baas et al., 1990): "…the continuous application of integrated, preventive environmental strategy to both processes and products to reduce risks to humans and the environment." The concept assumes that contamination is a result of the "ineffective" use of raw materials, products or byproducts.

The Natural Resource Based View (NRBV) of the firm introduced by Hart (1995) can be used as a theoretical perspective to understand the rationale behind the CP concept and other voluntary sustainability-related business strategies. The NRBV perspective considers scarce, valuable and non-substitutable resources, and the capabilities to manage them, as key pillars of competitive advantage. From this perspective, CP is seen as a strategic capability for minimizing emissions, effluents and waste through continuous improvement. Firms that adopt CP or related strategies will evidence simultaneous reductions in emissions and in capital expenditures for end-of-pipe pollution control. Over time, a CP strategy will move from being an exclusively internal (competitive) process to an external (legitimacy-based) activity as a pillar of the competitive advantage of the firm (Hart, 1995). In the NRBV of the firm, the positive balance between benefits and costs should trigger firms´ self-interest and lead them to adopt CP measures voluntarily.

Two closely related concepts are eco-efficiency (Schmidheiny, 1992) and pollution prevention (Erkman, 1997). These also assume environmental contamination is a result of the "ineffective" use of raw materials, products or byproducts. All of these concepts emphasize prevention-oriented alternatives that aim at improvement in design, production, delivery, use, and final management of products, services and processes.

- Typologies of CP Applications

Cleaner production encompasses a broad range of applications such as changes in manufacturing technologies and practices, changes in chemicals and other raw material inputs, and even changes in products and packaging (Hirschhorn, 1997). Different typologies have been put forward in the literature to classify CP applications.

Following the resource-based view of the firm (Wernerfelt, 1984), early publications emphasized reduced resource usage in industrial processes, such as energy efficiency, efficient water use, waste reduction, and recycling (Van Berkel, 1994; Baas, 1998; 1995). This typology uses the environmental benefits of applications as the main classification criterion of CP projects.

Later classifications take into account the level of innovation involved (Montalvo-Corral, 2002). The idea behind this typology is that CP innovations imply an organizational change process, where management and key staff people must learn to handle new operational routines and incorporate the prevention paradigm (Vickers and Cordey-Hayes, 1999). Many sectoral CP guides and manuals take this classification as their main structure[5] and distinguish among: (i) best practices as adjustments of operational procedures and planning practices, (ii) cleaner technology that requires identification, installation and operation of new equipment, and (iii) new activities that involve the creation of new organizational structures to handle preventive environmental activities.

The knowledge-based view of the firm (Grant, 1996), an extension of RBV theory, posits that the socially complex organizational processes created by human capital and organizational learning offer particularly strong competitive advantages because they are particularly difficult to imitate. Table 2.1 presents a summary of the two different cleaner production typologies.

Table 2.1 Different typologies used to classify CP applications

Classification criteria	Typologies	Examples
Environmental gains	• Energy efficiency • Water savings • Raw material savings • Waste recycling	• Stand-by mode of electric appliances • Irrigation optimization of green areas • Optimizing inventory planning • Re-use of valuable sub-products
Level of innovation	• Best practices • Technological innovation • New activities	• Adjustment of operational procedures • Change of the complete lighting system of the plant • Recycling unit that upgrades by-products for new clients

Source: Author

[5] (i) Centro Nacional de Producción más Limpia de Honduras (CNPLH), 2009. Guía de producción más limpia para la industria textil, [Cleaner production guide for the textile industry] . Tegucigalpa, Repœblica de Honduras: AGA & Asociados, http://www.cohep.com/pdf/GUIA%20DE%20P+L%20TEXTIL.pdf , consulted May 2011; (ii) Centro Nacional de Producción más Limpia & Tecnologias Ambientales (CNPML&TA), 2009. Guía de producción más limpia para el sector de recubrimientos electrolíticos en Colombia, [Cleaner production guide for the plating industry in Colombia], Universidad Pontificia Bolivariana, Grupo de estudios ambientales, www.invemar.org.co/redcostera1/invemar/docs/RinconLiterario/2009/octubre/JE_64.pdf, consulted May 2011, (iii) Centro de Promoción de Tecnologías Sostenibles (CPTS),2005. Guía Técnica General de Producción más Limpia, [General technical cleaner production guide], La Paz, Bolivia, www.bolivia-industry.com/sia/novedades/GUIA_PML.pdf, consulted May 2011

- Dissemination of CP in SMEs

Even though Hart´s (1995) theoretical perspective explains why firms should adopt CP for their own benefit, resistance to change and institutional barriers constrain dissemination among firms, especially small ones (Shi et al., 2010; Baas, 2006; Granek, and Hassanali, 2006; Howgrave-Graham & Van Berkel, 2006). Hence, CP dissemination is of interest to government as a strategy to reduce the environmental impact of industries that is complementary to traditional environmental regulatory instruments (UNEP, 2004). Examples can be found in the adoption of CP policies by numerous national and regional authorities in Latin America (Leal, 2006), and the establishment of a global network of CP centers by multilateral organizations and development banks in more than 100 countries (Ehrenfeld et al., 2002). The aim of these national and international initiatives is to persuade firms to adopt CP strategies on a voluntary basis.

The most common instruments used to influence CP adoption in SMEs are (Ehrenfeld et al., 2002): offering subsidized technical assistance, providing information exchange through manuals and best-practice guides, training programmes, public recognition of the environmental improvements of firms, cleaner technology funds, and voluntary agreements among industry leaders. These early demonstration-type approaches to CP have dominated the initiatives undertaken in Latin America (Jimenez, 2007; Blackman et al., 2009; Van Hoof and Herrera, 2007; Grutter and Egler, 2004). Table 2.2 illustrates examples of CP dissemination programmes developed in different parts of the world and their economic and environmental benefits, as reported in the literature. (Monetary values are converted to US dollars for consistency.)

Table 2.2 Economic and environmental benefits of several CP dissemination efforts targeting SMEs

Dissemination effort	**Cleaner production applications**	**Country**	**Required Investment ($ US)[h]**	**Financial indicators** - **NPV ($US)** - **Payback**	**Other indicators of benefits**
Profitable environmental management ("Gestión ambiental rentable GAP")[a]	Varied (best practice 50%, small technology innovation 50%)	Mexico	Between 0 – $ 1,630	0.25 – 1 year	Water savings Raw material savings Energy savings

External technical assistance[c]	Re-use of chemicals in the leather tanning industry	Palestine	$190	$7,112	Reduction of water use 58% Reduction of chemicals 28%
External technical assistance[d]	Water recirculation in slaughter house	Vietnam	$ 4,409	$1,263	Water savings (20 – 35 %) Reduction of sewage (15 – 20%) Reduction of waste (10- 15%)
External technical assistance[e]	Steam recuperation in the boiler system through recirculation	Colombia	$ 5,400	$1,900	6% monthly reduction in carbon emissions
External technical assistance[f]	Water circulation in food industry	El Salvador	$250	$1,750 (annual savings) 0.3 years	580m^3/year water savings

[a] Ruvalcaba et al., 2005, [c] Nazer. D., 2006, [d] Hong Nhat.P. 2007, [e] CNPML&TA, 2009, [f] Gradl et al., 2009

[g] GDP per capita, in thousands of US dollars: Mexico, USD 10,153 (2011); Palestine, USD 1,483 (2009); Vietnam, USD 1,374 (2011); Colombia, USD 7,132 (2011); El Salvador; USD 3,855 (2011); http://knoema.com/atlas/ranks/GDP-per-capita?gclid=CMnIs9y19rECFcGf7QodQwwA5w (August 20, 2012)

[h] Exchange rates: $ 1 USD = $ 12,2687 MXN; $1 Euro = $ 16.69 MXN www.exchange-rates.org (August 5, 2011)

The financial and environmental indicators of the CP experiences shown in the table 2.2 suggest the promise of CP for reduction of environmental contamination among this "hard to tackle" group of firms as well as its contribution to their individual competitiveness. Nevertheless, the effectiveness of these types of programmes for CP dissemination has been questioned (Baas, 2006). Dieleman (2007) found that less that 40% of firms that received technical assistance in CP improved their performance. Stone (2006a) and Sage (2000) found even lower adoption rates. Moreover, technical assistance schemes involve payments to costly specialized consultants, and therefore make CP dissemination costly and hard to scale up.

Scholars have proposed alternative approaches to spur the adoption of CP measures by SMEs in emerging economies. Blackman (2006) suggested that they should use group approaches in order to impact a large and diverse collection of firms. Stone (2006b) and Vickers (2000) highlighted the importance of organizational learning as a key approach to cleaner production implementation. Seuring and Müller (2008), Carter

and Rogers (2008), Srivastava (2007), Friedman and Miles (2002) and Sarkis (2002) introduced supply chain approaches as effective frameworks to engage suppliers in sustainability initiatives. Yet academic enquiry on the empirical effects of these types of mechanisms on CP dissemination among SMEs is still scant.

A combination of these alternative approaches was used in the design of a Mexican Sustainable Supply Programme (MSSP) aimed at disseminating CP practices among SMEs. The CP projects designed by SMEs that took part in this programme are the objects of this study.

2.3 Mexico´s Sustainable Supply Programme

This section describes the organization and design features of the Mexican Sustainable Supply Programme (MSSP) as the context in which the assessed CP initiatives were developed.

The MSSP was created in the context of growing international trade and difficulty controlling industrial pollution caused by SMEs in Mexico. The initiative was designed in 2005 by the Commission for Environmental Cooperation in North America (CEC)[6], part of the North American Agreement on Environmental Cooperation (NAAEC). The programme's main objective was the development of an innovative, replicable mechanism for the dissemination of sustainability practices among SMEs. In 2008, the Mexican Secretary of Natural Resources (SEMARNAT), as a member of the CEC Board, and Mexico's Federal Protection Agency (PROFEPA) began to promote the programme on a national scale, as part of the National Development Plan of President Calderon's government. At this writing (March 2012), the programme is still ongoing.[7]

The programme design included certain state-of-the-art features of CP dissemination. The main elements of the programme design may be summarized as follows:

A. Public-private partnership to facilitate environmental management: The CEC invited large private companies to collaborate in the engagement and improvement of the environmental performance of SMEs. CEC provided financial support for the operational cost of the pilot programmes, and the privately-owned large companies committed to take part in the programme by playing a facilitative role in engaging the efforts of the private sector.

B. Supply chain power to reach out to SMEs participating in global supply chains and generate scale effects: One of the main commitments of the large private companies was to select and invite a set of their suppliers (mainly SMEs) to participate in the programme. Groups of participating firms comprised one anchor company and about 10-15 suppliers (each of whom sent one or two participants to the programme) corresponding to the production-chain units within the programme. The large private "leading" companies had freedom to select which

[6] www.cec.org
[7] http://liderazgoambiental.gob.mx

suppliers to invite.

C. CP as pollution prevention applications: CP-related strategies and tools were used to design pollution prevention alternatives in each production chain. A step-by-step approach started with the analysis of the strategic and competitive context of the firm, benchmarking successful cases and furnishing references to similar companies within the supply chain. To prioritize improvement options, eco-maps were elaborated.[8] The eco-balance tool and the calculation of inefficiency cost oriented the design of improvement options and their feasibility. Finally, all companies presented a pollution prevention alternative to improve the economic and environmental perspectives of their operations.

D. Learning-by-doing approach to generate empowerment: At the heart of the MSSP is a 10-step educational training programme that emphasizes learning by doing. In this model, the participants themselves were required to generate CP projects that contribute to increasing their competitiveness and environmental performance. In this way, the training method aims at capacity building and the empowerment of employees (Stubbs et al., 2006) within each company as they "engage" their CP projects. Since leading companies as well as SMEs sent participants to the programme, the class experience itself and networking between the participants provided a direct opportunity for establishing relationships between clients and suppliers. At the completion of each cycle of the programme, there is a well-publicized ceremony to honor the participants and provide recognition for their efforts.

E. Train-the-trainer to scale up: In order to scale up the outreach of the programme to include a significant number of SMEs, local consultants and technical assistance centers were trained in the learning-by-doing methodology. In this way, a network of service providers was developed throughout the country to train supply chain groups in the different states of Mexico. Service providers were generally entrepreneurial centers in universities or technology centers known for their close relations and experience with industry.

Execution of the MSSP occurred from August 2005 onwards; its pilot phase, led by the CEC, ended in May 2008. From this time on and up to March 2012, SEMARNAT and PROFEPA continued the programme on a national level. The programme design remained the same throughout the programme.

The cost to operate the MSSP consisted of several components: costs involved in programme management, payment of service providers who delivered the training programme, logistical costs of the supply group meetings, and logistical costs involved in ceremonial activities such as opening and closing events. Programme

[8] Eco-mapping is a CP tool for identifying and prioritizing environmental impacts and resource consumption in a geographic area; eco-balance, or mass and energy balance, is another CP tool used to calculate efficiency of specific processes; inefficiency costing is an accounting technique that values the cost of waste and inefficiencies that occur in production processes (Van Hoof et al., 2008).

managers of CEC and SEMARNAT estimated total participation costs per supplier ranged from USD 500 – USD 1,500 per participating supplier.[9] The research for this paper drew on the programme's database, in which the consolidated results and details of the CP design projects are registered.

2.4. Research methodology and database

The central focus of this study is to examine the costs and benefits of CP projects designed by small firms that participated in the MSSP and the variables that influence these outcomes.

This study used cost-benefit analysis as its main methodology to answer the first research question: What were the economic and environmental costs and benefits of CP applications designed in the Mexican Sustainable Supply Programme? Cost-benefit analyses are commonly used by companies to take management decisions about projects (McLellan et al., 2009; Souza et al., 2009; Evans et al., 2006; Nazer, 2006; Guo et al., 2006; Dijkmans, 1999; Yang et al., 1997). In the economics literature, cost-benefit analyses are also used for decision-making regarding public support for environmental programmes and strategies (Hanley and Spash, 1993). These applications differ in their unit of analysis (programmes vs. companies or specific projects), but share the same techniques (Ahlroth et al., 2011).

The advantage of this methodology lies in the quantification of economic and physical material and energy flows resulting from sustainability efforts. The standard procedure of a cost-benefit methodology computes net present values (NPV) of specific actions (Hanley and Spash, 1993). Cost-benefit analyses often concern projects that have impacts in the future. This is especially important for prevention-oriented alternatives and programmes where benefits are reaped from the "non-occurrence" of environmental contamination and related economic costs (Van Berkel, 1994). To compute the NPV of benefits and costs that occur in the future, discounting is used. The discount rate is typically described as consisting of two parts, the pure time preference rate and a factor linked to the growth rate of consumption and risk in a particular country (in this instance, Mexico) (Banks, 2010). Details for estimating the discount rate and the NPV method employed are presented in Appendix A.

NPV and Payback as indicators were used to measure the extent of the anticipated financial outcomes depend on independent variables such as firm and participant characteristics. That leaves out the ongoing discussion in the environmental accounting literature, which emphasizes differences in how companies allocate cash in- and outflows related to process integrated technological changes in a production process of a specific CP-project.

[9] Operational costs to run the programme were paid for by different actors. In the pilot phase of the programme (2005–2008), CEC paid the cost of the service providers and assumed programme management. In this phase, anchor companies assumed the logistical costs of workshop meetings and ceremonial activities. Later, SEMARNAT and PROFEPA took the role of programme manager and financed the operational costs of the service providers and management. Anchor companies continued to assume the logistical costs for workshop meetings.

Turning now to the second research question of this study: what company and project characteristics influenced the programme outcomes? The analysis considered NPV as the dependent variable and firm characteristics and project types as independent variables. The relationships between the independent and dependent variables were analyzed using ordinary least squares (OLS) estimators. This method permits analysis of the individual effect of project types, controlling for firm characteristics such as sector type and firm size. The estimations characterize projects using three categorical variables: Firm Size, Type of Provider, and Project Typology. Model 1 uses Typology 1 presented in Table 2.1, while Model 2 uses Typology 2. Each of the foregoing variables has one omitted reference category to prevent multicollinearity (Gujarati, 2004; Gulati et al., 2009). Table 2.3 presents the variables, together with the full list of categories employed for each variable, and the reference category.

Table 2.3 Firm and project characteristics influencing CP costs and benefits

Variable	Categories	Reference category
Type of supplier	• Industrial parts (metal parts, electronic parts) • Printing (printing and packaging) • Raw materials (chemicals, minerals, agricultural products) • Indirect supplies (office equipment, filters) • Services (cleaning services, maintenance, catering)	• Industrial parts
Firm size	• Large (>250 employees) • Medium (51-250 employees) • Small (11-50 employees) • Micro (< 10 employees)	• Large
Project typology 1	• Best practice • Technology innovation • New activity	• Best practice
Project typology 2	• Combined savings • Energy efficiency • Raw material efficiency • Water efficiency • Waste valuation	• Combined savings

The natural logarithm of the NPV and the square root of the paybacks were used to reduce heteroskedasticity resulting from differences in firm sizes (Hanssen and Asbjørnsen, 1996). Separate models were elaborated to analyze the different typologies described in the research framework and STATA 7.0 was used to run the regressions. For a given firm j, the models estimated relate to the different project

typologies presented in table 2.3:

Model project typology 1

$$\ln NPV_j = \alpha_0 + \sum_{i=1}^{3} \beta_i * Firm\ Size_i + \sum_{i=1}^{4} \gamma_i * Type\ of\ Provider_i + \sum_{i=1}^{2} \delta_i * Typology\ 1_i + \varepsilon_j$$

$$Square\ root\ Y_j = \alpha_0 + \sum_{i=1}^{3} \beta_i * Firm\ Size_i + \sum_{i=1}^{4} \gamma_i * Type\ of\ Provider_i + \sum_{i=1}^{2} \delta_i * Typology\ 1_i + \varepsilon_j$$

where separate regressions are conducted for:

$$Y = \begin{cases} Savings\ CO2 \\ Savings\ Water \\ Waste\ Material\ Savings \\ Raw\ Material\ Savings \end{cases}$$

Model project typology II

$$\ln NPV_j = \alpha_0 + \sum_{i=1}^{3} \beta_i * Firm\ Size_i + \sum_{i=1}^{4} \gamma_i * Type\ of\ Provider_i + \sum_{i=1}^{4} \delta_i * Typology\ 2_i + \varepsilon_j$$

$$Square\ root\ Y_j = \alpha_0 + \sum_{i=1}^{3} \beta_i * Firm\ Size_i + \sum_{i=1}^{4} \gamma_i * Type\ of\ Provider_i + \sum_{i=1}^{4} \delta_i * Typology\ 2_i + \varepsilon_j$$

where separate regressions are conducted for:

$$Y = \begin{cases} \text{Savings CO2} \\ \text{Savings Water} \\ \text{Waste Material Savings} \\ \text{Raw Material Savings} \end{cases}$$

- *Programme database*

The programme database contains information about all the companies that participated in the programme from August 2005 to April 2011. In total, the database includes information on 119 supply chain groups covering 1,044 companies (72 anchor companies + 972 suppliers). The database includes a detailed description of their characteristics, as is discussed further below.

The data were gathered from different sources. First, all firms participating in the programme filled out an intake form, reporting general features such as their main activity, number of employees, sector they belong to and information about the number of participants from their firm taking part in the programme. Another

important source of information is the final presentation of the project(s) designed as a result of the ten-step training programme. These presentations contained detailed information about the type of CP alternatives to be implemented, estimated investments, and expected economic and environmental benefits.

All information was registered in the programme database. Projects were coded using two different methods of classification, as described in section 2. The companies were also classified regarding the type of good or service they supply, such as packaging, printing, raw materials, indirect supplies[10] and services. Descriptive statistics of the main database characteristics are presented in Appendix B.

The different supply chain groups covered 22 of Mexico's 32 states. The regions where most groups participated were Mexico City and Queretaro. A total of 72 leading companies participated together with 972 suppliers, with several leading firms participating in multiple iterations of the programme. These multiple group participants included Alpura (milk products), Grupo Modelo (beer), Jumex (foods), Nestle (foods), and Bristol Myers Squibb (pharmaceuticals). Ninety-five percent of the suppliers are classified as small and medium-sized companies. On average, two persons from each company participated in the training programme. In total, participating suppliers formulated 1,934 projects, which represents our population for purposes of analysis. Of the original database, 148 observations (projects) were withdrawn, due to incomplete information in their reports. The 72 participating leading companies formulated a total of 202 CP projects themselves. Benefits from these projects are calculated separately in this study and are not included in the regression analyses, as the leading companies are not SMEs.

The next section presents the results of the cost-benefit analysis. It begins with the cost-benefit analysis of the overall programme, then turns to the supply chain groups, the firms, and the individual projects. Results of the sensitivity analysis follow.

2.5 Cleaner production benefits in SME participating in MSSP

Table 2.4 shows the NPV of the programme, the supply groups, the firms and projects resulting from the MSSP. The results from the CP projects designed by the leading companies are not taken into account in the calculation as the focus of this study is on the suppliers participating in the MSSP.

The total NPV of the expected economic benefits of the programme (ignoring benefits to the leading companies that participated) is USD 157 million[11]. The arithmetic mean per supply chain group is USD 1.32 million; per supplier, USD 161,000: and per project, USD 81,000. These figures reveal the attractiveness of the projects. Most projects presented simple payback periods (time to recoup the initial investment)

[10] Materials, purchases and supplies used in the operation of the business, that are not directly associated with production and are part of operating expense (Choi and Hardly, 1996).
[11] All figures are reported in US dollars. Exchange rate: USD 1 = $ 12,2687 MXP; www.exchange-rates.org (August 5, 2011)

estimated at one year or less. The relatively large standard deviations shown in table 2.4 illustrate the great diversity in types of projects and potentials of specific groups and firms.

The administrative costs to operate the MSSP were subtracted from the NPV calculations, as were the required initial investments. As explained at the end of section 3, most of the logistical costs to operate the programme were assumed by leading companies and not quantified even in terms of the time dedicated by the participants in the programme. Furthermore, the results in the table show how the average NPV of projects has risen and fallen over time. However, it is notable that results per project in 2011 were still 33% higher than in 2006, despite the fact that the number of suppliers involved was more than an order of magnitude greater

Table 2.4 NPV of the expected economic benefits and payback periods of the CP projects designed by suppliers participating in the MSSP

Unit of analysis	Net Present Value ($ USD)[a]	Standard deviation ($ USD)	Payback (years)	Standard deviation
Whole programme (August 2005 – April 2011) (n = 1)	$ 156,496,559			
Average per supply group (n = 119)	$ 1,315,424	$ 1,300,816	0.79	0.75
Average per supply firm (n = 972)	$ 161,993	$ 412,101	0.79	1.40
Average per project (n=1934)	$ 80,002	$ 288,536	0.77	1.64
Average per project (year of participation)				
- 2006	$ 43,354 (n = 28)	$ 75,264	0.78	1.24
- 2007	$ 49,987 (n = 41)	$ 144,382	1.04	1.68
- 2008	$ 98,996 (n= 192)	$ 263,472	0.80	1.67
- 2009	$ 128,831 (n= 447)	$ 431,335	0.55	1.02
- 2010	$ 62,548 (n = 877)	$ 262,598	0.88	1.82
- 2011	$ 62,784 (n= 347)	$ 155,200	0.73	1.79

[a] Assumptions made to compute NPV are shown in Appendix A

Table 2.5 presents the environmental benefits of the programme as a whole. The table distinguishes between energy savings, water savings, waste-reduction and raw

material prevention. Yardsticks used are adjusted to Mexican realities (such as average family size, per capita water consumption, and per capita waste generation). Values were computed taking into account the lifetime of the projects, with duration depending on its type between 3–5 years[12].

Table 2.5 Total environmental benefits of the CP projects designed by suppliers participating in the MSSP

Unit of analysis (whole programme August 2005 – April 2011)	Benefits[a]	Yardstick [b]
• Energy savings (ton CO_2)	1,102,145	214,564 cars taken of the road
• Water savings (m^3)	15,438,427	30,650 families of 5 members / year
• Waste prevention (ton)	465,017	Waste generation / year of a city of 1,274,020 inhabitants
• Raw materials conserved (ton)	426,292	

[a] The total benefits takes into account the expected life of each project. No discounting was employed.
[b] Yardstick based on data from SEMARNAT, 2010

As mentioned above, the large standard deviations of economic benefits imply considerable heterogeneity among the different types of projects. To deepen understanding of the benefits generated, the relationship between types of projects and NPV, and between types of projects and payback periods, were analyzed. Figure 2.1 illustrates that payback periods for most of the projects are less than one year.

[12] These time periods depend of the type of projects designed, such as best practices, process adjustments, new technology, and waste recycling. The following expected durations were used in the calculations: best practice, 3 years; process adjustment, 3 years; technology change, 5 years; waste recycling, 5 years (Gradl et al., 2009; Hegde et al., 2000).

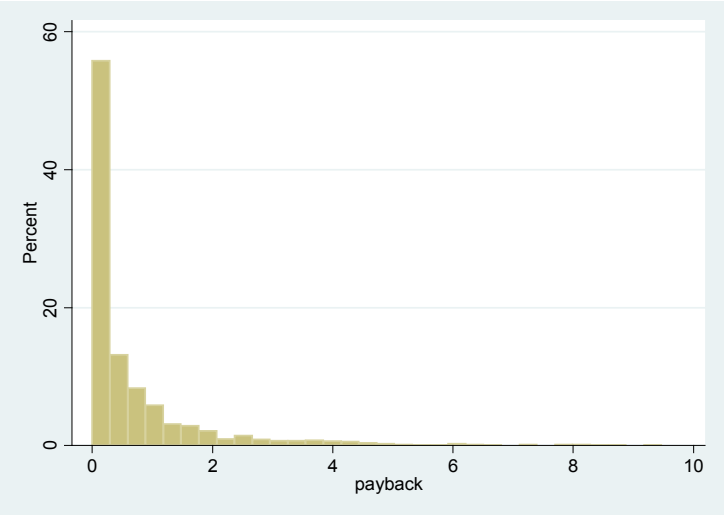


Figure 2.1 Payback periods of the cleaner production projects designed by the suppliers in the MSSP

Figure 2.2 provides insights into the NPV of different types of CP applications using box plots. Differences in NPV are shown for projects classified as best practices, new activities, and technology innovation. New activity projects offer a higher NPV than projects classified as either best practices or technology innovations. Box plots show the distribution of data in a graphical way. The shaded boxes represent one standard deviation above and below the line crossing the middle of the box, which shows the median value. The crossbars at the top and bottom of each line represent two standard deviations above and below the mean. In this way, the figures present normal distributions of the NPV of the different typologies. The points outside the box crossbars represent outliers. Outliers in Figure 2.2 mainly appear in the best practices category, which spans a relatively broad range of preventive alternatives.

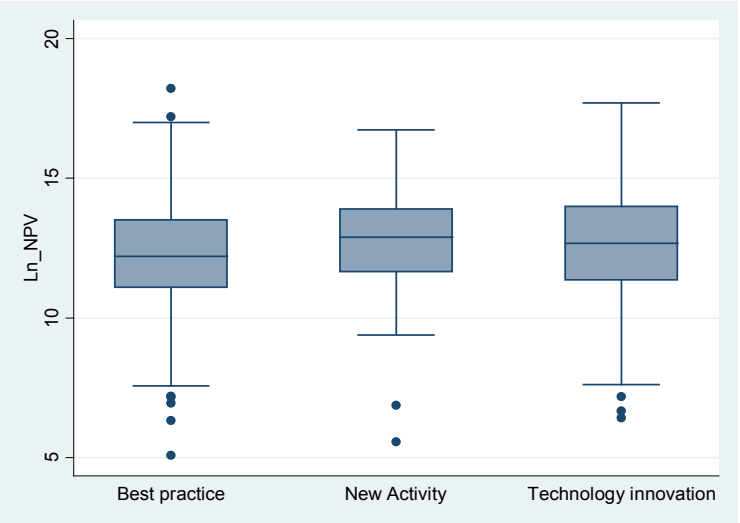


Figure 2.2 NPV of different types of CP projects developed in the MSSP (model project typologyI)

The second typology of project classifications is illustrated in Figure 2.3. Projects involving combined environmental savings[13] show a higher average NPV than other types of projects. Projects involving CO_2 savings and water show a lower NPV than those involving raw material savings and waste recycling. (The differences do not appear statistically significant in the figure 2.3, but we have not yet controlled for other factors, as we will do in the statistical analysis below.) One interpretation of these observations is that the costs of energy and water use in Mexico are relatively low compared to the costs of raw materials and waste management. The latter two types of costs are related, insofar as waste recycling may imply raw material savings, as inputs are re-used. Projects involving water savings appear the least attractive in terms of economic benefits; these types of projects generate a lower NPV and longer payback periods than other projects. Perhaps the explanation lies in the subsidized water prices that make this resource relatively cheap in comparison to other resources. Outliers in Figure 2.3 related to water efficiency can be explained by the relatively small variance in this category and the comparatively small number of observations in the database featuring water efficiency projects.

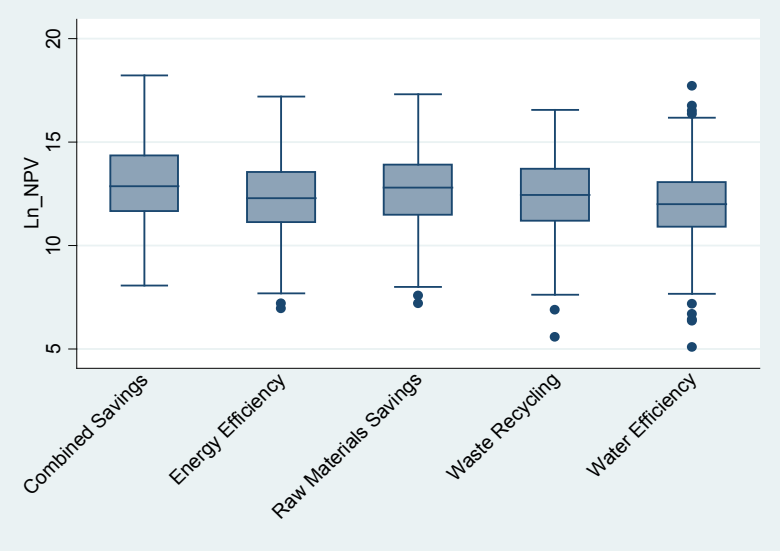


Figure 2.3. NPV of different types of CP projects developed in the MSSP (model project typology II)

To analyze the statistical significance of the patterns suggested by Figures 2.2 and 2.3, a linear regression analysis was conducted, controlling for supplier type and firm size. The results of the regression analyses are shown in Table 2.6 (Model 1) and Table 7 (Model 2). Model 1 differs from model 2 by taking into account different typologies of CP projects in the regression estimation. The results of the regression analyses were consistent with the findings depicted in Figures 2.2 and 2.3.

Project typology 1: Findings presented in Table 2.6 confirm the interpretation of Figure 2.2. That is, projects classified as technological innovation and new activities feature

[13] Combined savings programmes involve at least two types of savings: CO_2, water, waste reduction and/or raw materials.

significantly higher NPV than best practices (our reference category). Technology innovation projects also feature significantly higher CO_2 savings than best practices. This is to be expected, as these types of projects include structural adjustments – for example, redesign of lighting systems, installation of capacitor banks, or replacement of existing machinery. Projects classified as new activities show significantly lower CO_2 benefits than best practices, although new activities produce significantly greater water savings, waste savings and raw materials savings. As these results suggest, best practices often include energy savings related to CO_2 reduction, while new activities mainly include valuation of waste streams.

Table 2.6 Outcomes of linear regression model 1

VARIABLES	NPV Model 1	Savings CO2 Model 1	Savings Water Model 1	Waste Savings Model 1	Raw Material Savings Model 1
Medium	-0.518***	-3.692***	-20.61***	-0.692	-0.678
	(0.0999)	(1.173)	(4.673)	(0.843)	(0.801)
Small	-1.079***	-7.455***	-25.62***	-0.322	-0.205
	(0.113)	(1.327)	(5.287)	(0.954)	(0.906)
Micro	-1.164***	-7.436***	-34.11***	-1.265	-1.990
	(0.209)	(2.461)	(9.802)	(1.769)	(1.680)
Printing	-0.210	-3.036	-1.362	-0.128	-1.048
	(0.209)	(2.443)	(9.730)	(1.756)	(1.668)
Raw material	-0.124	2.712*	6.897	1.595	0.364
	(0.135)	(1.587)	(6.321)	(1.141)	(1.083)
Indirect Supplies	-0.656***	0.216	-8.775	-0.460	-1.098
	(0.171)	(2.032)	(8.093)	(1.461)	(1.387)
Services	-0.479***	0.867	-4.418	1.093	-0.567
	(0.146)	(1.714)	(6.826)	(1.232)	(1.170)
Technology innovation	0.451***	6.255***	0.107	-0.884	-0.296
	(0.0920)	(1.068)	(4.252)	(0.768)	(0.729)
New Activity	0.513***	-6.145***	15.95*	4.683***	5.251***
	(0.176)	(2.123)	(8.457)	(1.526)	(1.449)
Constant	13.02***	10.35***	37.91***	2.329**	2.862**
	(0.139)	(1.630)	(6.493)	(1.172)	(1.113)
Observations	1,806	1,932	1,932	1,932	1,932
R-squared	0.087	0.047	0.026	0.010	0.010

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.6 also provides interesting insights into the role of firm size, with the general result being that the smaller the company, the smaller the NPV of its projects. For micro-, small- and medium-sized firms, table 2.6 shows statistically significant

differences with our reference group “large-sized firms.” Negative coefficients indicate a significantly lower NPV as compared to large firms. A similar trend is observed for environmental benefits. For water savings, a reduction in firm size results in smaller water savings. Surprisingly, micro-sized firms formulated projects with slightly larger CO_2 savings than companies identified as small firms. Another statistically significant relationship is that projects designed by medium-sized firms that participated in the programme generated less raw material savings than larger firms that designed similar projects.

The table also provides insight into the effects of supplier type on project characteristics. Firms classified as providers of indirect supplies, and firms providing services generated lower economic benefits than suppliers of industrial parts (the reference category). A partial explanation of these results may be that most service providers designed small projects in their internal operations (for example their own physical plant). Most of them did not redesign or improve services such as cleaning, consultancies, and transportation, which could have represented higher potentials for economic savings. With respect to environmental benefits, raw material suppliers designed projects with significantly higher CO_2 savings than industrial parts suppliers (the reference category). An explanation may be that the transformation processes used to deliver raw materials require on average more energy resources than does the industrial parts production process. Projects of indirect suppliers resulted in significantly larger raw material savings than suppliers of industrial parts.

Project typology 2: The regression results in table 2.7 confirm the general picture presented in Figure 2.3. Projects focused on combined savings produced significantly higher economic benefits than projects that focus on any single benefit, be it energy efficiency, water efficiency, raw material efficiency, or waste recycling. The coefficients in Table 2.7 indicate the order of value of the various types of projects: prevention-oriented projects involving material savings resulted in higher economic benefits than waste recycling, energy efficiency, or water savings. The project typology used in model 2 shows consistent results with environmental savings in the sense that energy efficiency projects are positively related to CO_2 savings, and water efficiency projects are positively related to water savings. Unlike CO_2 and water, which represent homogeneous indicators of project savings, waste reduction and raw materials represent a range of different types of materials and wastes with diverse volume-value ratios.

Results for firm size, and for supplier type, are consistent with those in Table 2.6. Smaller firms generate projects with lower NPV, and lower CO_2 and water savings. Companies providing indirect supplies or services generated projects with significantly lower NPVs than did companies producing industrial parts (the reference group). The next section discusses the aforementioned findings in light of the research questions guiding this study.

Table 2.7 Outcomes of linear regression model 2

	Logarithm of dependent variable	Square Root of dependent variable			
VARIABLES	NPV Model 2	Savings CO2 Model 2	Savings Water Model 2	Waste Savings Model 2	Raw Material Savings Model 2
Medium	-0.544***	-4.355***	-18.75***	-0.638	-0.798
	(0.0995)	(1.082)	(3.986)	(0.807)	(0.784)
Small	-1.117***	-8.239***	-19.91***	-0.538	-0.406
	(0.113)	(1.223)	(4.507)	(0.912)	(0.886)
Micro	-1.238***	-7.815***	-25.18***	-1.151	-2.272
	(0.208)	(2.267)	(8.352)	(1.691)	(1.642)
Printing	-0.123	-1.173	-2.718	-0.381	-1.140
	(0.208)	(2.246)	(8.276)	(1.676)	(1.628)
Raw material	-0.0491	2.521*	2.291	1.965*	0.931
	(0.135)	(1.464)	(5.395)	(1.092)	(1.061)
Indirect Supplies	-0.605***	0.204	-9.693	-0.503	-0.929
	(0.170)	(1.870)	(6.891)	(1.395)	(1.355)
Services	-0.410***	0.208	-5.428	1.335	-0.0457
	(0.146)	(1.580)	(5.823)	(1.179)	(1.145)
Energy Efficiency	-0.625***	9.661***	-38.25***	-10.01***	-9.199***
	(0.137)	(1.499)	(5.524)	(1.118)	(1.086)
Water Efficiency	-1.115***	-9.979***	86.22***	-10.14***	-9.339***
	(0.162)	(1.763)	(6.498)	(1.316)	(1.278)
Raw Material Efficiency	-0.360**	-9.234***	-38.32***	-9.836***	-5.191***
	(0.168)	(1.857)	(6.841)	(1.385)	(1.345)
Waste Recycling	-0.603***	-9.471***	-39.23***	1.091	-2.877**
	(0.159)	(1.754)	(6.464)	(1.309)	(1.271)
Constant	13.73***	12.37***	53.65***	9.272***	9.479***
	(0.175)	(1.923)	(7.087)	(1.435)	(1.394)
Observations	1,806	1,932	1,932	1,932	1,932
R-squared	0.098	0.194	0.295	0.098	0.057

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

2.6 Cost–benefits of CP in supply chains

The findings of this research confirm significant economic and environmental benefits from CP projects designed and put in place under the Mexican programme, and provide insights on the variables influencing these economic and environmental outcomes. Both typologies for CP applications used in this analysis provided significant explanatory power in characterizing the NPV for different types of projects. Thus, the findings confirm the relevance of the classifications for the evaluation of CP dissemination programmes such as the Mexican case. Moreover the results show how SMEs in an emerging country can contribute to significant economic and

environmental benefits within global supply chains if the right context is created.

The majority of projects feature paybacks of one year or less. Also, 94% of the designed CP projects presented positive NPVs. Divergence of paybacks across different types of projects appears relatively small; virtually all of them pay back quickly. Yet projects identified as new activities, which in most instances involve waste recycling, are in economic terms the most beneficial as they require relatively small investment and result in high rates of return. Projects classified as technology innovations feature higher economic and environmental benefits than projects identified as best practices. Most observations of best practices are related to energy efficiency projects. It is somewhat surprising that these projects present lower NPVs. A possible explanation is that subsidies of electricity prices for small and medium sized industrial consumers (up to 10% depending the year of analysis[14]) (INEGI, 2010) lowers the value of conducting energy efficiency projects. In addition, the relatively low costs for industrial use of water in Mexico, ranging from 1 – 5 cents per cubic meter[15], contribute to relatively low NPVs for water saving projects.

Furthermore, the results show how the average NPV of projects designed in the programme has risen and fallen over time. This suggests the presence of some learning effects in the rollout of the programme, and diminishing marginal returns as the programme has scaled up. However, it is notable that results per project in 2011 were still higher than in 2006, despite the fact that the number of suppliers involved was more than an order of magnitude greater. This suggests that diminishing marginal returns may not be a major problem for the programme, particularly if new leading companies are brought into the programme. Further research will be needed to clarify these initial thoughts about the dynamics that occurred during the rollout of the MSSP.

This information about the outcomes of cleaner production projects makes it possible to focus the tools and cases applied in the training programme of the MSSP in a way that particular results, such as economic or certain types of environmental benefits, can be maximized. The short payback periods and attractive NPV of the projects also suggest that there are still available numerous “low-hanging fruits” (Van Berkel, 1994) from optimizing the efficiency of supply chains participating in the programme.

The findings strongly suggest that firm size is positively related to economic and environmental benefits. Larger firms design projects with larger economic and environmental impacts. This suggests lessons for SEMARNAT and other leading Mexican institutions and companies participating in the programme: search out other large upstream supplier companies as further efforts toward environmental progress in supply chains are pursued; conversely, more modest results must be accepted to the extent programme participants consist mainly of smaller companies.

The effect of supplier type on environmental benefits is less clear. This research only shows a few significant outcomes with regard to supplier type in relation to CO_2 and

[14] Electricity cost for industrial use oscillates around 1 cent per KwH. (www.cfe.mx)
[15] www.conagua.gob.mx/CONAGUA07/Noticias/Edomex.pdf

water savings. Projects designed by printing firms and indirect supplies have significantly smaller environmental savings. Firms identified as printing and raw material suppliers generate, on average, projects with greater economic benefits than providers of indirect supplies and services. Accordingly, this research provides some guidelines for selecting suppliers to be invited in future initiatives of a similar nature.

The wide range of different projects designed by diverse firms illustrates that CP tools, such as eco-maps, eco-balances, and inefficiency cost, apply to a wide range of different-sized enterprises in different lines of business. The SMEs were able to create tangible knowledge-based advantages using CP. This finding contrasts with that of Jenkins (2004), who bemoans the lack of tailor-made tools and strategies for environmental improvement in SMEs. Comparing this study´s outcomes with Jenkins' argument, it appears that the strategy used for dissemination, and not the tools themselves, was the most important factor in achieving improved dissemination of environmental improvement among SMEs.

The cost-benefit outcomes of the CP projects designed in the MSSP compare favorably to findings reported in the literature on CP dissemination efforts in other parts of the world (Ruvalcaba et al., 2005, Nazer, 2006, Hong Nhat, 2007, CNPML&TA, 2009, Gradl et al., 2009). Paybacks are similar to the cleaner production applications reported in table 2, and NPVs were significantly larger. An explanation might be found in the average size of the firms. An additional hypothesis considers the different dissemination mechanisms used in the different efforts. Most prior efforts relied primarily on technical assistance from specialized external consultants; in contrast, the MSSP used a learning-by-doing method in which job-floor personnel identified and designed for themselves viable CP projects. Further research should examine how the MSSP method performs in terms of known barriers to CP dissemination in SMEs, such as the lack of technical know-how and information about attractive practices and technologies (Van Berkel, 2006; Grutter and Egler, 2004; Hilson, 2000), and lack of empowerment and motivation of staff involved in the development and implementation of preventive alternatives (Stone, 2006b; Baas, 2006).

The results of the MSSP suggest that the use of "supply chain power" to reach out to a significant group of local SMEs and larger providers is a promising strategy. In less than six years, the Mexican initiative reached out to more than 972 suppliers nationwide. This interpretation echoes Blackman (2006), who proposes group approaches as strategies to connect SMEs in developing countries to sustainability actions. Group approaches bring down the costs of technical assistance and information dissemination in CP, and strengthen organizational capacity for collaboration and information exchange, which helps to create tangible knowledge-based advantages within the perspective of the NRBV (Hart, 1995). The idea of using client-supplier relationships to involve SMEs also seems promising as a way to overcome the lack of external pressures from stakeholders, which has been identified as a main limitation for decision-making towards environmental improvement of small firms (Baas, 2006; Grutter and Egler, 2004).

In addition to the benefits obtained through the dissemination of CP applications in supplier firms, the leading companies that participated in the MSSP also formulated a significant number of CP projects. These also offered significant environmental and economic benefits, as firm size is positively related to the scale of their improvement options. Nevertheless, because the focus of this study is on SMEs, the projects initiated by leading companies are not included in the analysis.

The analysis in this study focuses on "internal" NPV understood as tangible financial benefits internalized to the balance sheet of the firm that designed the CP projects. It is somewhat surprising that the internal NPVs are highest for waste management and new activity, rather than energy efficiency or new technology. The first two mostly involve applications where supplier and leading company collaborate. Milstein et al. (2002) identify other "intangible" values of sustainability investments that result from network relationships and learning effects. In this study these network and learning effects are not evaluated, but the reasoning of Milstein et al. (2002) suggests that the intangible aspects of these collaborative efforts would be higher than for non-collaborative projects. Thus, waste management projects in the supply chain, in programmes comparable to MSSP, are expected to be the most attractive CP applications.

Finally, the results illustrate how a voluntary CP-based mechanism developed by means of public-private partnerships can generate significant environmental improvements. The aggregate environmental benefits of the programme would neutralize the environmental impacts generated by a small city with a population of about 40,000. Moreover, the economic benefits of the programme expressed in NPV are equivalent to the annual minimum wage of 170,000 [16] Mexican citizens.

Accordingly, voluntary mechanisms stand to play an important role for environmental policy implementation in developing countries (Blackman et al., 2006). The basic idea behind these mechanisms is that the role of government may usefully be changed from being interventionist to playing a more facilitative role, encouraging efforts by the private sector itself (Frijns and Van Vliet, 1999). The significant scale of the aggregate benefits of the MSSP supports this argument. Furthermore, a voluntary mechanism such as that employed for the programme opened opportunities for both public and private institutions to communicate indicators of environmental quality improvements. Often, regulatory and economic agencies only report indicators related to administrative processes (Espinosa and Rodriguez, 2003; Romo, 2005).

2.7 Conclusions

This chapter presents the economic and environmental performance of an innovative programme aimed at small and medium-sized enterprises (SMEs) included in supply chains of major manufacturers in Mexico. Known techniques such as cost-benefit analysis and linear regression models are used to study relationships between firm

[16] www.sat.gob.mx

and project characteristics, and economic and environmental outcomes.

The study's database includes a large sample of companies in comparison with other quantitative studies involving SMEs (Kusyc and Lozano, 2007). Information contained in the database is chiefly drawn from that made available by the participating companies regarding the CP projects they designed. The database does not contain information concerning the implementation rate of these projects. This is unfortunate, and a key limitation, as several CP programmes report limited application percentages despite the attractive economic and environmental benefits of the designed alternatives (Stone, 2006a). In the following chapter the implementation rates of the designed projects and their real economic and environmental benefits are assessed.

3. Organizational Learning in Cleaner Production among Mexican Supply Networks[17]

This chapter assesses the utility of a Mexican programme designed to promote organizational learning in cleaner production among suppliers of large manufacturing and food processing companies. The chapter demonstrates how organizational double loop learning was attained in a programme employing blended learning methods, with supply networks as a cleaner production dissemination vehicle. Insights were generated into how characteristics of supply firms and their participating managers influenced organizational learning in cleaner production. Concepts drawn from organizational learning theory were used as the framework of analysis.

[17] The text of this chapter is based on an article published by Van Hoof, B., 2013. Organizational Learning in Cleaner Production among Mexican Supply Networks, Journal of Cleaner Production, In Press, Accepted Manuscript, http://dx.doi.org/10.1016/j.jclepro.2013.07.041.

3.1 Introduction

In the 1990s, Cleaner Production (CP) was heralded as a promising concept for improving the environmental performance of firms with significant potential for cost effectiveness (Hirschhorn, 1995; Baas, 2006). In the following years, implementation efforts were pursued by international organizations, national and regional governments, universities, consultancies, foundations, business associations and numerous firms (Baas, 2006; Stone, 2006a; Ehrenfeld et al., 2002). Many demonstration projects, training and technical assistance programmes have confirmed the beneficial cost-benefit balance of the CP promise (Van Berkel, 1994, Nath, 2006; Shi et al., 2007; Dobes and de Palma, 2010). However, widespread application of cleaner production has not materialized, especially within small and medium-sized firms (Stone, 2006a; Dieleman, 2007).

Theoretical insights as well as empirical data, suggest a reason why CP implementation has lagged behind potential improvement levels, i.e. a lack of attention to social factors (Zilahy, 2004; Stone, 2006a). Practical adaptation of CP efforts, it is argued, requires innovative behaviour at different organizational levels; acquisition of new knowledge; collaborative actions; and decision-making by managers (Clark and Roome, 1999; Montalvo, 2006). As long as the traditional approaches, mechanisms, and instruments for CP dissemination remain largely focused on the technical aspects, limited implementation is to be expected (Stone, 2006b).

Organizational learning theory has been employed to study the "missing link" [18] in the adaptation of CP (Zilahy, 2004, Baas, 2006; Stone, 2006a, 2006b; Dieleman, 2007). This theory describes the complex and iterative processes where organizations acquire knowledge to create and redefine mental models (Senge, 1990; Zadek, 2004). Complementary models describe the different learning loops and organizational elements involved in learning (Argyris, 1998; Argyris and Schön, 1996). Furthermore, organizational learning is identified as a means to foster sustainability by institutionalizing new thinking (Lozano, 2011).

Findings from studies show how the learning process implied in applying CP practices entails key organizational features, such as leadership, cultural awareness, organizational structure (Baas, 2006; Zilahy, 2004), learning as a change perspective (Dieleman, 2007), and empowerment (Stone, 2006a, 2006b). Other authors highlight insufficient organizational learning as the reason for limited outcomes of CP applications (Clark and Roome, 1999; Stone, 2006a).

So far, authors have focused largely on theoretical solutions to programme design and outcomes. New approaches that fully integrate organizational learning concepts within dissemination mechanisms have not been reported, and knowledge drawn from empirical evidence of organizational learning in CP is limited (Stone, 2006a; 2006b). This study was designed to contribute to the literature by assessing the

[18] Zilahy (2004) defined a CP-gap as the lag between CP implementation rates and their potential improvement levels as suggested by both the theoretical CP possibilities and practical solutions.

experience of a Mexican Sustainable Supply Programme (MSSP), designed to promote organizational learning in CP among suppliers of large manufacturing companies. Experience drawn from the Mexican programme provides a consistently measured empirical database for empirical research.

Three questions guided the research in this chapter: (i) What organizational learning levels did suppliers taking part in the MSSP attain? (ii) What characteristics of suppliers and participating managers appear to have influenced the organizational learning process? (iii) How did organizational learning by suppliers in CP evolve? In order to address these questions, the research method included exploration of organizational learning theory and its fit vis-à-vis to the empirical data of the MSSP. In the following sections these questions are addressed.

3.2 Organizational learning in cleaner production

This chapter was built upon sociological perspective of organizational learning. Some consensus exists in this field about learning as a dynamic and complex concept that can unify various levels of analysis (Dodgson, 1993; Lam, 2000). Also, most models and theories perceive CP learning as an intentional process, aimed at purposeful innovation and adaptation to the environment (Huber, 1991); involving information-processing, accumulation, and sense making (Argyris and Schön, 1996); and, it is interactive, accumulative and auto-generative (Senge, 1999). Organizational learning is a main requirement for change towards sustainability, which is fairly easy to identify once it occurs, but more difficult to address while it is in process (Lozano, 2012).

Another underlying concept of this study was CP, defined as "…the continuous application of integrated, preventive environmental strategies to processes, products, and services to reduce risks to humans and the environment..." (Baas et al., 1990). This concept assumes that contamination is a result of the ineffective and inefficient use of raw materials, products or by-products. Examples of CP applications include improvements in the efficient use of raw materials, energy, and water by means of changes in management, improvements in operational procedures, recycling of waste materials, and installing cleaner technologies. The adoption of a CP strategy by firms implies an organizational change process, where management and key staff must learn how to develop, implement, and monitor improvements stemming from new operational routines (Vickers and Cordey-Hayes, 1999).

This paper´s author reviewed inter-linkages among organizational theory and CP relevant to this research: Firstly, 'organizational learning theory' relates to an epistemological dimension of human knowledge, distinguishing between explicit and tacit knowledge (Lam, 2000). Explicit knowledge in CP implies know-how on handling CP tools for diagnosis and identification of preventive alternatives. This type of explicit knowledge involves understanding and the skills to employ CP tools, including eco-maps, eco-balances, inefficiency cost-calculations, and clean technology. In traditional dissemination approaches this type of knowledge is often provided by specialized technical assistance and/or via workshop training (Stone, 2006a).

Tacit knowledge can be understood as the practical experience needed to deal with "real life" situations of decision-making involved in CP implementation by firms. It is considered, experienced, grounded, intuitive, personal, context based, and unarticulated (Lam, 2000). It is generated by learning-by-doing and experimenting. This tacit knowledge is found in the experience of managers and staff attached to firms targeted for CP. Both tacit and explicit knowledge interrelate and are indispensable for successful CP implementation (Stone, 2006a).

Secondly, 'ontological dimensions of organizational learning theory' separates levels of learning by individuals, groups and communities, and examines their interactions (Lam, 2000; Dodgston, 1993). Individual knowledge corresponds to the knowledge of the organization that resides in the brain and skills of individuals, and involves human agency and complexity. Organizational knowledge refers to the way knowledge is distributed and shared among members of an organization; it is manifested in unique routines and knowledge bases, and represents more than the sum of individual learning (Dodgson, 1993). Group learning implies that the individuals involved change their shared mental models (Senge and Sterman, 1994).

Individual learning and organizational learning are interrelated in the way that individual learning facilitates group learning, and organizational learning and vice versa (Senge, 1990). Traditional technical assistance and training programmes in CP emphasize individual knowledge (Remmen and Lorentzen, 2000) paying little attention to empowerment of the organizational knowledge base (Stone, 2006a). This study assessed how training of individual managers affected organizational learning of firms (Vidal-Salazar et al., 2012).

Thirdly, 'organizational learning theory' reviews organizational learning levels, based on a model proposed by Argyris and Schön (1996), and subsequently extended by Hawkins and Torbert (Snell and Chak, 1998) and compatible with Senge (1990, 1999). This model considers learning as a process of detecting and correcting errors and/or creating new situations (Senge, 1990). Learning involves extrinsic and intrinsic motivations and commitment, understood as "the human energy that activates the mind" (Argyris, 1998: 99).

Distinct systemic levels of learning were established. Zero organizational learning appeared when fresh imperatives were issued and no organizational action was taken. Personal commitment might be manifested, but contradictions between planning and control mechanisms in organizations interfered to make adaptive behaviour implausible in organizations (Argyris, 1998). For example, 'zero-learning' existed when staff ignored the implementation of CP measures, even when stakeholders ordered them to do so (Baas, 2006).

Single-loop learning implies simple, adaptive responses that do not affect underlying ideas or structures (Argyris and Schön, 1996). It follows a linear process, mainly motivated extrinsically, to cope with situations (Senge, 1990). Many organizations excel at single-loop learning and protect primary loops that inhibit learning (Argyris

and Schön, 1996). Should a company experience a degree of single-loop learning in CP, little or no progress would have occurred beyond the initial phase of implemention of preventive measures as a part of the dissemination programme (Stone, 2006b). Explicit knowledge might have been acquired; however, tacit application of CP in practice did not materialize.

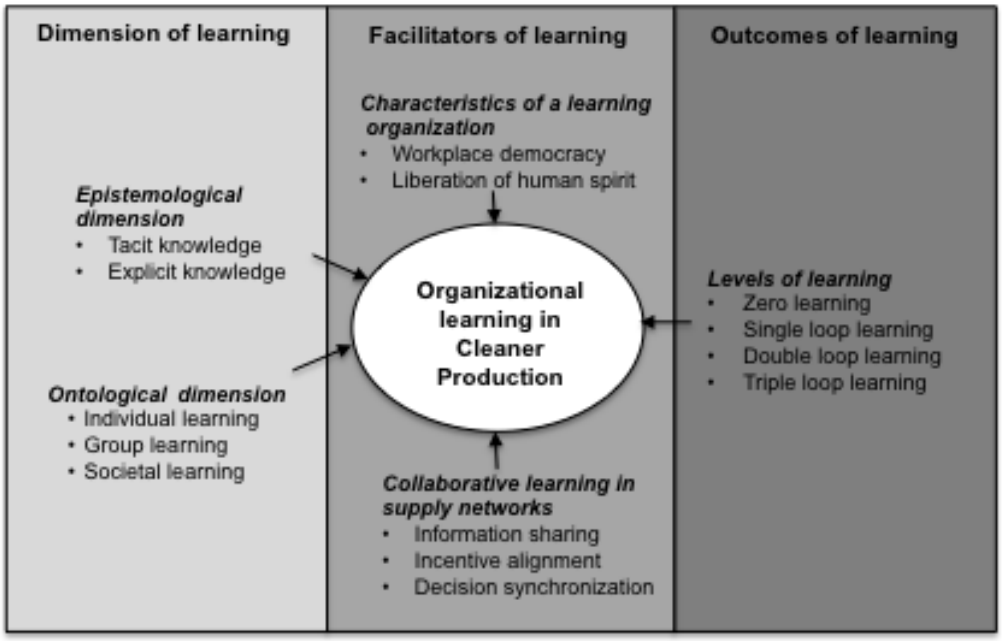
At the double-loop learning level, members begin to see new ways of solving problems and develop new core ideas (Argyris and Schön, 1996). By resolving immediate issues, double-loop learning delves into the underlying structure of the systems and root causes. It follows a cyclical process that compares to generative learning, and is important to the creation of new situations by intrinsic motivation (Senge, 1990). Double-loop learning in CP is achieved when: company staff adopt a preventive attitude toward environmental management, and undertake continuous improvement cycles (Stone, 2006b); CP is integrated into organizational routines where information on sustainability circulates and becomes part of the organization's knowledge base (Clark and Roome, 1999).

Triple-loop learning involves the creation of new methodologies, approaches, and routines concerned with "learning how to learn" (Clark and Roome, 1999; Snell and Chak, 1998). Triple-loop learning in CP occurs when a company's employees develop and implement strategies to solve more complex, shared, sustainability issues, as integral parts of business strategy (Senge, 1999).

Fourthly, 'organizational learning theory' may depend on the characteristics of a learning organization (Pedler et al., 1991). In their framework to assess organizational learning, Snell and Chak (1998; p.338) refer to "an organization that facilitates the learning of all its members and continuously transforms itself". The model's eleven characteristics, based on the principles of workplace democracy and liberation of human spirit, is especially appropriate for the purpose of this study, as it fits the incremental perspective of CP as a strategy to advance toward sustainability (Clark and Roome, 1999), and can be used to recognize social preconditions that influence CP implementation (Zilahy, 2004; Stone, 2006b).

Lastly, 'collaborative learning in supply network theory' was employed to investigate supply relationships that were deemed to be important enablers of organizational learning, both as purveyors and clients (Simatupang and Sridharan, 2005). As important stakeholders, clients can trigger organizational learning in and among suppliers (Hult et al., 2003). In addition, supply networks represent opportunities for information sharing, incentive alignment, and decision synchronization (Simatupang and Sridharan, 2005). These are important sources for knowledge acquisition, information processing, feedback, and the generation of trust in learning–action networks of sustainable business, including CP (Clark & Roome, 1999; Hult et al., 2003; Seuring and Müller, 2008; Carter and Rogers, 2008).

Dimensions of learning recognize the epistemological and ontological dimensions; the characteristics of a learning organization and network systems are considered to be facilitators of learning with the proposed framework, whereas the loop-learning model discussed specifies outcomes of learning. Combining these approaches to organizational learning theory, in relation to CP, Figure 3.1 summarizes the dimensions, facilitators and outcomes of organizational learning in CP as the framework of this research.



Source: Author

Figure 3.1 Selected approaches of organizational learning theory used in researching the MSSP.

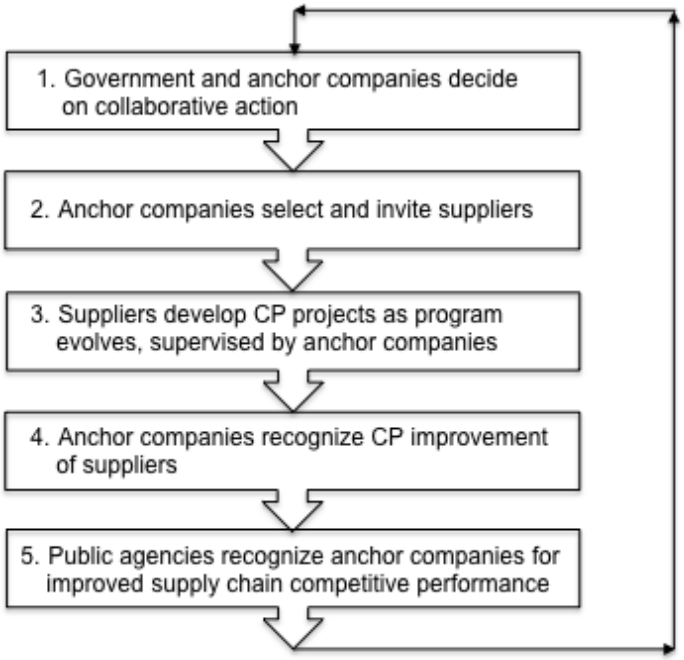
The concepts were combined in the framework connected to the research questions posed for this study: The dimensions of learning specified by the epistemological and ontological dimensions helped to explain the type of learning that occurred during the MSSP. The distinctive levels identified as outcomes of learning provide a framework to assess the differential performance between firms, whereas the facilitators of learning helped us to understand how learning occurred in the MSSSP.

3.3 Learning approach applied in the Mexican Sustainable Supply Programme

The MSSP is a public-private initiative launched by the Commission of Environmental Cooperation in North America (CEC), established by the North American Agreement on Environmental Cooperation (NAAEC). From the time of the MSSP design, efforts were sought to employ an innovative mechanism for disseminating CP among, for the most part, small-sized suppliers of large companies in Mexico. This study focussed its assessment on suppliers and participating managers, in the period spanning September 2005 to May 2008.

The method for implementing the programme features blended learning, as a pedagogical tool, focused on supply networks, i.e. the tool employs a combination of different learning methods (Rosett and Vaughan-Frazee, 2006). The blended learning principles of the MSSP was evident by the engagement of the participants in solving business related problems, such as CP projects, in their companies. Existing knowledge of processes and procedures was utilised as a foundation for acquiring new knowledge on CP. New knowledge was introduced through social interaction with peers, and applied by the learner, then integrated into the workplace. The learning methodology facilitated collaboration, not only among the participants in the course, but also with their work colleagues. In this way participant supervisors were also involved in the project design. An online Internet platform provided technical support and virtual interaction among participants and instructors, and provided access to a copious database of CP examples.

The workshop content featured step-by-step application of CP methods and tools, including eco-maps, eco-balances, estimating cost inefficiency, preventive alternatives, and use of financial and environmental indicators. The training pedagogy employed an "anchor-type" blend (Rosett and Vaughan-Frazee, 2006), starting with classroom activity followed by discussion of the individual's experience. Participant interaction was supported with online resources linked to workplace learning between workshops, while suppliers' managers were required to generate CP projects featuring workplace application of acquired knowledge. Accordingly, the training method aimed at CP capacity building and employee empowerment within each company, as their respective projects were developed.



Source: Author

Figure 3.2 The learning approach employed by the MSSP to foster organizational learning in CP.

The learning process took place in the context of supply networks. Leading Mexican and multinational companies invited groups of about 10-15 suppliers to volunteer as programme participants. Additionally, the companies went along with, and supervised, advances made in CP initiatives developed by their respective supplier groups. At the end of the training programme, the anchor companies recognized the outcomes of CP initiatives developed by their suppliers in a well-publicized closing ceremony. Hence the supply network setting sought to trigger CP learning, instil management commitment among suppliers, facilitate information sharing and collaborative learning, and promote peer feedback. Figure 3.2 summarizes the programme structure.

3.4 Research methodology

The research methodology used complementary research strategies: Firstly, quantitative data analyses were employed to assess differential learning among suppliers. Secondly, the qualitative perceptions of individual managers about learning, as perceived through their participation in the workshop cycles of the MSSP, were surveyed. Descriptive statistics were used for examining the learning levels achieved, whereas regression analyses supported evaluation of how supplier characteristics influenced organizational learning in CP. Thirdly, comparison of the MSSP design features with theoretical models, discussed in Section 2, was based on the personal involvement of the author in the programme design, and in the facilitation of the workshop series.

- *Constructs and their operationalization*

CP organizational learning was assessed by establishing a fit between the theoretical results of the organizational learning developed in section 3.2, and the empirical MSSP data. The model was built on the reasoning proposed by Baas (2006), who related effective CP implementation directly to a firm's level of learning. The different levels of the research model were defined in accordance with Argyris and Schön (1996) and were compatible with learning as an accumulative process as proposed by Senge (1990). Moreover, the epistemological dimensions of CP learning proposed by Lam (2000) were considered in the operationalization of the research model:

(i) Initial-learning in CP – represented by suppliers that initially joined MSSP, but withdrew without completing a CP project. An initial intention to learn was manifested when a firm first accepted the invitation to participate. Nevertheless, neither explicit nor tacit knowledge was evidenced. Similarly, the companies did not achieve individual or organizational learning.

(ii) Single-loop learning in CP – represented by suppliers who had participated in MSSP, presented a CP project at the end of the training programme, but six months later had failed to provide evidence of implementation. Evidence of explicit knowledge in CP was illustrated by presentations. Nonetheless, tacit learning was

not evidenced. Individual managers showed a capacity to develop CP projects that were not institutionalized within their organizations.

(iii) Double-loop learning in CP – represented by suppliers that, within six months after participating in the MSSP, confirmed implementation of the CP project designed during the programme. Tacit and explicit learning in CP were demonstrated, individual knowledge flows throughout the organization, with new organizational routines, were established. Information processing, accumulation, and sense making had come about.

(iv) Double-loop learning plus in CP – represented by suppliers that confirmed implementation of the CP project they had designed, and claimed planning additional CP activities following MSSP participation. The research model assumed that these CP activities could be viewed as direct results of the MSSP. We termed this level as "double-loop learning plus" insofar as it does not fulfil the requirements of triple-loop learning described in Section 3.2. Both explicit and tacit knowledge in CP were manifested at an advanced level, generating new organizational knowledge bases.

Measurements of organizational learning by means of uni-dimensional concepts is controversial as some authors have argued that organizational learning is composed of interrelated dimensions while others have defended the uni-dimensionality of the concept (Vidal-Salazar et al., 2012).

- *Data gathering*

Data gathering for the study followed established approaches, as recommended and used in the field of CP and organizational learning (Stone, 2006a; Van Berkel, 2006; Zhu et al., 2008). Table 3.1 presents the different research instruments in relation to research objectives, information sources, number of responses and moment of application.

The programme database contained information on the characteristics of the suppliers and the moments of programme dropouts, which were gathered during the MSSP workshop series.

Survey I. was emailed by CEC and filled out by the suppliers' managers who had personally participated in the MSSP. Questionnaires were sent to an early group of participating firms between March-June 2007, and a second questionnaire to a later group of participants between August-September 2008. CEC carried out follow-up calls and data collection free from any intervention on the part of the anchor companies. Out of 133 cases,[19] 74 valid responses were collected (56%). In addition five follow-up

[19] Follow-up questionnaires and calls were directed to firms completing the training programme, and presenting CP projects. The 44 firms that withdrew from the MSSP presumably did not continue CP activities following their limited participation, and were not given follow-up questionnaires. The other 133 supplier firms evidenced feedback on CP implementation, either at the end of the training programme or as part of feedback questionnaires.

visits were carried out to check self-reported implementations. All visits confirmed answers given.

Table 3.1 Features of the instruments applied in the process of data gathering in the MSSP.

Features / Instrument	Research objective	Information source	Responses	Moment of application
(1) Programmeme database	• CP learning: – Initial-learning; supplier dropout – Single-loop learning; CP project design	• Managers of suppliers	NA	• During the MSSP workshop series
(2) Survey I	• CP learning: – Double-loop learning; project implementation – Double-loop learning plus; project implementation + new project	• Managers of suppliers	75 / 177	• 6-8 months after MSSP workshop series
(3) Survey II	• Perception learning experience	• Managers of anchor companies	270	• After completion of MSSP workshop series

Suppliers' managers of filled out Survey II. during the programme's final workshop. Out of 291 participants who completed the training programme from 2005 to 2008, 270 responded.

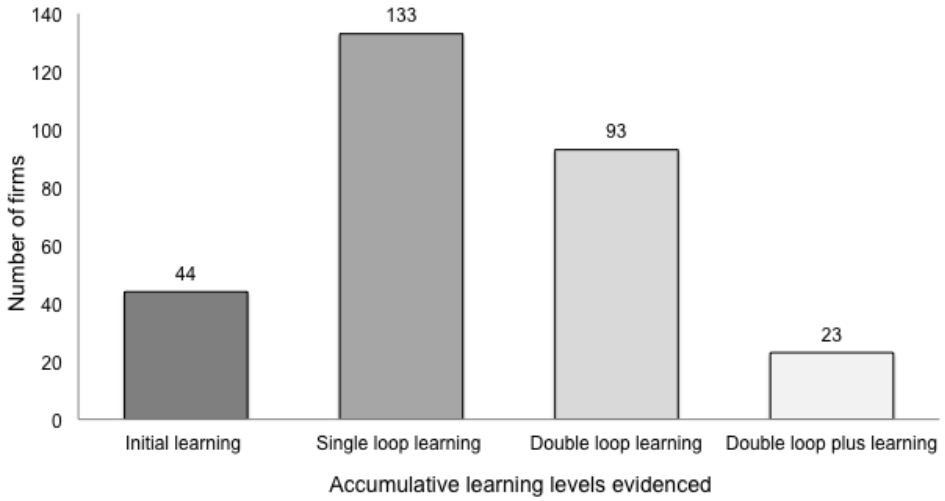
3.5 Findings relating to organizational learning of suppliers and managers participating in the MSSP

Figure 3.3. presents the findings from the first MSSP research question: What learning levels did firms participating in the MSSP achieve? The frequency distribution of firms at each learning level of the proposed research model were plotted. Also shown is the accumulated number of companies reaching a particular level of learning. As learning entails a cumulative process (Senge, 1999), the research model assumed that firms meeting double-loop learning also attained the single-loop stage. Similarly, firms identified in the double-loop-learning-plus category also accomplished the single and double-loop learning levels. The horizontal axis shows learning levels, whereas the vertical axis presents the number of participant firms.

The first bar, from left to right in Figure 3.3, represents firms that withdrew from the MSSP programme, without evidencing CP-related learning. These firms were 25% of the total population of firms initially committed to participate in the programme, but failed to develop a CP project. A closer look at the database shows most of these firms

only attended the first three of the ten workshops. See Appendix B for frequency analysis of the point at which supplier firms dropped out of the MSSP.

The second bar, from left to right, represents firms that showed evidence of a certain level of CP learning. Out of the total, 23% of firms attained to the single-loop learning level, as shown by their capability to design a CP project on their own. The 93 companies (53%) that attained higher learning levels, by implementing CP practices, are represented by double-loop learning in the applied research model. The remaining 13% of firms that reported designing new CP projects, following participation in the program, are denoted as double-loop learning plus.



Source: author

Figure 3.3 Learning levels attained by suppliers taking part in the MSSP

The qualitative survey complemented quantitative analysis by providing insights into individual participant learning experience. Table 3.2 shows positive and unanimous perceptions of individual learning experiences, both as respects acquired CP skills and network relationships. Individual motivation concerned with MSSP participation is also noteworthy: most allocated more than the recommended four hours per week to the programme, attended most of the ten workshops, and visited the programme website about three times per week.

At the end of the training programme, managers of participating suppliers showed high confidence in their own capacity to design CP projects. This capacity fits the first loop learning level of our research model. Likewise, they believed the firms they represented would implement their projects and adopt CP as a structural improvement strategy derived from second-loop learning experience. Comparing results in table 3.2 with those of figure 3.1 shows that 30% of the firm's that designed CP projects, did not evidence the expected second loop experience. This might indicate some contradictions occurred between organizational planning and control systems, and personal commitment, as highlighted by Argyris (1998).

The perceptions of participants revealed network relationships as facilitators of organizational learning in CP. Enhanced relationships with other suppliers were ranked higher than relationships with the very anchor companies that invited their participation in the programme. Participants representing other suppliers were considered an important source of information and for exchange of experience. Additional comments gathered from the survey confirmed these findings, and mentioned other network benefits such as the establishment of new commercial relationships and social contacts. Nonetheless, few participants reported design and implementation of CP projects that involved close collaboration with other firms from the same supply group. Participants reported a fairly high level of satisfaction with the training method and materials employed. Both theory and practice modules were viewed as important components of the CP project design, as was a meeting with a specialized consultant. Other comments noted that the training experience was complete and insightful. Over 90% of respondents claimed they would recommend MSSP participation to their suppliers and other companies.

Table 3.2 Perceived learning experiences of individual participants in the MSSP.

Questions asked to participants about their learning experience in the MSSP	**Min.***	**Max.***	**Mean**	**S.D.**	**Mode**	**n****
CP competences						
- Will you be able to design CP projects on your own?	1	5	4.5	0.5	5	270
- Are you confident that the CP project you designed will be implemented?	1	5	4.5	0.5	5	270
- Are you confident you will continue your work in CP after your participation in MSSP?	1	5	4.6	0.4	5	270
Network experience						
- Did you improve relationships with other suppliers?	2	5	4.1	0.5	4	268
- Did you improve relationships with your client (anchor company)?	2	5	3.8	0.5	4	268
- Excellence of contribution of your colleague participants	1	5	4.2	0.7	4	264
Training design						
- Was the practice module helpful in developing the CP project?	1	5	4.4	0.6	5	270
- Was the theory module helpful in designing the CP project?	1	5	4.3	0.7	4	270
- Was the consultant's site visit helpful in designing the CP project?	1	5	4.6	0.4	5	270
Programme participation						
- Average hours per week visiting the MSSP website	<2	+8	4.1	3.2	3-2	270
- # workshops attended (out of 10)	<3	9-10	7.8	3.4	9-10	270
- Average # visits to MSSP website (times per week)	0	>3	2.8	1.0	3	268

* Likert scale: 1 = not at all, 2= do not agree, 3 = to some extend, 4 = agree and 5 = completely agree.
** n is the number of respondents (participating managers of suppliers).

The regression analysis presented in Table 3.3 addresses the second research question: Which firm's and participant's features appear to have influenced organizational learning among firms participating in the MSSP? Scores show how certain features lead a firm or participant to fulfil the criteria for a given learning level category. P-values indicate significance of relationships. Organizational determinants of learning include the firm's sector and size. Service suppliers present a significant positive relationship to the 'initial' learning category, with suppliers of packaging materials as the control variable. This relationship is consistent over different categories of organizational learning. For higher learning categories (double-loop and double-loop plus), the coefficient was negative, illustrating how service providers achieved significantly less learning than packaging suppliers. Sectors such as raw materials, indirect supplies and printing materials, showed no significant differences vis-à-vis the control variable.

Table 3.3 Effects of supplier and participating managers´ characteristics on organizational learning.

	Marginal effects			
Variables	**Initial Learning**	**Single-loop Learning**	**Double-loop Learning**	**Double-loop-plus Learning**
Services	0.318**	-0.003	-0.252**	-0,062***
	(0.159)	(0.036)	(0.116)	(0.023)
Printing	-0.099	-0.029	0.081	0.047
	(0.095)	(0.037)	(0.074)	(0.058)
Raw material	0.145	0.021	-0.122	-0.044
	(0.109)	(0..13)	(0.091)	(0.029)
Indirect Supplies	-0.001	-0.001	0.001	0.000
	(0.099)	(0.021)	(0.083)	(0.037)
Medium	-0.157**	-0.034*	0.130**	0.061*
	(0.074)	(0.02)	(0.062)	(0.032)
Large	-0.055	-0.014	0.046	0.023
	(0.099)	(0.031)	(0.081)	(0.049)
Administrative Profile	0.236*	0.0187	-0.194*	-0.061**
	(0.126)	(0.016)	(0.100)	(0.027)
Technical Profile	0.181**	0.036*	-0.149**	-0.067*
	(0.091)	(0.021)	(0.076)	(0.037)
Other Profile	0.268	-0.001	-0.215	-0.052**
	(0.209)	(0.04)	(0.154)	(0.024)
Directive Position	-0.047	-0.012	0.039	0.020
	(0.122)	(0.036)	(0.101)	(0.058)
Operational Position	0.078	0.0148	-0.066	-0.027
	(0.115)	(0.019)	(0.097)	(0.037)
Commercial Position	-0.112	-0.028	0.093	0.047
	(0.094)	(0.028)	(0.077)	(0.046)
Participant Experience	-0.001	-0.000	0.000	0.000
	(0.004)	(0.001)	(0.003)	(0.001)

Standard errors in parentheses.
*** p <0.01, ** p<0.05, * p<0.1

Firm size appears to influence the likelihood of organizational CP learning. Medium-sized firms revealed a significantly lower propensity to zero loop learning than small-sized companies, the control variable. Learning level categories were consistently significant and positive, as confirmed by the significant p-values in table 3.3: compared with small firms, while medium-size companies showed positive attainment of organizational CP learning.

The regression analysis also showed significant relationships with respect to participants' professional profiles. Participants combining a technical and administrative background attained a significantly higher learning level (positive p-value). Pure technical and pure administrative profiles showed a significant positive relationship towards initial learning. In comparison to the control variable (combined professional profile), pure profiles showed a higher propensity to drop out of the programme, as indicated by the negative significant p-value in table 3.3. Participant characteristics such as holding higher hierarchal posts or having greater work experience, did not appear to have had significant influence on organizational learning.

3.6 How MSSP organizational learning came about

Design features of the MSSP were aligned with organizational learning theory, such as proposed by Argyris and Schön (1996) and Senge (1999). First, the CP method, which lay at the heart of the programme, facilitated learning as a process for detecting and correcting errors and/or creating new situations (Senge, 1990). Moreover, the supply chain setting stimulated extrinsic and intrinsic motivation and commitment (Argyris, 1998: 99).

High CP adoption rates by suppliers attending programme workshops facilitated sharing tacit and explicit knowledge. Lam (2000) notes that the blended learning method, such as used in the MSSP, provides a structure for attaining explicit knowledge by means of workshop training; also, "learning by doing" strengthened tacit CP capabilities. Perceptions by individual participants of networking experiences suggest complementary learning of both tacit and explicit knowledge. The combination of MSSP approaches confirmed arguments made by Vickers and Cordey-Hayes (1999), namely, that capacity to accumulate organizational knowledge depends on the interplay of the external and internal environment. Moreover, the systematic approach to disseminate CP, as deployed by the MSSP, differs from traditional training and technical assistance programmes that rely mainly on one type of learning (Remmen and Lorentzen, 2000; Stone, 2006a).

The findings confirmed learning in different ontological dimensions for both suppliers and individual participants. Alignment among these dimensions was shown by high individual expectations over CP project implementation, and the fairly high implementation attained. Only in some firms were contradictions identified between organizational planning and control mechanisms, and personal commitment, which is one of the pitfalls of empowerment identified by Argyris (1998). This means that individual CP knowledge and skills were distributed, and shared the organizational

routines and knowledge bases of the suppliers (Lam, 2000; Dogston, 1993). The occurrence of this dynamic organizational learning process within the MSSP contrasts with practices cited by Stone (2006a, 2006b), who noted little attention to empowerment of the organizational knowledge base, as shown by limited management commitment, lack of leadership, and communication barriers to CP dissemination.

The research model employed for this study followed the interpretation of CP single-loop learning offered by Stone (2006a). In her impact assessment of a technical assistance programme in New Zealand, criteria for identifying single-loop learning was whether or not a CP project designed by an external consultant was implemented. If no implementation was evidenced, no organizational learning was assumed (Stone, 2006a). The CP dissemination approach employed for the MSSP entailed a blended learning method, where participants themselves, not external consultants, designed a CP project. Accordingly, evidence of a CP project design was itself considered evidence of single-loop learning. By designing a CP project, programme participants provided explicit knowledge in the application of CP tools, such as eco-maps, eco-balances, and inefficiency cost calculations within the context of their firm (tacit knowledge). Moreover, they proved their adaptive capacity (Senge, 1990) in responding to the objective asked for by the MSSP.

Firms that designed and implemented their own CP projects attained double-loop learning, for the purposes of this study. This implied that the explicit and tacit CP knowledge of individuals was adapted within the organization, when devising new routines and arrangements involving management commitment (Clark and Roome, 1999; Stone, 2006a, 2006b). Generative learning came about were new situations were created, and new mental models were institutionalized within the organization (Senge, 1990). Extrinsic motivation, such as supply chain demands, and intrinsic motivation of individual mangers, were aligned (Argyris, 1998).

The 70% adoption rate of CP projects designed by firms completing the training sessions appears remarkable when compared with outcomes of other CP dissemination programmes; Dieleman (2007) reported implementation rates of about 40% for projects designed under the PRISMA programme, undertaken in the Netherlands in the 1990s; Sage (2000) reported similar implementation rates for firms participating in the Eco-profit programmes in Austria; while Van Berkel (2006) also claimed limited outcomes in terms of CP implementation for technical assistance offered by external consultants.

A small number of MSSP firms (23%) confirmed they designed additional CP projects following participation, and reported on-going improvements based on their CP experience. In the research model used, this advanced organizational learning level was identified as double-loop-plus. The type of evidence provided implied adoption of new core ideas and new ways of solving problems within the firm, even if it failed to fulfil triple-loop learning criteria, as specified by Senge (1999), Clark and Roome (1999) or Snell and Chak (1998). These authors considered the creation of new methodologies and systems, and “learning how to learn”, as implications of this

highest level of organizational learning. In the MSSP research model this type of learning was not considered, insofar as no empirical data was available for analysis.

In the framework of this research, collaborative learning in supply networks was considered as a complementary dimension. Individual perceptions confirmed networking as an important facilitator of learning, as proposed by Simatupang and Sridharan (2008), and Lozano (2008). Fellow suppliers were viewed as important sources of information, motivation, and social interaction, even to a greater extent than anchor companies expected to play a networking leadership role.

Comparison of learning by MSSP suppliers with the characteristics of a learning organization, as proposed by Snell and Chak (1998), supported the understanding of how organizational learning in CP came about. The MSSP blended learning approach fitted the first principle of workplace democracy: liberation of the human spirit by empowering participants to design their own CP projects, and shown by 133 of the 177 firms; CP became part of the organization; and, CP projects got implemented. Snell and Chak's model shows how the emphasis of the learning strategy on joint supplier-client CP teams fosters higher, more complex, levels of learning, as experienced under the MSSP. The principle of participative policy-making was applied in supply chain relationships, the main MSSP participation driver. Suggestions from stakeholder groups, such as clients and other suppliers, introduced new CP thinking within firms, as shown by participant perceptions.

MSSP participants gained access to explicit and tacit knowledge by means of workshop meetings, site visits, and participant interaction. An active CP knowledge base was sparked at most participating firms. Nonetheless, the programme design did not include mechanisms to insert CP tools into on-going, continuous improvement efforts. Within the programme, accountability of advances in CP learning was assessed in workshop meetings, taking into account strategic value and risk. A CP culture was nurtured among participant groups, as confirmed by individual participants. The collegiality principle was mainly evidenced by hierarchical approval of CP measures. Suppliers' management became involved in CP decisions triggered by commercial relationships and, on occasion, pressures. Although trust among participants improved along the way, CP implementation by most suppliers was mainly a top-down decision. Research findings show that most individual participants believed their CP projects would be implemented; in fact, 93 out of 133 were implemented.

CP achievement rewards under the MSSP emphasized public recognition of companies, not of individuals. The programme design did not include flexible reward systems to honour those responsible for CP achievement, nor were behaviour incentives for company staff contemplated. Strengthening the MSSP reward system might well contribute to attaining higher learning levels by suppliers. Research findings show how combined technical and administrative participant profiles stimulated higher-level learning. Similarly, Snell and Chak's model recognizes interdisciplinary teams, as enabling structures, for higher order learning. The

programme featured on-going CP interaction with stakeholders as a precondition for higher order organizational learning, yet an on-going search for new CP knowledge and opportunities was not included. Of 177 suppliers, only 23 reported some evidence of new CP activities.

The MSSP featured an inter-company, and collaborative, learning climate. Suppliers identified fellow participants as significant sources of information and of experience exchange. They also encouraged an improvement in trust among suppliers, exceeding that shared with the anchor companies inviting them to join the programme. Although the programme's learning methodology focused on intra-organizational CP tools, collaborative measures were not emphasized. Outcomes of the qualitative survey show individual participants expressed confidence that they would continue working in CP, thus contributing to their career development, but the study did not seek evidence of this happening.

Table 3.4 presents the framework to access organizational learning, as proposed by Snell and Chak. Adjustments were made to the authors' model, based on insights drawn from the MSSP study. Highlighted cells (shadowed) identify the fit between the prescriptive theoretical model and the features of this study. References to triple-loop learning are included, but, as noted earlier, this learning dimension was not considered. Further research is required to provide insights by probing into MSSP triple-loop learning levels. The aforementioned principles offer references to identify alternatives for improving the MSSP design and CP dissemination in general.

MSSP design should emphasize ongoing learning by strengthening follow-up activities within its design. The design of MSSP could be improved by stressing ongoing learning after firms' first participation in the workshop cycles. Design of follow-up workshops cycles that address learning in CP related concepts, such as eco-design and industrial ecology, could contribute to strengthening ongoing learning. Also, inviting suppliers to become anchor companies of their own supply chains could emphasize the advantages of higher-level learning, and contribute to CP dissemination. Yearly meetings and public recognition of new CP related efforts would be desirable.

Table 3.4 Characteristics of learning as occurred in the MSSP.

Learning Dimension	Initial learning in CP	Single-loop learning in CP	Double-loop learning in CP	Triple-loop learning in CP
1. Learning approach strategy	Participation in a CP programmes without evidencing improvements.	Respond to CP dissemination requirements by designing CP measures.	CP becomes part of the organization and CP implementation comes about.	Sustainability becomes part of the complex system the business is part of, such as supply chains and clusters.
2. Participative policy making	Pressure forces staff to participate in CP initiatives.	CP implementation depends on fit with existing company values.	CP may change company's governing values. CP suggestions from stakeholder groups are welcomed.	Ongoing attempts to increase information channels, communication and collaboration of CP initiatives are evident.
3. Access to knowledge	Tacit and explicit CP knowledge remain with the individual, with no spread of information.	External experts bring in explicit CP knowledge. Staff provides tacit knowledge. Individual knowledge is emphasized and built on.	Tacit and explicit CP knowledge are integrated. An active organizational knowledge base in CP is created and used to continue the learning and implementation process.	CP tools are part of daily work of all employees. The CP organizational knowledge base is regularly expanded and renewed as continuous improvements are implemented.
4. Accountability	No assessment of CP benefits.	CP dissemination is based solely on cost-benefit analysis.	CP benefits are assessed on strategic values (risk prevention, cost reduction, improvements, market values).	Strategic benefits of CP culture are assessed along the entire supply chain.
5. Collegiality	No exchange of CP information between individuals and staff takes place.	Top-down approval of CP measures.	Open negotiations between top management and operational levels related to assessment and implementation of CP measures.	Improved open communication, mutual goal seeking and trust in exchanges of CP knowledge and experiences. Collaborative design and implementation of preventive measures are standard practice.
6. Reward flexibility	CP does not affect rewards of staff involved.	Rewards related to CP implementation are decided and distributed in a top-down	Flexible reward systems are designed to honor those responsible for CP achievements.	Collective impact of the reward system on attitude and behaviour in CP are assessed and supported

		manner.		throughout the company.
7. Enabling structure	Only a specialist can implement CP; other staff has given limited responsibility for CP implementation.	Assignment of CP responsibility to individual personnel is commonplace.	CP teams combine staff from different departments.	New flexible organizational structures are created for internal and external CP initiatives.
8. Recognition of outside information	"End of pipe" staff vision. CP will not work.	Specific intelligence on CP development is used.	Regular interactions with stakeholders on CP developments.	Ongoing search for new knowledge about CP opportunities and regular interaction with CP developments and critics.
9. Intercompany learning	No notice is taken of CP measures implemented by others.	Internal improvement only. No exchange of information or experience.	Alignment of CP interests with those of other firms, openness and trust for exchange of CP knowledge.	Learning in CP is shared with other firms such as suppliers and clients. Collaborative CP measures are developed and implemented.
10. Learning climate	Pressure forces staff participation in CP initiatives.	CP teams are assigned to specific CP projects aimed at improvements in task efficiency.	New CP initiatives are supported by top management and throughout the company.	CP initiatives are stimulated and formulated at all levels. Active participation, creativity and, criticism are stimulated. Continuous improvement through CP is a common practice.
11. Self-development opportunities	CP tasks are not connected to work responsibilities of staff involved.	Team members focus on CP measures only in their direct workplace.	CP measures contribute to personal and professional career development within and outside their direct workplace.	Personnel improve coaching and counseling in CP within and outside the firm.

Source: Author, based on Snell and Chak, 1998

3.7 Conclusions

This chapter highlights organizational learning as part of cleaner production by proving how organizational characteristics and managers´ profiles influenced implementation of preventive environmental practices in small and medium sized firms. Moreover it showed how collaborative learning, principles of workplace democracy, and the liberation of human potential facilitated organizational learning in CP of suppliers part of global production chains. Additionally, this study proposes a framework for studying the impact of CP dissemination efforts based on organizational learning concepts.

A major Mexican government effort to promote Cleaner Production featuring 177 suppliers and 14 anchor companies served as the empirical setting for analysis. Few studies have reported empirical information on continuous improvements in CP by a significant group of companies. Therefore the results of this study contribute to the literature by deepening, through empirical evidence, an understanding of how organizational characteristics and the manager profiles influence CP dissemination.

The theoretical implications emerging from this study suggest organizational learning, as part of CP. Human intention and decision-making are part of the CP strategy, as they influence adaptation of prevention oriented measures for reducing environmental load. This view challenges traditional assumptions that innovative technology, such as CP, is based, mainly, on scientific evidence and economic benefits.

Interpretation of the research model on organizational learning used for this study shows the MSSP proved an effective approach for disseminating CP among supplier firms, based on a blended learning methodology, and supply chain relationships. Evidence of high-level learning shows that the approach employed provides an alternative to traditional CP dissemination mechanisms that rely on technical assistance provided by external consultants.

4. Suppliers –Experiences from Mexico[20]

This chapter examines the experience of 14 anchor companies participating in the Mexican Sustainable Supply Programme, a public voluntary environmental initiative aimed at disseminating cleaner production practices among 177 suppliers launched in 2005 and still under way. Reasons for anchor company participation in the programme were reviewed, together with perceived benefits following project completion. How anchor firms contributed to cleaner production project dissemination was assessed. Literature on public voluntary environmental initiatives and sustainable supply chain management supported the research framework.

[20] The text in this chapter is based on a manuscript elaborated with co-author Marcus Thiell of the Los Andes University, School of Management. The manuscript is in a revision process of the Journal of Cleaner Production.

4.1 Introduction

Public voluntary environmental initiatives (PVEI) are typically undertaken by regulators to encourage firms to develop and implement projects to achieve environmental improvement beyond mere legal compliance (Lyon and Maxwell, 2007). Initiatives of this kind often feature combinations of incentives to trigger participation, such as publicity, technical assistance, and positive interaction with regulators (Lyon and Maxwell, 2007). Their appeal lies in a promise to mutually serve governments, industry, and environmental interests (Steelman and Rivera, 2006). Research findings in emerging economies show that voluntary initiatives help overcome weak environmental regulatory enforcement by means of strengthened efforts in information diffusion and capacity building (Blackman et al., 2010).

Sustainable supply chain management (SSCM) has been found to be a useful concept for improving environmental, social, and economic performance within a supply chain context (Carter and Rogers, 2008; Vermeulen and Seuring, 2009). The central idea of this approach refers to the role of supply chain management as a catalyst for generating inter-organisational value and sustainable inter-firm competitive advantage by means of collaboration between the focal organisation and its market partners on the supply and distribution sides of the chain (Gold et al., 2010). Additionally, SSCM practices have been shown to contribute to resource efficiency (Cai et al., 2010; Zhu et al., 2008), trigger unique capabilities in relationship management (Walker et al., 2008) and strengthen a firm's reputation (Andersen and Skjoett-Larsen, 2009).

Cleaner Production (CP), a key feature of SSCM practices, is defined as "the continuous application of an integrated, preventive environmental strategy, applied to both processes and products in order to reduce risks to humans and the environment" (Baas et al., 1990). CP encompasses a broad range of measures that emphasise reduced resource usage in industrial processes, such as energy efficiency, efficient water use, and recycling (Van Berkel, 1994; Hirschhorn, 1997).

Several PVEI have employed supply chain mechanisms, such as CP, to disseminate improved practices among groups of companies (Seuring and Müller, 2008). CP dissemination comes about when participating firms finally design and implement preventive measures within their productive activities (Baas, 2006). Examples of such programmes include the Green Supplier Network Programme led by the US Environmental Protection Agency, the Smart CEBU Programme sponsored by the European Community, and the Mexican Sustainable Supply Programme (MSSP) under review. Launched by the Commission of Environmental Cooperation for North America (CEC), the MSSP sought to improve environmental performance among small and medium-sized enterprises (SME), using supplier relationships for knowledge sharing and CP dissemination.

A number of studies have examined why firms participate in PVEI, including some in emerging economies (Lyon and Maxwell, 2007; Blackman et al., 2010; Jiménez, 2007; Rivera, 2004). Moreover, a growing body of literature examines why companies

undertake SSCM initiatives (Zhu et al., 2010; Walker et al., 2008; Hu and Hsu, 2010; Lee, 2008). Yet little is known about reasoning that leads anchor companies to participate in PVEI designed as SSCM programmes, what benefits they obtain, and what contribution they make to disseminating sustainable practices.

This chapter aims to fill this gap by posing the following research questions: (1) What makes anchor companies take part in public voluntary environmental initiatives designed as sustainable supply chain programmes? (2) What benefits do anchor companies perceive by participation in such programmes? (3) How can anchor companies influence CP dissemination within such programmes? The following sections address these questions.

4.2 Reasoning for taking part in dissemination initiatives

- *Reasoning for taking part in public voluntary environmental initiatives*

PVEI span a broad range of means undertaken by environmental regulators to invite firms to set and achieve environmental goals in exchange for modest subsidies (Lyon and Maxwell, 2007). Most voluntary initiatives include pollution prevention and provide climate change-related information, such as case studies of successful projects, peer-to-peer information sharing, and public recognition (Lyon and Maxwell, 2007). Instead of compulsory measures, weaker incentives are often employed when there is little political will to enforce environmental regulation (Lyon and Maxwell, 2007).

Neo-institutional theory explains why managers favour participating in PVEI, citing decision-making drivers external to the organisation, such as regulatory pressures, market demands, competitors, and social pressures (Darnall, 2003; Lyon and Maxwell, 2007). In this context, DiMaggio and Powell (1983) offer a framework for gaining legitimacy, stressing isomorphism as a generalised perception that an organisation's actions are desirable, proper, or appropriate within some social system of norms, values, and beliefs.

Based on this theoretical foundation, several works identify regulatory pressure as a main reason why firms participate in PVEI (Darnall, 2003; Lyon and Maxwell, 2007 Rivera, 2004; Christmann and Taylor, 2001). It is held that firms seek to establish and maintain good relations with environmental authorities to pre-empt compulsory restrictions (Rivera, 2004). Participation in PVEI provides firms with an opportunity to proactively interact with regulators. This may especially be relevant for companies more likely to be monitored or be affected by government decisions (Blackman et al., 2010; Henriques and Sadorsky, 1996).

Christmann and Taylor (2001) hold forces such as ISO 14000 certification, multinational ownership and exports to developed markets may lead firms to participate in PVEI. Darnall (2003) mentions intra-organisational forces, such as continuous improvement, environmental capability and slack resources as reasons for

doing so; Lyon and Maxwell (2007) add cost reductions, access to free resources, and employee commitment.

Intra-organisational drivers follow a logic offered by the resource-based view (RBV) of the firm (Barney, 1989; Hart, 1995). In this framework, knowledge-based advantages, such as socially complex organisational processes and reputational assets influence decision-making (Darnall, 2003; Grant, 1996). Literature reviewed generally agrees that reasons for firms taking part in PVEI vary and change over time (Darnall, 2003; Lyon and Maxwell, 2007).

- *Reasoning for taking part in sustainable supply chain programmes*

Reasons why SSCM initiatives hold appeal to companies have been probed for over fifteen years (Gold et al., 2010). As in literature on PVEI, a number of theoretical frameworks has been crafted to understand managers' reasoning for participation; in addition to the aforementioned neo-institutional and RBV approaches, network theory and corporate social responsibility (CSR) may also be considered.

CSR highlights the role a company plays in society and seeks to improve overall relations with stakeholders (Carroll, 2008). Companies contribute to societal interests by undertaking philanthropy, seeking legitimacy, or pursuing CSR to gain competitive advantage (Carroll, 2008). Accordingly, the CSR paradigm explains firms' participation in SSCM activities as a way to contribute to society (Walker et al., 2008; Andersen and Skjoett-Larsen, 2009; Mont and Leire, 2009). Anchor companies, as focal members of a supply chain, are often charged with responsibility for negative environmental and social impacts (Kovács, 2008; Vermeulen and Seuring, 2009). Such charges may be echoed by the press and opinion leaders, and thus impact a firm's reputation, profit or share price (Mont and Leire, 2009; Welford and Frost, 2006).

Similarly, network theory describes the business world as a web of interdependent relationships developed and fostered through collaboration aimed at deriving mutual benefits (Miles and Snow, 1986). As opposed to RBV, network theory also considers inter-organisational relationships as a source of competitive advantage (Chen et al., 2004). In their analysis of green purchasing behaviour, Xu et al. (2007) identify companies, consumers and governments as key network actors, and show how their interaction and power relations may explain business reasoning. Following this logic, Bowen et al. (2001) show that partnering with suppliers is a key step to facilitate SSCM.

Enforcement of environmental regulations may affect a supplier's costs, flexibility or reliability (Vachon and Klassen, 2006a), and hence impact competitiveness of the entire supply chain. Regulatory enforcement also drives innovation to seek cost reductions, especially for firms with a proactive environmental strategy (Porter and Van der Linde, 1995). By means of certain SSCM practices, such as eco-design and green purchasing, firms can pre-empt regulatory obligations (Zhu et al., 2010).

Consumer demand for environmental business practices incites firms to consider their suppliers' environmental performance (Cai et al., 2010). Eco-design of products and services supports developing a sustainable supply chain (Zhu et al., 2010), and labelling schemes based on life-cycle analysis require firms to control potential impacts along the entire supply chain (Finkbeiner, 2009; Vermeulen and Seuring, 2009). Normative forces, such as industry and business association membership, may also stimulate environmental practices along the supply chain (Walker et al., 2008). Competitors serving as environmental leaders may become benchmarks for others to follow (Walker et al., 2008). Moreover, suppliers can provide valuable suggestions for implementing environmental projects (Walker et al., 2008; Vachon and Klassen, 2008).

Waste containment and CP in the supply chain also relate to cost reduction and support quality improvements (Walker et al., 2008; Hu and Hsu, 2010). Rising prices for energy and raw materials lead firms to improve efficiency and corresponding cost savings in the supply chain (Vachon and Klassen, 2006a; Hines and Johns, 2001).

- *Reasoning for CP dissemination in public voluntary environmental initiatives designed as sustainable supply chain programmes*

Each of the aforementioned bodies of literature illustrate similar reasoning and build on related theoretical frameworks, identifying forces such as regulator, market, and society pressures, cost reduction, and organisational capabilities that either drive or bar management decisions.

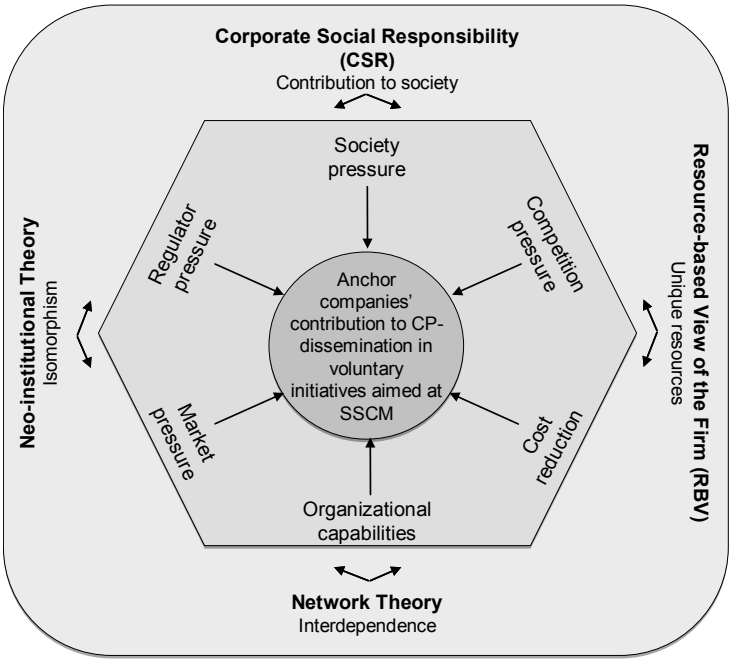


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Figure 4.1 Forces and theoretical approaches that influence anchor companies contribution to CP dissemination in voluntary initiatives aimed at SSCM

Finally, the complexity of supply chain structures and its inherent forces can drive its actors to not only participate in SSCM programmes, but also to break through existing routines in order to design and implement CP practices (Baas, 2006). Given anchor company power in supply chains, they may influence CP dissemination in their supply networks (Seuring and Müller, 2008; Fayet and Vermeulen, 2012).
Figure 4.1 summarises how the above-mentioned forces and theoretical approaches influence anchor companies contribution to CP dissemination in voluntary initiatives aimed at SSCM.

4.3 The operating structure of the Mexican Sustainable Supply Programme

To foster dissemination of environmental practices among Mexican SME, the CEC, part of the North American Agreement on Environmental Cooperation (NAAEC), designed the MSSP as an innovative and replicable PVEI. To ensure effective programme functioning, (multi-) national anchor companies played a key role in motivating participation by SME suppliers. CP was the approach selected to spur environmental improvements and yield cost reductions among suppliers.

The MSSP was launched August 2005 and is still under way. The programme period studied refers to August 2005 until May 2008. During this period, CEC served as host and organiser, supported by the Mexican chapter of the Global Environmental Management Initiative (GEMI) and Environmental Queretaro State Public Agency (SEDESU). Firms participating included 14 (multi-) national anchor companies with operations centred in Mexico City and Queretaro. Each anchor company selected a group of suppliers to join the programme; in total, 177 suppliers agreed to participate.

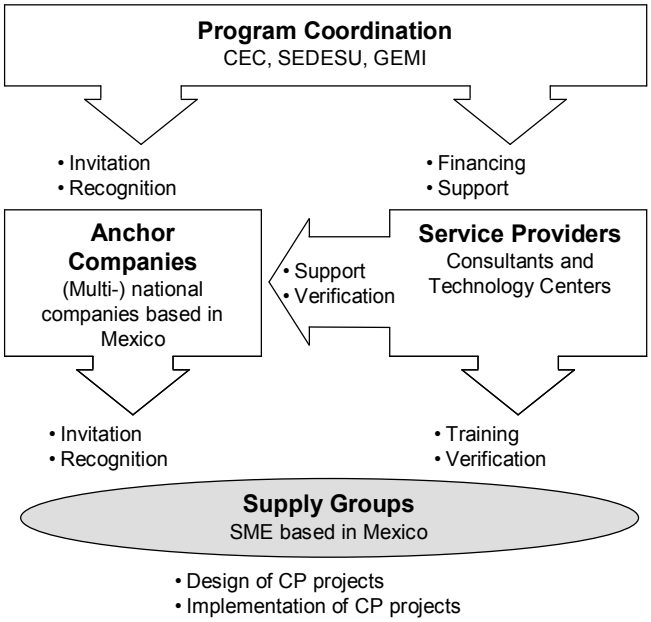

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Figure 4.2 The operating structure of the MSSP and key activities of each actor

Anchor companies were asked to commit to a number of responsibilities: (i) invite at least 10 suppliers in close proximity; (ii) provide logistical support; (iii) assign a representative to oversee activities and communication; (iv) recognise programme outcomes; and (v) support the design and implementation of emerging CP projects.

At the heart of the programme was a three-month series of ten interconnected workshops on CP based on learning-by-doing. Suppliers were required to design and implement CP projects to increase economic and environmental performance. Upon completion of each workshop series, a well-publicised ceremony was held to recognise participants' efforts. Figure 4.2 illustrates the MSSP operating structure and the key activities of each actor.

4.4 Research methodology

The methodology featured two complementary research instruments: semi-structured interviews and surveys to gauge perceptions and opinions expressed by anchor company managers concerning (a) reasons for participation in the MSSP and (b) perceived project benefits. An additional survey directed to suppliers measured anchor company contribution to CP dissemination. Descriptive statistics were used for examining reasons and benefits, whereas cluster analysis supported the evaluation of the anchor company contribution levels and regression analysis how anchor company characteristics influenced CP dissemination outcomes.

- *Constructs and their operationalisation*

To understand reasons of anchor firms to join MSSP and its post-programme benefits, the six forces presented in figure 4.1 were used as constructs to design interview guidelines and surveys.
The contribution of anchor companies to CP dissemination was operationalised as follows:

i. Number of suppliers that participated in the programme and designed CP projects; presenting a CP project was deemed evidence of awareness of CP opportunities (Van Berkel, 1994). Accordingly, the research design considered anchor firms featuring a larger group of suppliers designing CP projects as superior contributors to CP dissemination.

ii. Percentage of suppliers per supply group that implemented CP projects; implementing CP projects implies organisational change and appropriation of the concept in organisational routines (Stone, 2006; Dieleman, 2007). Consequently, the more suppliers of an anchor company implemented a CP project, the better the company in terms of CP dissemination.

iii. Number of suppliers that withdrew from the programme and failed to design a CP project. These suppliers initially agreed upon developing CP initiatives through MSSP participation, but declined their commitment to the programme during the workshop series. The lower the number of supplier dropouts of an anchor company's supply group, the better the anchor company´s performance

in CP dissemination. Appendix D presents the number and moments of supplier dropouts.

- *Data gathering*

Data gathering for the study followed established approaches used in the field of PVEI (Montiel and Husted, 2009) and SSCM (Andersen and Skjoett-Larsen, 2009; Vachon and Klassen, 2008; Vachon and Klassen, 2006a). Table 4.1 presents the different research instruments in relation to research objectives, information sources, number of responses and moment of application.

Table 4.1 Features of the instruments applied in the process of data gathering

Features Instrument	Research objective	Information source	Responses	Moment of application
(1) Interview	• Reasons • Benefits • CP project design • CP project implementation	• Managers of anchor companies	9 / 14	• After completion of MSSP workshop series
(2) Survey I	• Reasons • Benefits	• Managers of anchor companies	11 / 14	• 3-4 months after interviews
(3) Survey II	• CP dissemination: project design • CP dissemination: project implementation	• Managers of suppliers	133 / 177	• 6-8 months after MSSP workshop series
(4) Programme database	• CP dissemination: supplier dropout	• Managers of suppliers	NA	• During the MSSP workshop series

Representatives of anchor companies participating twice in the MSSP were interviewed only once, following their second participation. Respondents included two general directors, two technical directors, one corporate sustainability director, and four environment, health, and safety (EHS) directors.

Survey I was e-mailed by CEC to anchor company managers who personally participated in the MSSP. Three of the 14 anchor companies participated twice in the MSSP, completing workshop series with two different supply groups. 11 anchor companies responded the questionnaire, including those participating twice.

Data collection for Survey II was directed to participating suppliers and carried out by CEC free from any interference by anchor companies. A total of 133 suppliers provided information on design and implementation of CP projects. 44 firms that withdrew from the MSSP already at an early stage of the workshop series were not included in Survey II; it was assumed these firms did not continue CP activities.

The programme database contained information on the characteristics of the anchor companies, their suppliers and the moments of programme dropouts, which were gathered during the MSSP workshop series.

4.5 Anchor companies´ performance in the MSSP

- *Reasons for MSSP participation*

Table 4.2 presents the rank order of reasons given by anchor firms for participating in the MSSP. "Development of supplier performance" was the most important reason, followed by "leadership in sustainability" and "corporate social responsibility". Cost-related arguments, such as qualifying for subsidies or cost of logistics and raw materials, showed least importance. Reasons related to pressure from environmental regulators show mixed results: low priority was assigned to regulator pressure, but moderate priority for collaborating with CEC and other environmental agencies.

Table 4.2 Reasons of anchor companies for MSSP participation

Reason given for participation	Min.*	Max.*	Mean	S.D.	Mode	n
Development of the supplier performance	2	5	4,1	1,2	5	11
Leadership in sustainability	1	5	3,5	1,6	5	11
Corporate Social Responsibility	1	5	3,4	1,5	4	11
Collaborate with environmental authority	1	5	3,3	1,0	3	11
Collaborate with CEC	1	4	3,0	1,4	3	11
Participate in a new initiative	1	5	2,9	1,8	1	11
Capture subsidies	1	5	2,2	1,5	1	11
Regulatory pressure	1	4	1,6	1,0	1	11
Prospect of higher logistical costs	1	4	1,5	1,0	1	11
Prospect of higher raw material costs	1	5	1,4	1,4	1	11

* Likert scale: 1 = not important, 2= little importance, 3 = some importance, 4 = important, 5 = very important

Factors related to improving environmental performance shown in Table 4.2 appear to have outscored cost-related arguments in reasoning that led to programme participation, being indicated by the top three reasons versus those ranked least important. This finding may be explained by the stronger programme presence of non-commercial managers representing anchor companies in MSSP. Moreover, standard deviation supports the perception that reasons stated by anchor companies were unclear; no specific reasons for participating were compelling.

Factors favouring participation, such as regulatory enforcement and cost reductions are mentioned in PVEI literature (Lyon and Maxwell, 2007; Darnall, 2003) and that on SSCM (Cai et al., 2010, Vachon and Klassen, 2006a). Yet neither factor seems to have proven very important in decision-making over MSSP participation. Manager perceptions lend credence to the notion that, at the time the programme was launched; environmental regulation enforcement in Mexico was weak (Montiel and Husted, 2009; Delmas and Toffel, 2004; Velázquez et al., 2008). Similarly, few anchor companies

referred to market forces; this finding may imply that demand for environmentally friendly products and services in Mexico's domestic market remained limited (Dasgupta et al.,1997; Velázquez et al., 2008).

Interviews provided further insights into the diversity of anchor-company reasoning for participating in the programme. One manager stated that once the programme was under way, a call from an important client contributed to upgrading the strategic importance of participation; in this instance, pressure from a client influenced company commitment. This outcome mirrors network theory findings that a dominant supply chain player can influence a supplier's decision-making (Miles and Snow, 1986; Seuring and Müller, 2008; Fayet and Vermeulen, 2012).

- *Perceived benefits from MSSP participation*

As shown in Table 4.3, the strongest perceived benefit of programme participation was "strengthening corporate reputation with suppliers", followed by "economic benefits emerging from own CP projects" and "strengthened general corporate reputation". Ranked least important were benefits related to "strengthened trust with suppliers" and "strengthened operational capacity in CP".

Table 4.3 Perceived benefits of anchor companies from MSSP participation

Perceived benefits of participation	Min.*	Max.*	Mean	S.D.	Mode	n
Strengthened corporate reputation with suppliers	3	5	4,4	0,81	5	11
Economic benefits from own CP projects	1	5	3,7	1,3	5	11
Strengthened general corporate reputation	1	5	3,6	1,4	5	11
Strengthened corporate reputation with environmental authority	1	4	3,5	1,5	5	11
Strengthened corporate reputation with clients	1	5	3,0	1,5	1	11
Strengthened relations with suppliers	3	5	2,9	1,8	4	11
Economic benefits obtained from supply	1	5	2,5	1,4	2	11
Strengthened trust with suppliers	3	5	2,2	1,5	4	11
Strengthened operational capacity in CP	1	4	1,6	1,0	3	11

* Likert scale: 1 = no benefits, 2= little benefits, 3 = some benefits, 4 = significant benefits, 5 = very significant benefits

"Strengthened trust with suppliers" and "strengthened relations with suppliers" were ranked poorly as perceived programme benefits for anchor companies; yet "strengthened corporate reputation with suppliers" ranked as the most important benefit. This apparently contradictory finding may suggest that this externally financed supplier development programme increased reputation and power position in the supply chain without encouraging anchor companies to focus on additional

components of supplier development such as trust building and relationship improvement.

As a perceived programme participation benefit, “economic benefits from own CP projects” ranked second, which is to be expected as the scale of operations of large companies is likely to yield cost savings from CP-applications (Van Hoof and Lyon, 2013). Also noteworthy is that “economic benefits obtained from supply” was ranked as less significant. In the interviews, only one anchor-company considered economic benefits in supplier relations as a benefit. All others expressly confirmed that economic gains obtained from the programme mainly benefited suppliers. This may indicate that large firms failed to view their participation as an opportunity to lower supply costs, identified by Carter and Rogers (2008) as “low hanging fruits” for efficiency improvements.

Interviews also confirmed perceiving other benefits from MSSP participation, such as capacity building, aligning the supply and environmental departments, and attaining improvements in sustainable supply. Jiménez (2007), Blackman et al. (2009), and Dasgupta et al. (1997) found similar arguments as significant reasons for company participation in PVEI in Chile, Colombia, and Mexico. Certain interview responses mentioned that benefits from participating in the programme turned out to be more significant than initially expected. Five anchor companies publicised programme participation in environmental reports and global corporate sustainability publications; three reported that participation led to recognition from corporate headquarters.

Mode and variance analysis of perceived benefits shows high dispersion in anchor firm perceptions. Nonetheless, perceived benefits from participating in the programme proved to be more significant than reasons for doing so stated at the outset. Table 4.3 shows higher arithmetic means and smaller variations in benefit perceptions in comparison with reasons for participation demonstrated in Table 4.2. Further explanation for variations displayed in reasons for participation versus perceived benefits may be that, for most companies, MSSP was their first SSCM experience in Mexico, making unfamiliarity with potential benefits of participation plausible. Once the programme was under way, most companies brought in their supply managers and supply chain benefits became clearer.

Anchor companies’ diverse reasons and perceived benefits over programme participation coincide with findings reported by Montiel and Husted (2009), suggesting some firms participate in PVEI largely in order to legitimise their practices. Surprisingly, none of the anchor firms considered the availability of free resources provided by CEC and SEDESU to programme participants as significant. In contrast, Montiel and Husted (2009) found access to free resources a main condition for institutional entrepreneurs to join new initiatives.

Additional insights drawn from interviews support the hypothesis that programme expectations were unclear. Initially, most anchor companies were represented by EHS managers. Responses from interviews suggest that these managers were not familiar

with their respective firm's supply management practices. Once supply managers became involved in the programme, several EHS managers confirmed the programme provided a first opportunity for strengthening inter-departmental collaboration. Some interviewees even mentioned collaboration with the supply departments of their firm as a perceived benefit from participation.

- *Contribution of MSSP anchor companies to CP dissemination*

Cluster analysis findings provide evidence of how anchor companies contributed to CP dissemination. Figure 4.3 shows performance scores for each company's supply group. The horizontal scale shows the number of suppliers per group that completed participation in the programme, i.e., designed CP projects. The vertical scale measures the percentage of firms per group that implemented CP projects. Hence the upper-right quadrant shows the top performing anchor companies together with their corresponding supply groups; these groups attained the highest rate of implementation, involving the largest number of suppliers.

Anchor companies identified by the codes BM2, CP2, CR, GM, HK, JM, and JM2 formed the cluster of "top CP dissemination". The two other clusters mainly differ in terms of CP project implementation while supply group size for CP project design was similar. Two companies, CL and SK, are classified as cluster of "poor CP dissemination" because their participating suppliers designed CP projects but did not implement them. The cluster represented by anchor companies BB, BM, CP, GI, IA, JC, NE, and RD achieved "average CP dissemination" performance.

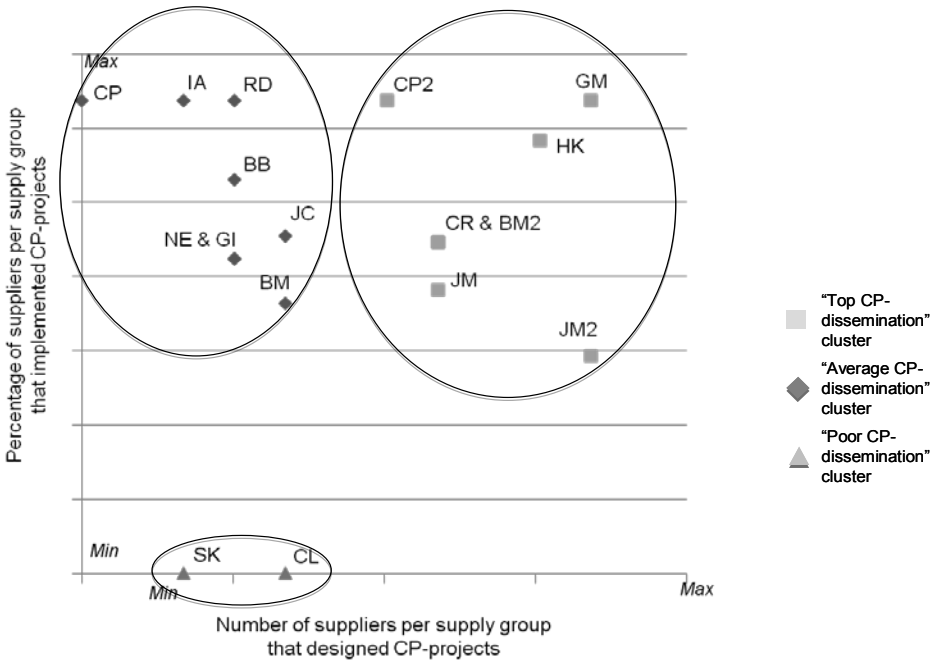

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Figure 4.3 Contributions of MSSP anchor companies to CP dissemination in terms of project design and project implementation

Cluster analysis findings show that two different learning effects may have improved anchor company contribution to CP dissemination. As demonstrated in Figure 4.3, BM2, CP2 and JM2 showed better performances in their second participation. This may be an outcome of learning on how to disseminate sustainable practices among suppliers. Moreover, learning by programme coordinators and service providers may have contributed to performance improvement. This argument is supported by the high performance of companies CR, GM, HK and JM, all of whom took part in later stages of the MSSP. This finding is consistent with literature that identifies learning effects as an important element of SSCM initiatives (Vachon and Klassen, 2006b).
Findings did not prove consistent relations between contributions to CP dissemination on the one hand and factors for reasoning and perceived benefits on the other hand. This may confirm earlier research findings that indicate a heterogeneous range of such factors in PVEI (Darnall, 2003; Lyon and Maxwell, 2007) and SSCM (Lee, 2008).

- *Impact of anchor companies characteristics on supplier dropout*

Table 4.4 Impact of anchor company characteristics on supplier dropout

EQUATION	VARIABLES	logit	Marginal effects
Dropout	Invited by GEMI	0.003	0.000
		[0.821]	[0.111]
	Previous experience with supply chain programmes	-3.347**	-0.660***
		[1.329]	[0.212]
	Ownership	0.203	0.028
		[0.638]	[0.091]
	Participation of supply manager in project team	2.978*	0.310**
		[1.681]	[0.131]
	ISO 14000 certified	-0.396	-0.051
		[0.694]	[0.089]
	Second pilot presentation	-0.954	-0.109
		[1.118]	[0.103]
	Third pilot presentation	0.398	0.053
		[0.948]	[0.126]
	Constant	3.038*	
		[1.691]	
	Number of observations	152	152
	Robust standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1		

The logit model (see Appendix E) assessed the negative marginal effect anchor company characteristics had on supplier dropouts. Table 4.4 shows how two anchor company features appear to trigger significant marginal effects: “previous experience with supply chain programmes”, and “supply manager participation in the project team”. The p-value indicates a negative relationship between previous experience with supply chain programmes and dropout. This implies anchor company acquaintance with similar programmes, thus preventing or reducing dropout among suppliers

invited. Supporting the findings of the cluster analysis, this outcome is also consistent with results from studies undertaken in Great Britain and the US (Hines and Johns, 2001).

Supply manager participation contributes positively to dropout (see positive p-value). In other words, anchor firms represented in the programme only by EHS-managers result in significantly lower dropout. Furthermore, findings also show that anchor companies featuring integrated teams comprised of supply and EHS managers obtained poorer results in CP dissemination among suppliers than companies represented by a single manager. This outcome is remarkable as supply managers are presumed to play a central role in strategic supplier selection (Ha and Krishnan, 2008). One explanation for this may be that coordination between EHS and supply managers seemed limited. Several anchor companies with previous experience in supply chain programmes featured proven environmental leadership, evidenced by programme certification; but for most such companies, participation in the MSSP was their first effort in sustainable supply. Other anchor company characteristics, such as foreign ownership and ISO 14000 certifications, did not relate significantly to programme outcomes; this finding resembles that reported by Rivera (2004) in his study of Costa Rica's hotel industry.

4.6. Conclusions

This chapter examined the reasons and benefits a series of anchor companies claimed for participating in the MSSP, a public voluntary environmental initiative. Also analysed was the contribution made by anchor companies in achieving the MSSP objective: disseminating CP practices among Mexican SME suppliers. Findings uncover heterogeneous reasons for anchor companies to participate in the programme and assert that benefits perceived following programme completion exceed expectations. Moreover, learning effects by anchor companies and programme organisation contribute to dissemination of CP practices among suppliers. Anchor companies represented in the programme exclusively by environmental, health and safety managers resulted in significantly lower supplier dropout.

The use of two research instruments offered complementary insights; statistical analyses of surveys provided empirical evidence for research questions addressed, whereas semi-structured interviews enabled a better understanding of the statistical results. The combination of cluster and regression analysis proved consistency of findings.

This study contributes to literature by integrating PVEI and SSCM reasoning into a conceptual scheme founded on management theory. This framework suited systematic data gathering and understanding of complex network forces. Empirical evidence is provided to the dissemination concept proposed by Baas (2006), addressing the fulfilment of the sequence (a) participation, (b) project design, and (c) project implementation as indicator of successful CP dissemination.

The overall positive perception of MSSP benefits should encourage other anchor companies to participate in SSCM programmes designed as PVEI, especially those with previous experience in supply chain programmes. The study also offers regulatory and environmental agencies recommendations for project launch and management: the most suitable anchor companies to disseminate sustainable practices among suppliers are characterised by previous experience in supply chain programmes. Similar programmes should aim to start with a limited amount of anchor companies in the initial stage, and allow the network organisation to learn from progress made and exploit learning in following stages. The finding that perceived benefits outscore expectations shows the importance of communicating programme potential. Similarly, disseminating success stories should prove helpful in promoting future programmes.

5. Collaborative Capacity for Sustainable Supply Chain Management: Small and Medium Sized Enterprises in Mexico[21]

This chapter tested a theoretical model of collaboration capacity as a multi-dimensional organisational construct to gauge cleaner production dissemination within supply chains. The construct measured operational, cooperative, and communicative routines of small and medium-sized firms to design, implement and communicate results of cleaner production projects. Assessment focused on the collaboration capacity of 177 suppliers that participated in the Mexican Sustainable Supply Programme between 2005 and 2008. The results reveal how a supplier's collaboration capacity is influenced by characteristics of firms and managers, such as the firm's sector, the number of participating managers and their profiles.

[21] The text in this chapter is based on a manuscript elaborated with co-author Marcus Thiell of the Los Andes University, School of Management. The manuscript is in a revision process of the Journal of Cleaner Production.

5.1 Introduction

Multi-stakeholder initiatives have frequently been used in demonstration projects designed to accelerate the implementation of cleaner production (CP) approaches and other sustainability-related strategies to improve the environmental, economic, and social performance of firms (Stone, 2006; Baas, 2006). These initiatives included a wide range of mechanisms, including environmental clubs (Sage, 2000), waste exchange programmes (Paquin and Howard-Grenville, 2009), eco-industrial parks (Chertow and Ashton, 2009), and sustainable supply chain initiatives (Seuring and Müller, 2008; Carter and Rogers, 2008). These multi-stakeholder initiatives differed from traditional implementation approaches that rely on training and technical assistance of employees of individual firms, by applying collective methods as a strategy for promoting environmental improvement among larger groups of companies.

Collective methods were designed to reduce the costs of implementation derived from economies of scale, and were recommended for targeting small and medium-sized firms (SMEs) in emerging markets (Puppim de Oliveira, 2008; Blackman, 2006). Moreover, interactions with actors interested in the firms' activities provided grounds for collaborative learning and action in sustainability (Clarke and Roome, 1999). Similarly, collaboration is a key element of problem-solving because it facilitates dynamic interactions where even incremental actions may produce significant and enduring improvements to help the transition towards sustainable organisations (Lozano, 2007).

Lozano (2007) also noted that the ability of firms to collaborate in sustainability initiatives requires the development of a multi-dimensional organisational capacity to recognise value and collaboration skills. While working together implies understanding each other, exchanging information, drawing and sharing group values, solving problems, and developing new reasoning. The readiness of firms to do so is defined as collaboration capacity. This construct outlines the intra-organisational routines entailed in the transfer and absorption of knowledge and the development of capacity for both sustainable and collaborative action (Huxham, 1993). Firms developing and implementing pollution reduction efforts, for example, that help to fulfil shared objectives, exhibit higher levels of collaboration capacity, while companies with low-level collaboration capacity fail to achieve these shared objectives (Huxham, 1993).

The literature generally focuses on technical stratagems to improve the environmental performance of firms, while overlooking organisational dynamics (Baas, 2006; Stone, 2006; Mitchell, 2006; Boons and Baas, 1997). Furthermore, the literature emphasises the role of anchor companies in sustainable supply chain management (Vachon and Klassen, 2008; Seuring and Müller, 2008; Carter and Rogers, 2008; Sarkis, 2002; Bowen et al., 2001). But little is known about the collaboration capacity of SMEs, and their capability for successfully joining sustainable supply chain initiatives.

This chapter addresses this gap by assessing the collaboration capacity of SMEs participating in the Mexican Sustainable Supply Programme (MSSP). The MSSP offered a unique opportunity to test the construct of collaboration capacity with SME suppliers in the context of an emerging economy. The research questions were: (1) What level of collaboration capacity did SME participation in the MSSP achieve? (2) Did the characteristics of participating companies and managers influence the collaboration capacity of individual suppliers, and if so, how? In order to answer these questions, the research method included the exploration of a conceptual model of collaboration capacity and its fit vis-à-vis the MSSP empirical data. In the following sections these questions are addressed.

5.2 Collaborative theory and sustainable supply chain management

This section addresses collaboration capacity in sustainable supply chain management as a construct for understanding the ability of small and medium- sized firms to connect to multi-stakeholder initiatives. Literature on collaboration theory and sustainable supply chain management is reviewed.

- *Collaboration theory*

Collaboration theory examines interactions among actors, such as in supply chains (Soosay et al., 2008; Gray, 1985). This social science related approach describes the process, forms, and elements of collaboration as a phenomenon that "occurs when a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms and structures, to act or decide on issues related to that domain" (Wood and Gray, 1991).

Collaboration focuses on networks rather than markets and hierarchical governance structures (Powell, 1990). Network partners are interdependent; they participate voluntarily, complement each other's strengths, aim at mutual benefits, and share mutual trust (Soosay et al., 2008; Blomqvist and Levy, 2006; Lambe et al., 2002; Powell et al., 1996). An underlying assumption of collaboration theory considers collaboration to be a beneficial activity for competitiveness (Huxham, 1993) that outweighs potential collaboration pitfalls, such as lack of control, loss of flexibility, and direct financial costs.

Furthermore, collaboration theory highlights collective problem solving of complex issues by means of innovation (Storer and Hyland, 2009; Heimeriks and Duysters, 2007; Blomqvist and Levy, 2006; Inkpin, 1998; Powell et al., 1996). In this context, collaboration aims at confronting complex problems that exceed the capacity of individual firms (Gray, 1985). The problem domain addressed in this paper was defined as the improvement of the ecological performance of SME suppliers. In this inter-organisational field, problem solving through effective collaboration (Lambe et al., 2002) is evidenced by the adoption of high impact CP projects by suppliers.

The preconditions for collaboration entail mutual trust among partners' rational and emotional elements, commitment in attitudes and behaviour, and communication of intention and outcomes (Blomqvist and Levy, 2006; Sharma et al., 1994). These collaboration competences are evidenced in intra- and inter-organisational activities and resources, such as information processing, knowledge absorption, management and control, as well as in communication and negotiation skills. Inter-organisational resources include common norms, the language needed for problem identification, direction setting, and structuring of solutions (Blomqvist and Levy, 2006; Gray, 1985).

Collaboration has been proposed as a pathway for sustainability (Lozano, 2007; 2008). It involves a paradigm change from an individualistic focus towards efforts to achieve common interests by introducing small actions that produce significant and enduring improvements to support the transition towards more sustainable organisations. The same author introduced a non-zero sum game where collective gains outweigh individual costs. This reasoning especially applies to sustainable supply, where winning or losing in negotiations with suppliers and anchor companies is not what matters, but rather, reaching a system optimum where all players develop sustained relationships.

- *Integration of collaboration theory into sustainable supply chain management*

Sustainable supply chain management implies that chain partners, such as anchor companies and suppliers, implement measures to improve their environmental performance (Seuring and Müller, 2008). These improvements may involve organisational changes in individual companies, joint efforts by supply chain partners, or system-wide changes involving a wider range of stakeholders (Cai et al., 2010; Vachon and Klassen, 2007). Depending on how closely partners are integrated, benefits and efforts are shared or negotiated (Carter and Rogers, 2008).

Within sustainable supply chain management, CP is viewed as a prevention-oriented environmental management approach, providing opportunities for resource efficiency and reduced environmental loads (Vachon and Klassen, 2007; Seuring and Müller, 2008). Among supply chain partners, CP applications include adjusting operational procedures, technologies and/or developing new activities, such as product re-use or waste recycling (Lee, 2008; Hirschhorn, 1997). The implementation of these CP measures in and among firms requires specific knowledge of the technical tools needed for priority setting, and the capability to change organisational routines (Stone, 2006; Hult et al., 2003).

Both collaboration and sustainable supply chain management, including CP, are considered as "higher level" organisational capacities (Gray, 1985; Gold et al., 2010): referring to the Japanese Koysei philosophy, Lozano (2008) identified "economic survival" and "internal improvements" as requisite organisational routines for "co-operation outside the company". Similarly, Boons (2009) wrote that the recognition of ecological value by firms is a precondition for deploying strategies aimed at improving their environmental performance. Moreover he argued that only firms with "higher-

level" capabilities recognise ecological value as part of continuous operational improvement in implementation of pollution controls or prevention-oriented measures.

Building on these concepts, the new construct of collaboration capacity for sustainable supply chain management was developed. This construct integrates a firm's internal structures and processes, as required, to recognise ecological value and, by means of improvements in environmental performance, contribute to such multi-partner initiatives. Based on Boons (2009) and Huxham (1993), the following organisational routines were used as dimensions of collaboration capacity for sustainable supply chain management:

- *Operational routines:* knowledge and organisational skills needed to operate efficiently while protecting ecological value. For this research, operational routines include knowledge of specific tools related to cleaner production, knowledge of operational processes, and organisational skills to innovate or re-design processes.

- *Coordinative routines:* knowledge and organisational skills required to develop partnerships with other firms and additional stakeholders, such as public agencies, non-governmental organisations, academic institutions, and consultancies. Coordinative routines involve the knowledge and skills to identify the needs of others and to align activities. In this research, coordinative routines were related to the capacity for developing collaborative CP projects that involve stakeholders in project design and implementation.

- *Communicative routines:* knowledge and organisational skills used to shape the value context. These types of routines are related to the way firms communicate sustainability. In this research communicative routines refer to the measurement of CP project impact, and information exchange between stakeholders.

These three organisational routines include both (a) the intention to carry out activities based on knowledge and recognition (CP intention), and (b) undertaking the activity in accordance with the intention and supported by the corresponding skills (CP action). These levels are interrelated, as intention is a condition precedent to performing an activity; nonetheless, the presence of intent does not necessarily ensure an activity will be performed (Boons, 2009). Table 5.1 summarises the framework of "collaboration capacity for sustainable supply chain management" as a social organisational construct, as used in this research.

Table 5.1 Organisational routines involved in collaboration capacity for sustainable supply chain management

Engagement in sustainable supply chain initiatives	Organisational routine	Related capacity
Collaboration Capacity	Operational	• Intention to apply sustainability strategies and tools. • Skills to innovate operational processes.
	Coordinative	• Intention to create partnerships, to identify common goals, and to negotiate. • Skills to develop collaboration projects.
	Communicative	• Intention of information exchange with stakeholders based on measurements. • Skills to communicate across the organisation and among stakeholders.

Source: Based on Boons, 2009

5.3 Developing collaboration capacity in the Mexican Sustainable Supply Programme

The MSSP was designed as a voluntary inter-organisational initiative designed to facilitate implementation of CP practices within Mexican SMEs that are integrated into global supply chains. Stakeholders included the Commission of Environmental Cooperation in North America (CEC), the regional environmental authority of the State of Queretaro (SEDESU), the Mexican Chapter of the Global Environmental Initiative (GEMI), large corporations with operations in Mexico, and local suppliers. Research focused on the programme's pilot phase from August 2005 to May 2008. Participants included fourteen anchor companies and 177 suppliers.

The MSSP design featured several mechanisms related to the aforementioned competences to develop collaboration in sustainable supply chain management. Supply relationships between anchor companies and SME local suppliers were used to motivate the latter to improve ecological performance. Acceptance of invitations extended by anchor companies to suppliers was voluntary, aimed at assembling groups of about ten to fifteen firms per supply chain. To promote participation, public agencies offered to finance training workshops for capacity building in CP methods. Public recognition was awarded to anchor companies collaborating with the MSSP.

Suppliers accepting the invitation to participate in the programme were expected to attend a series of ten workshops, featuring step-by-step application of CP methods. Upon completion of the workshops, each firm made a presentation of a CP project designed to improve ecological performance, and efficiency in operations. Profit attributed to cleaner production projects was expected to benefit suppliers as well as to contribute to the supply chain's overall performance.

The collective learning method applied in the programme included several complementary characteristics: Representatives of participating firms learned to apply CP tools such as eco-maps, estimation of cost inefficiency, eco-balances, and preventive alternatives. Accordingly, each participant acquired knowledge of how to design and implement CP practices in operations.

Workshop meetings were held at anchor company facilities. Throughout the ten workshops, participants were expected to share their experience, work together, and establish social relationships as a means for strengthening ties and generating trust.

Presentations of CP applications among peers emerging from the training programme, together with public recognition of anchor companies for their achievements, were expected to motivate communication among participants. Both financial and ecological indicators were used to facilitate a common language. Table 5.2 presents the MSSP design features as a collaborative CP learning mechanism.

Table 5.2 MSSP design features related to developing collaboration capacity for sustainable supply chain management

Organisational routine	Related organisational capacities	Design feature of the MSSP
Operational	• Intention to apply sustainability strategies and tools. • Skills to innovate operational processes.	• Capacity building in CP tools (eco-maps, eco-balances, inefficiency cost). • Invitation of at least two representatives of each supplier.
Coordinative	• Intention to create partnerships, to identify common goals, and to negotiate. • Skills to develop collaboration projects.	• Supply chain power to trigger participation. • Exchange of experience with peers in a group process. • Time to foster social relations and trust among participants.
Communicative	• Intention of information exchange with stakeholders based on measurements. • Skills to communicate across the organisation and among stakeholders.	• Supply chain power to trigger participation. • Exchange of experience with peers in a group process. • Recognition of project design and implementation by anchor companies. • Executive presentations noting financial and environmental results.

5.4 Research methodology and data gathering

A quantitative research methodology was used to assess the fit of MSSP empirical data with the theoretical model of collaboration capacity. Construct operationalisation, data collection, and methods of analysis are presented in the following.

- *Constructs and their operationalization*

Research questions were operationalised following the framework presented in Table **1.** Variables measured in the MSSP were used to gauge organisational routines defining collaboration capacity for sustainable supply chain management. An additional category, initial collaboration capacity, identified firms that had not yet demonstrated intentions or actions related to operational, coordinative, or communicative routines:

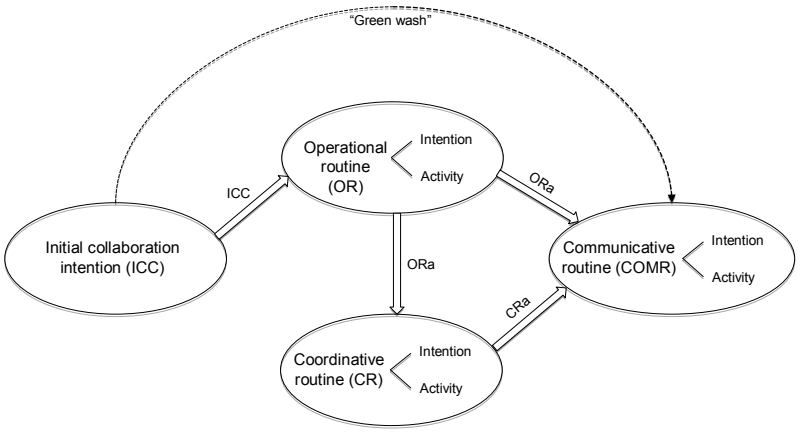
(i) Initial collaboration capacity (ICC): This dimension denotes that not all suppliers signed in to the MSSP developed the necessary routines in accordance with the objectives of the MSSP. These firms showed an initial intention to participate in this multi-actor sustainability initiative, but failed to show progress in operational, coordinative or communicative routines and withdrew from the programme after participating in some workshops.

(ii) Operational routine (OR): Suppliers showing evidence of this organisational routine presented a project at the end of the workshop cycle related to CP applications. The presentation of a CP project represents an intention for operational improvement, as project designs relate to activity planning and cost-benefit analysis. The activity dimension is demonstrated by firms that confirmed their skills by implementing CP projects within six months after participating in the MSSP.

(iii) Coordinative routine (CR): Suppliers showing evidence of this organisational routine presented a CP project at the end of the workshop cycle, involving external stakeholders. These projects, labelled external projects, required more complex organisational capacities than internally oriented CP applications as coordinative routines. They also included the organisational capacity to negotiate with external stakeholders and understand their needs. Hence, firms that presented CP projects classified as “external projects” proved intention, while those that also confirmed implementation evidenced activity.

(iv) Communicative routine (COMR): Communicative organisational routines relate to the exchange of information concerned with CP project outcomes. Within the research model, indicators that evidenced communication intention measured CP project outcomes, while exchanging information with stakeholders on these outcomes was considered as evidence of communication activity.

Organisational routines featured in the research model were inter-dependent and complementary, as illustrated in Figure 5.1.



Source: author

Figure 5.1. Dependent and complementary relationships of organisational routines for collaboration capacity

Figure 5.1 illustrates that the coordinative dimension is considered to also include the operational dimension; i.e., a firm evidencing a coordinative routine by presenting an external project was assumed to have developed operational knowledge and skills for the design of CP projects. Similarly, communicative routines require operational or coordinative routines as predecessor. The option of evidencing communicative routines without operational or coordinative routines was considered to be "green wash". Given these predecessor relationships, coordinative and communicative routines were denoted as higher-level organisational capacities related to collaboration (Huxham, 1993). Table 3 presents the operationalisation of collaboration capacity used in this study. In accordance with Vidal-Salazar et al. (2012) and Aragón-Correa et al. (2007), uni-dimensional estimators were used to study organisational routines as dimensions of collaboration capacity for sustainable supply chain management.

Table 5.3 Operationalisation of collaboration capacity for sustainable supply chain management

Organisational routines	Dimension of organisational change	Estimator
Collaboration intention	Initial intention or activity (ICC)	Dropout
Operational routine	Intention (ORi)	CP project design without confirmed implementation
	Activity (ORa)	CP project design with confirmed implementation
Coordinative routine	Intention (CRi)	CP project design (external project) without confirmed implementation
	Activity (CRa)	CP project design (external project) with confirmed implementation
Communicative routine	Intention (COMRi)	Measurement of outcomes of CP project implementation
	Activity (COMRa)	Exchanging information with stakeholders on outcomes of CP project implementation

- *Data gathering*

MSSP data contained information about 191 companies (14 anchor companies plus 177 suppliers).[22] About 75 percent of the suppliers were classified as SME.[23] As anchor companies extended invitations only to suppliers located in surrounding locations, 71 percent of the suppliers were located in Mexico City and 29 percent in Queretaro. Supply sectors included packaging, printing and promotion, raw materials, services and indirect supplies – all first tier suppliers.

Data was gathered from several sources. All firms participating in the programme filled out an intake form, reporting their main activity, number of employees, sector, and information about the profiles of managers taking part in the programme. Another source of information was the final presentation of projects delivered by the participants at the end of the 10 workshops. These presentations contained detailed information about the type of CP applications to be implemented, estimated investments, and expected economic and environmental benefits.

To obtain feedback on CP project design and implementation levels as well as communication efforts, follow-up questionnaires were mailed to all participating companies. Questionnaires were sent to an early group of participating firms in March-June 2007 and to a later group of participants in August-September 2008. CEC carried out follow-up calls and data collection free from any intervention of anchor companies. Of 133 cases,[24] 74 valid responses were collected (56 percent).

- *Methods of analysis*

Data analysis was undertaken by means of frequency distributions identifying firms fulfilling each organisational routine dimension. Additionally, regression analysis examined how characteristics of suppliers and participating managers influenced collaboration capacity routines.

Marginal effects of explanatory variables, such as participation characteristics of suppliers, were estimated by means of a logit model (Wooldridge, 2008). This standard statistical method permitted an analysis of the individual effects of organisational routines, controlling for firm characteristics such as firm size and sector. Similar standard methods are used in related literature (Vachon and Klassen, 2006). The following formula represents the 'routine model' that analyses how independent variables of suppliers and participants relate to organisational routines of collaboration capacity for sustainable supply chain management:

[22] Three of the 14 anchor companies participated twice in the MSSP, completing workshop series with two different supply groups.

[23] SME in Mexico were defined by law as follows: micro-sized firms under 10 employees; small firms, 10 to 50 employees; medium-sized firms, 51 to 250 employees; large firms, over 250 employees.

[24] Follow-up questionnaires and calls were directed to firms completing the training program and presenting CP projects. The 44 firms that withdrew from the MSSP presumably did not continue CP activities following their short presence, and were not handed follow-up questionnaires. A total of 133 suppliers provided information on CP implementation and communication either at the end of the training program or as part of feedback questionnaires.

Equation i: Routine model

$$\begin{aligned} Y_i = \beta_0 + \beta_1 \text{packaging}_i + \beta_2 \text{printing}_i + \beta_3 \text{RawMaterial}_i \\ + \beta_4 \text{IndirectSupplies}_i + \beta_5 \text{Medium}_i + \beta_6 \text{Large}_i \\ + \beta_7 \text{TechnicalProfile}_i + \beta_8 \text{Administrative Profile} \\ + \beta_9 \text{Number of participants}_i + \beta_{10} \text{Location}_i + \varepsilon_i \end{aligned}$$

$$\text{Where } Y_i = \begin{cases} 1 & \text{if the firm met level Y} \\ 0 & \text{d. l. c.} \end{cases}$$

And where Y = {ORi, ORa, CRi, CRa, COMRi, COMRa}
An ordered probit model was employed to predict the presence or absence of a particular firm (with specific features and participant characteristics) in a given combination of organisational routines, based on dichotomous values for a set of predictor variables; in this study, the dependent dichotomous variable is equal to 1 if the firm showed a certain organisational routine, and 0 otherwise (Horowitz and Savin, 2001). Similar analysis is used in studies that concern behaviour of SME in network situations, e.g., those presented by Malhotra (2002) and Gulati et al. (2009). The second model, denoted as 'routine combination model', studies the impact of independent variables of suppliers and participants on combinations of organisational routines:

Equation II: Routine combination model

$$\begin{aligned} Y_i = \beta_0 + \beta_1 \text{packaging}_i + \beta_2 \text{printing}_i + \beta_3 \text{RawMaterial}_i + \beta_4 \text{IndirectSupplies}_i \\ + \beta_5 \text{Medium}_i + \beta_6 \text{Large}_i + \beta_7 \text{TechnicalProfile}_i \\ + \beta_8 \text{Administrative Profile} + \beta_9 \text{Number of participants}_i \\ + \beta_{10} \text{Location}_i + \varepsilon_i \end{aligned}$$

$$\text{Where } Y_i = \begin{cases} 1 \text{ firm evidenced combination ORi} + \text{COMRi} \\ 2 \text{ firm evidenced combination ORa} + \text{COMRi} \\ 3 \text{ firm evidenced combination ORa} + \text{COMRa} \\ 4 \text{ firm evidenced combination CRi} + \text{COMRi} \\ 5 \text{ firm evidenced combination CRa} + \text{COMRi} \\ 6 \text{ firm evidenced combination CRa} + \text{COMRa} \end{cases}$$

The models control for supply sector and firm size, as in previous research (Friedman and Miles, 2002; Delmas and Montiel, 2009). "Micro sized" and "indirect supplies" were used as dummy variables, STATA 7.0 to run the regressions.

5.5 Results: Collaborative capacity of SMEs within the Mexican Sustainable Supply Programme

Building on the research model specified in the foregoing section, Table 5.4 presents frequency distributions of organisational routines performed by suppliers to answer the first research question: What level of collaboration capacity did SME participation in the MSSP achieve? A significant proportion, 53 per cent, showed evidence of

activities undertaken to implement CP projects, defined in this study as operational routines. A much smaller proportion of suppliers verified communicative routines. Only 23 per cent reported results of their CP activities. Firms that advanced CP activities but did not measure final outcomes, did not demonstrate communicative intention.

Consistent with assumptions of the research model, an even smaller proportion of suppliers demonstrated coordinative routines. Only ten per cent confirmed their intention by developing CP projects that actively involved outside stakeholders, such as customers or new commercial partners; about eight per cent reported i of this type of project. These results imply that the MSSP, notwithstanding its design as a sustainable supply programme, failed to yield major collaboration efforts in terms of collective CP projects.

Firms that withdrew from the programme evinced only initial collaboration capacity. Despite accepting a major customer's invitation to participate in the supply chain initiative, these suppliers failed to carry out their intention to collaborate in the MSSP. Accordingly, these firms showed neither operational, cooperative or communicative CP intentions nor activities. A further analysis of programme withdrawals showed that most firms dropped out after attending the first workshop, and hence did not perceive any benefits from the training offered.

Similarly, frequency distributions show how the intention to carry out a certain activity does not necessarily imply that activities emerge. Intentions scored higher frequencies than activities. In operational routines, 70 per cent of intentions materialised, whereas both communicative and coordinative intentions turned into action in 78 per cent of the cases. Table 5.4 presents the frequency distribution for organisational routines involved in collaboration capacity for sustainable supply chain management.

Table 5.4 Suppliers showing evidence of organisational routines related to collaboration capacity for sustainable supply chain management

Organisational routines	Dimension of organisational change	Number of suppliers	Percentage of population n = 177
Collaboration intention	Initial intention or activity (ICC)	44	25%
Operational routine	Intention (ORi)	133	75%
	Activity (ORa)	93	53%
Coordinative routine	Intention (CRi)	18	10%
	Activity (CRa)	14	8%
Communicative routine	Intention (COMRi)	41	23%
	Activity (COMRa)	32	18%

Table 5.5 presents the combinations of organisational routines undertaken by suppliers. The research framework specified that operational routines were predecessors for firms performing coordinative and/or communicative routines. The

research model considered the combination of coordinative action and communicative action, (CRa + COMRa), as the most advanced level of collaboration capacity. This combination identified firms that evidenced their knowledge and capacity to develop CP projects, negotiate and coordinate activities required for its implementation, and the organisational capacity to measure and communicate outcomes of CP initiatives to external stakeholders. Only a very small percentage of MSSP supplier firms reached this level of collaboration capacity.

The findings presented in Table 5.5 show no evidence of two combinations; (ORi + COMRa), and (CRi + COMRa). These levels combine the intention to develop CP projects, together with communication of results to external stakeholders. In other words, none of the firms communicated results without proving implementation;

Table 5.5 Suppliers showing evidence of combined organisational routines related to collaboration capacity for sustainable supply chain management

Combined organisational routines				**Number of suppliers**	**Percentage of population n = 177**
Withdrawals		Initial intention	(ICC)	44	25%
Operational intention	+	Communicative intention	(ORi + COMRi)	41	23%
		Communicative activity	(ORi + COMRa)	0	0%
Operational activity	+	Communicative intention	(ORa + COMRi)	32	18%
		Communicative activity	(ORa + COMRa)	14	8%
Coordinative intention	+	Communicative intention	(CRi + COMRi)	7	4%
		Communicative activity	(CRi + COMRa)	0	0%
Coordinative activity	+	Communicative intention	(CRa + COMRi)	7	4%
		Communicative activity	(CRa + COMRa)	7	4%

To answer to the second research question, “Did the characteristics of participating companies and managers influence the collaboration capacity of individual suppliers, and if so, how?”, the relationship between the characteristics of suppliers and participating managers, and organisational routines was examined. Regression analyses were performed to measure relationships between the dependent (collaboration capacity categories) and independent variables (firm features and participant characteristics).

The results presented in Table 5.6 show how the supply sector appeared to influence organisational routines. Firms belonging to the printing industry displayed significantly higher propensity to perform operational routines than services suppliers (control

group), while evidencing fewer coordinative capabilities as measured by negative p-values.

Table 5.6 Characteristics influencing organisational routines related to collaboration capacity in sustainable supply chain management

VARIABLES	ORi	ORa	CRi	CRa	COMRi	COMRa
Supply sector: packaging	-0.0813	0.194	0.0404	0.0620	0.0495	0.193
	(0.281)	(0.266)	(0.180)	(0.184)	(0.323)	(0.334)
Supply sector: printing	0.143**	0.155	-0.0889*	-0.0790**	0.0518	-0.0491
	(0.0724)	(0.0998)	(0.0464)	(0.0390)	(0.153)	(0.110)
Supply sector: raw material	0.0812	0.205*			0.110	-0.116
	(0.0930)	(0.114)			(0.167)	(0.0943)
Supply sector: indirect supply	0.0753	0.194*	-0.0349	-0.0521	0.278**	0.239
	(0.0813)	(0.104)	(0.0477)	(0.0343)	(0.134)	(0.150)
Medium-sized company	0.0799	0.169*	-0.0457	-0.0327	0.0707	0.0124
	(0.0763)	(0.0922)	(0.0559)	(0.0525)	(0.128)	(0.103)
Large-sized company	0.00966	0.0183	0.0290	0.0159	0.0748	-0.0549
	(0.0932)	(0.116)	(0.0722)	(0.0609)	(0.144)	(0.112)
Location Queretaro	0.00256	-0.191**	0.0513	-0.0242	-0.378***	-0.340***
	(0.0743)	(0.0869)	(0.0573)	(0.0401)	(0.107)	(0.0616)
Technical profile	-0.0993	-0.119	0.0539	0.0308	-0.301**	0.00213
	(0.0844)	(0.0968)	(0.0586)	(0.0552)	(0.131)	(0.0980)
Administrative profile	-0.313**	-0.125	0.0298	0.0331	-0.240	-0.109
	(0.137)	(0.135)	(0.0962)	(0.0908)	(0.169)	(0.112)
Number of participants > 1	0.177**	0.183*	0.106**	0.0447	0.334***	0.255***
	(0.0808)	(0.0935)	(0.0481)	(0.0415)	(0.125)	(0.0896)
Observations	177	177	149	149	110	111

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Firms located in Queretaro showed significantly lower implementation of CP projects and communication activities than firms located in Mexico City, as explained by the negative p-values shown in Table 6. In comparison to Mexico City, the control group, market forces such as pressure of environmental regulators and peers were less developed in Queretaro. This finding suggested how contextual factors could have influenced supplier performance. The research data also showed that, in a population of 177 suppliers, not a single raw material supplier developed an external CP project, and thus they failed to evidence coordinative routines. Certain participant characteristics seem to have influenced the collaboration capacity of suppliers. Technical profiles[25] of participants showed a significant negative relationship with

[25] Technical profile refers to engineering or technical training, employed in such areas as quality control, maintenance, and operations.

communicative routines, whereas administrative profiles[26] showed significant negative relationships vis-à-vis operational routines. Moreover, firms represented by two or more managers scored higher levels on all routines than firms represented by only one participant. Accordingly, the number of participants per firm appears to be of significance for firms wishing to get the most out of taking part in programmes such as the MSSP, and thus when inviting participants. Table 5.6 presents the results of processing the data in relation to the regression model.

Table 5.7 Characteristics influencing combined organisational routines related to collaboration capacity for sustainable supply chain management

Variables	Marginal effects			
	ORa + COMRi	**ORa + COMRa**	**CRa + COMRi**	**CRa + COMRa**
Supply sector: packaging	-0,151	0,069	0,012	0,07
	(0,249)	(0,063)	(0,025)	(0,172)
Supply sector: printing	0,498***	-0,370**	-0,023	-0,105**
	(0,176)	(0,161)	(0,025)	(0,042)
Supply sector: raw material	0,541***	-0,404***	-0,025	-0,113**
	(0,14)	(0,124)	(0,026)	(0,051)
Supply sector: indirect supplies	0,383**	-0,291**	-0,017	-0,074**
	(0,164)	(0,139)	(0,02)	(0,038)
Medium-sized company	0,088	-0,055	-0,006	-0,027
	(0,166)	(0,103)	(0,012)	(0,054)
Large-sized company	0,052	-0,034	-0,003	-0,015
	(0,186)	(0,125)	(0,01)	(0,051)
Technical profile	-0,155	0,092	0,01	0,053
	(0,14)	(0,088)	(0,014)	(0,049)
Administrative profile	0,092	-0,063	-0,005	-0,024
	(0,29)	(0,208)	(0,016)	(0,068)
Number of participants (>1)	0,006	-0,004	0	-0,002
	(0,221)	(0,137)	(0,014)	(0,07)
Location at Queretaro	0,602***	-0,497***	-0,021	-0,084**
	(0,127)	(0,129)	(0,021)	(0,04)

Standard errors in parentheses.
*** p <0.01, ** p<0.05, * p<0.1

Characteristics influencing combinations of operational routines show opposite p-values vis-à-vis combinations of routines representing coordinative and communicative routines. Moreover, the supply sector also appeared to influence the combinations of routines that were implemented. Suppliers, classified as printing, raw material, and indirect supplies, presented higher propensity to demonstrate combinations of operational and communicative routines (ORa + COMRi). Nonetheless, companies in these sectors showed a significantly lower propensity to

[26] The Administrative profile refers to a participant with an administrative profession such as management, accounting or marketing, and assigned to corresponding areas by the firm they represent.

communicate results of collaboration in CP projects (CRa + COMRa). Company location also appeared to be significant in terms of its impact on routine combinations. Location in Queretaro, as opposed to Mexico City, was negatively related to combinations of coordinative and communicative routines. These results confirmed similar findings to those presented in Table 6; that supply firms in Queretaro contributed less to fulfilling programme objectives than those located in Mexico City. Firm size, characteristics of managers and number of participating representatives did not appear to have significantly influenced the combinations of organisational routines implemented. Table 5.7 presents the relationships between firm and participant characteristics and combined organizational routines.

5.6 Discussion: Collaborative capacity for cleaner production in supply chains

Research findings reveal that MSSP suppliers achieved differing levels of collaboration capacity. Complex capacities (Winter, 2006), such as coordinative and communicative routines, were not evidenced by the majority of participants. This might suggest that the MSSP focused chiefly on technical knowledge and operational skills – thus coinciding with Baas (2006) and Stone (2006), who claimed that most CP implementation programmes based on technical assistance and workshop training, were mainly aimed at overcoming technical pitfalls and measuring CP cost-benefits. Attention to more complex organisational capabilities in these types of programmes was often overlooked, and outcomes of the implementation programmes were therefore, limited (Baas, 2006; Stone, 2006).

Contrary to results reported in the literature (Dieleman, 2007; Stone, 2006; Van Berkel, 2007), the MSSP project implementation results were relatively high. Firms participating in the MSSP implemented innovations by modifying existing operational processes, thus evidencing intra-organisational changes. Some companies evidenced coordinative routines by designing projects involving external stakeholders. Following collaboration theory reasoning (Wood and Gray, 1991; Lozano, 2007), this MSSP research outcome supports the notion that collaboration may contribute to inter-organisational dynamics by strengthening knowledge absorption capacity, structuring solutions, and motivating activity around a commonly defined problem or goal (Blomqvist and Levy, 2006; Gray, 1985).

The positive relationship shown between firms evidencing high-level collaboration capacity, and managers combining administrative and technical profiles, supports the findings of Stone (2006), who underscored the importance of management skills for implementing CP-related activities. Accordingly, this, and earlier findings, provided guidelines for MSSP coordinators and those of similar programmes with regard to which firms and managers to invite in order to obtain effective CP implementation.

Indirect suppliers' lack of strategic character may account for the low collaboration capacity level shown for participating firms belonging to this sector (Mol et al., 2003). Strategic purchases from different types of suppliers distinguish their strategic importance for operational activities. Indirect suppliers of office equipment, for

example, are easily replaceable. Accordingly, loose interactions with these latter types of suppliers are prevalent and recommended (Nollet et al., 2005).

Shifting its CP innovation project locus away from individual firms, and towards inter-organisational domains could strengthen the design of the MSSP. Instead of expecting each supplier to design their own CP project, CP application would directly link supplier and customer interests. Powell et al. (1996) highlighted this common locus of innovation as an important condition for learning through networks (Hult et al., 2003). Also, Boons and Baas (1997) identified the lack of coordination capabilities as a key problem of industrial ecology-related approaches, such as sustainable supply chain management. They proposed a symbiotic interdependency, such as waste re-use among suppliers and buyers, as an alternative strategy.

An additional suggestion for improving the design of initiatives, such as the MSSP, was to strengthen their impact on the collaboration capacity of suppliers by formally communicating CP implementation benefits. Even when the MSSP training programme showed evidence of stimulating inter-organisational communication by generating a common language and trust among participants, little emphasis was given to the measurement of CP project outcomes. Clarke and Roome (1999) suggested that formal communication of sustainability initiatives trigger management involvement, together with intra- and inter-organisational communication. Soosay et al. (2008) underscored the importance of top management involvement as a requirement for supply collaboration. The formal communication of benefits obtained from implementing CP projects could be included in initiatives like the MSSP, by designing complementary tools such as certification and public recognition.

Recommendations for MSSP improvement notwithstanding, it should be noted that the programme design included several conditions that favoured collaboration; first, the voluntary nature of participation ensured supplier autonomy (Wood and Gray, 1991). Second, a clear collaboration strategy was defined by linking the individual interests of anchor companies and suppliers to common interests of supply chains (Blomqvist and Levy, 2006; Maloni and Benton, 2000; Huxham, 1993). Third, both trust (Blomqvist and Levy, 2006) and open communication among managers (Wondolleck and Yaffee, 2000), were generated in workshop training. Fourth, a commitment to undertake collaboration (Blomqvist and Levy, 2006) was fostered by selecting participants from established buyer-supplier relationships. Fifth, learning-by-doing was applied both as a means for learning to collaborate (Lambe et al., 2002), and as a tacit organisational asset (Huxham, 1993; Powell et al., 1996). Accordingly, the MSSP can be viewed as a voluntary environmental initiative that employed collaboration concepts as a key mechanism for CP implementation.

5.7 Conclusions

This chapter highlights collaboration capacity as a multidimensional organisational construct in CP implementation initiatives. The study identified different levels of collaboration capacity of SME suppliers explained by organizational characteristics and

their managers´ profiles. Additionally, this study proposed a framework for the operationalisation of collaboration capacity in sustainable supply chain management.

The collaboration capacity of 177 suppliers was assessed to determine how that capacity contributed to the CP implementation goals of a major multi-stakeholder effort, undertaken in Mexico's emerging economy. The comparison of research findings with the theoretical model of collaboration capacity provided an understanding of the effects of collaboration on the implementation of CP among SME suppliers. Empirical evidence for this study was obtained by statistical analyses of consistently collected data.

Collaboration capacity for sustainable supply chain management represented a new organisational construct, introduced to identify a firm's capability to connect to a supply chain's sustainability initiatives, and to design and implement environmental projects. The construct combined concepts drawn from literature on collaboration theory and CP, and emphasises the operational, cooperative, and communicative routines required for the successful implementation of initiatives involving buyer-supplier relationships.

Collaboration capacity may be viewed as a complex, structured and multi-dimensional organisational construct that generates competitive advantage based on sustainability. Therefore, collaboration capacity is a significant concept for CP implementation within supply chains and networks.

6. Supply Networks for Cleaner Production

This chapter proposes a framework for improving environmental performance of Small- and medium-size enterprises (SME) in emerging markets. Two complementary fields of study, cleaner production (CP) and sustainable supply chain management (SSCM), were combined to examine organizational and inter-organizational dynamics for disseminating preventive environmental practices in supply networks. Foregoing chapters provide empirical evidence for deduction and validation of the findings. This chapter addresses the general underlying thesis questions, explaining how improvement of SME environmental performance in emerging markets can be achieved.

6.1 Introduction

The author's motivation for undertaking this thesis stems from his interest in tackling the challenge of improving SME environmental performance in emerging markets. Presumed drivers and barriers identified in the literature yield little insight into the intra- and inter-organizational relationships involved in environmental improvement of firms. There is little understanding of underlying dynamics and explanatory variables of why some firms improve their environmental performance and others don't. Success stories show that preventive environmental practices work in some cases, but knowledge is lacking of challenges entailed in disseminating these practices among a critical mass of small firms.

Several frameworks examine the dissemination of sustainability-related concepts. Boons et al. (2011) propose factors to consider for understanding dissemination of CP-related approaches at a societal level, such as industrial ecology efforts by regional industrial systems. Baas (2006) suggests a structure to identify drivers and barriers for CP dissemination practices, including technical assistance, practitioner seminars, and information supply. These frameworks provide structure to analyze the dissemination process of preventive environmental practices, noting relevant drivers and barriers; but they fall short in explaining intra- and inter-organizational dynamics involved in dissemination processes among firms.

To advance in this direction, this thesis proposes to bridge the existing fields of CP and SSCM and contribute to new thinking for disseminating preventive environmental practices. The experience of the Mexican Sustainable Supply Programme (MSSP) serves as the focus for analysis. Programme design combined CP and SSCM to reach out to a significant group of SME and motivate dissemination of preventive environmental practices. Earlier chapters examine MSSP experience, using different lenses to study CP and SSCM.

Based on CP-related thinking, Chapters 2 and 3 addressed the first research question: How can SME differential performance be explained in the implementation of preventive environmental practices? Chapter 2 studied how different typologies such as energy, water, and waste management projects explain differential economic and environmental benefits; also, firm size influences CP project success. In Chapter 3, professional profiles of managers are shown to influence design and implementation of preventive environmental practices. Moreover, "learning-by-doing" proves effective in strengthening organizational capacity for the design and implementation of preventive environmental practices.

Chapters 4 and 5 address the second research question: How to explain differential dissemination-performance of firms participating in public environmental voluntary initiatives aimed at sustainable supply chain management? Chapter 5 examines reasons and benefits claimed by a series of anchor companies for participating in the MSSP, and analyzes their contribution to achieving MSSP objectives. Responses uncover mixed reasoning by anchor companies for participating in the MSSP, and

highlight how learning outcomes from anchor companies as well as programme organization positively influence SSCM performance. Chapter 6 tests a theoretical model of collaborative capacity as a multidimensional organizational construct to gauge cleaner production dissemination among suppliers; findings explain how characteristics of firms and managers influence supplier collaboration capacity in implementing SSCM.

These findings deepen knowledge of the underlying dynamics occurring in the CP dissemination process, even as they fail to provide a full understanding of how CP and SSCM interact with each other. Combining these fields provides an opportunity to integrate a new framework for multi-level and multi-discipline assessment of dissemination routes for sustainability-related concepts, as called for by Baas (2006) and Boons et al. (2011).

This chapter responds to these recommendations by posing a third research question: How can initiatives combining CP and SSCM contribute to dissemination of preventive environmental practices in SME? Findings related to this question feature theoretical propositions concerned with the interaction of CP and SSCM in disseminating preventive practices among SME. These propositions address the general underlying question of this thesis.

6.2 Integrating the fields of cleaner production and sustainable supply chain management

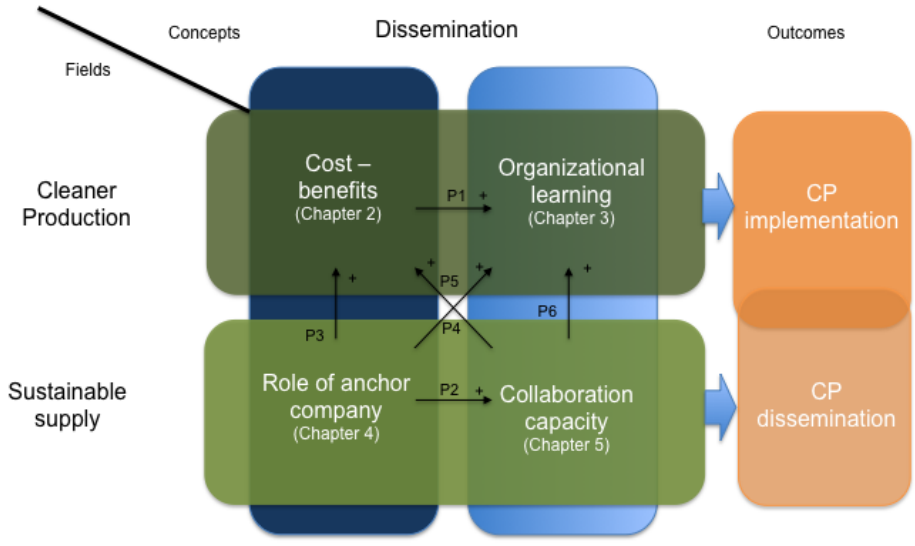
The theoretical lens employed in this thesis combines the fields of CP and SSCM. Both fields aim to improve performance of firms searching for sustainability by proposing changes in operating practices (Baas, 1998; Gold et al., 2010). Also, in both fields management literature sheds light on organizational and inter-organizational dynamics of firms and supply networks (Baas, 2006; Stone, 2006a; Sarkis, 2002). Differences in the two fields are evident in terms of analysis objectives and how these can be approached. Whereas CP centres its applications on process improvement, organizational procedures and waste reductions (Hirschhorn, 1997), SSCM takes a wider view and studies sustainable practices within the scope of client-supplier relationships (Carter and Rogers, 2008). Both CP and SSCM are part of industrial ecology (IE); CP seeks preventive environmental practices as part of the ecological metaphor and SSCM is recognized as one of its applications (Seuring et al., 2009).

Several CP management concepts were examined in order to explain the underlying dynamics for disseminating environmental improvements among MSSP suppliers. Cost-benefit analysis, for example, employed in this thesis as a lens for the study of intra-organizational dynamics, has long been considered a basic theoretical assumption in CP literature in driving implementation and dissemination of preventive environmental practices (Hirschhorn, 1997; Van Berkel, 1994; Baas et al., 1990). Cost-benefit resulting from the adoption of preventive alternatives is supposed to influence CP management decision-making; projects featuring larger benefits are understandably more attractive for implementation than those offering smaller benefits.

Subsequent literature holds that organizational learning contributes to CP implementation (e.g. Baas, 2006, Stone, 2006a, 2006b; Zilahy, 2004; Dieleman, 2007). Accordingly, this study employs organizational learning as a complementary lens to cost-benefit analysis for assessing intra-organizational dynamics of MSSP suppliers. Hitherto, little empirical work has examined relationships among these complementary concepts. Based on theoretical deduction, literature expects that companies designing more profitable CP projects show higher levels of organizational learning. In this chapter, the relationship will be validated with empirical information drawn from the MSSP.

Analysis of inter-organizational dynamics presented in this thesis includes multilevel assessment of dissemination dynamics in SSCM. A first SSCM-related concept studies drivers that presumably lead anchor companies to participate in SSCM initiatives. Literature on SSCM (e.g., Carter and Rogers, 2008) and public voluntary environmental initiatives (e.g., Lyon and Maxwell, 2007), offer frameworks for analysis of anchor company reasoning. Accordingly, these frameworks were used to study behaviour of anchor firms participating in the MSSP.

SSCM literature suggests anchor companies pursuing sustainable supply practices often involve their suppliers in complex problem-solving by enforcing collaboration among participants (Gray, 1985; Bowen et al., 2001); hence collaboration capacity of suppliers was identified as a SSCM-related concept to understand dissemination dynamics. Literature assumes a positive relationship between proactive reasoning for SSCM and involvement of suppliers in sustainability initiatives (Seuring and Müller, 2008; Gold et al., 2010; Simatupang and Sridharan, 2008). In this chapter, empirical MSSP data was used to verify this relationship.



Source: Author

Figure 6.1 Framework for integrating the study of CP and SSCM

Drawing on research focused separately on each of four concepts, Figure 6.1 presents relations between research fields and concepts, i.e., cost-benefit, organizational learning, anchor company motives and suppliers' collaboration capacity. By assessing interrelationships between the two fields of CP and SSCM, inter- and intra-organizational dynamics are combined, and new thinking is generated for dissemination of environmental improvements in SMEs. In total, relationships (R1 – R6) were used to validate CP and SSCM interaction among cost-benefit, organizational learning, anchor company role and collaborative learning concepts as grounding for formulating new theoretical propositions.

6.3 Research methodology

Research presented in earlier chapters sought to validate interrelationships between CP and SSCM. Cost-benefit and organizational learning concepts, and their operationalization, were used to measure interrelationships.

- *Concepts and their operationalization*

Chapters 2 and 3 present two independent concepts to gauge the effectiveness of CP dissemination. Both were operationalized as follows:

- *Cost*-benefit (Chapter 2) was measured by means of expected economic benefits and expected environmental benefits. In this research two complementary tests for cost-benefit relationships are undertaken; one takes into account economic benefits, and another examines a key environmental benefit (Abdi and Williams, 2010) such as energy, water, and raw material savings, or waste reduction.

- *Organizational* learning (Chapter 3) was measured by gauging CP project implementation. Building on theory proposed by Argyris and Schön (1996), a four-stage model is described, distinguishing among: (i) initial learning, (ii) single-loop learning, (iii) double-loop learning and (iv) double-loop plus learning. Supplier responses to feedback questionnaires probing dropout, design, and implementation of CP projects are employed to estimate these variables.

SSCM is analyzed in light of two different concepts described in Chapters 4 and 5. The operationalization of the central concepts, role of anchor companies and collaborative learning, was achieved in the following way:

- *Role of anchor companies* (Chapter 4) was gauged by: number of suppliers anchor companies enlisted in the programme, and number withdrawing. These indicators distinguish between three groups of anchor companies: (i) Top CP dissemination cluster, (ii) Average CP dissemination cluster, and (iii) Poor CP dissemination cluster.

- *Collaborative learning* (Chapter 5) assessed evidence of three competences: operative, coordinative, and communication capacity. All three capacities are

analyzed in terms of level of intention (planned actions) and confirmed activity (implementation). CP project communication drawn from supplier responses to feedback questionnaires served as means for estimating these variables.

Table 6.1 presents the fields, concepts, variables and estimates used in testing relationships found in the integrated framework.

Table 6.1 Fields, concepts and estimates used for validating conceptual relationships.

Fields	Concepts	Variable	Estimates
Cleaner Production	Cost-benefit (Chapter 2)	• Economic benefits (low, average, high) • Aggregate environmental benefits (low, average, high)	• Benefits of CP project (in USD) • Benefits of CP project: m3 water, Kwh energy, mt waste, mt raw material
	Organizational learning (Chapter 3)	• Initial learning • Single loop learning • Double loop learning • Double loop learning plus	• Dropout • Design of CP project • Implementation of CP project • Implementation + new design CP project
Sustainable Supply Chain Management	Role of anchor company (Chapter 4)	• Top CP dissemination • Average CP dissemination • Poor CP dissemination	• Number of suppliers that participated in the programme and designed CP projects; • Percentage of suppliers per supply group that implemented CP projects; • Number of suppliers that withdrew from the programme and failed to design a CP project.
	Collaboration capacity (Chapter 5)	• Communicative routines	• Communication of results of CP project

- *Data gathering and methods of analysis*

Data were drawn from a variety of sources, such as presentations of final project designs, interviews with managers of participating firms, and other MSSP records, such as workshop attendance.

Standard statistical methods (e.g., square root) were employed to assess relationships among variables. Chi-square analyzes significance of the relation between two variables, where the null hypothesis (H_0) establishes the independence of variables. An H_0 rejection suggests a positive or negative relationship between variables (Sirkin, 2006).

Complementary linear regression models were used to deepen analysis of the relation between cost-benefit and other concepts included in the research model, such as organizational learning, role of the anchor company and collaboration capacity of suppliers. Control variables include firm size, sector type, and type of CP project, as noted in earlier chapters.

6.4 Analysis of the interrelation between cleaner production and sustainable supply chain management

CP and SSCM readings from the MSSP study are remarkable, as empirical evidence shows cost-benefit is not significant for implementation and dissemination of preventive environmental practices. Outcomes of the square root assessment (Table 6.2) consistently confirm that cost-benefit does not relate significantly to other concepts included in the research model, whereas relationships among other concepts evidence significance. This finding verifies the relevance of independent measurements used in the research models. Additional regression analysis confirmed the outcomes of square root assessment when controlled for firm size, sector type, and type of CP project (see Appendix A).

Detailed analysis of these findings corroborates that, within the MSSP, suppliers' organizational learning, as measured by CP project implementation, was not influenced by cost-benefit expectations of CP projects designed. Organizational learning, and the type of professionals involved in CP project design, influence implementation. MSSP findings empirically echo literature that highlights the importance of organizational aspects for CP implementation in firms (Stone, 2006a; 2006b; Dieleman, 2007; Zilahy, 2004; Vickers, 2000). Moreover, the finding shifts a major underlying assumption of CP based on cost-benefit towards organizational learning.

Collaboration capacity of suppliers, estimated in terms of communication of CP benefits, does not depend on cost-benefit expectations of CP projects. Yet participants' professional profiles influence capacity to collaborate (see Chapter 5), as occurs with organizational learning. Empirical data also shows how "soft" organizational characteristics such as collaboration capacity and capacity for learning influence improvement of preventive environmental practices among firms. These organizational features outweigh technical and economic features in the implementation and dissemination process.

Also, cost-benefit of projects designed by suppliers is independent of anchor company commitment to MSSP objectives. Anchor companies participating in the MSSP neither searched for economic benefits, nor clearly perceived environmental gains. Responses of anchor company representatives to questions relating to reasons for joining the MSSP confirmed non-financial interests, such as "development of supply chain", "sustainable leadership" and "corporate social responsibility" as main motives (see chapter 4), thus invalidating their perceived benefits from participating.

Table 6.2 presents the outcomes of square root assessment undertaken to identify significance of relationships among concepts included in the framework proposed.

Table 6.2. Square root analysis: significance of relationships between CP- and SSCM-related concepts.

Concepts	Organizational learning	Role of anchor company	Collaboration capacity
Economic benefits	4,45 (0.39)	5.04 (0.28)	4.02 (0.13)
Environmental benefits	1,45 (0.83)	4.02 (0.403)	1.82 (0.40)
Organizational learning	- -	17.87 (0.00)	7.66 (0.05)
Role of anchor company		- -	5.06 (0.08)
Collaboration capacity			- -

*** p <0.01, ** p<0.05, * p<0.1

Anchor companies influence suppliers' CP organizational learning in a positive manner; square root analysis shows a significance of 99% between anchor companies' capacity to influence supplier participation in the MSSP and the level of CP organizational learning achieved by them. This empirical relationship bears out how SSCM stands to stimulate CP in supply networks, and supports the point made by Seuring and Müller (2008: 1700): "Anchor companies may well play an important role in promoting measures in the public interest downstream in their supply chain."

Suppliers' CP organizational learning also correlated (95%) with collaborative capacity in supply chain initiatives. Companies that both implement CP projects and achieve higher organizational learning are expected to communicate the results of these projects. Suppliers who do better in CP implementation also communicate better. As communication is a core element of collaboration (Huxham, 1996), this implies that CP also supports SSCM. Moreover, it shows the complexity of organizational learning as a multidimensional interactive process (Clark and Roome, 1999; Boons, 2009); learning in one field affects automatically learning in another field.

Collaboration capacity of suppliers is also positively and significantly (95%) correlated with the role of anchor companies. This means that more proactive anchor companies influence communication of outcomes of CP projects designed by their suppliers. This finding proves how anchor companies can stimulate suppliers' capacity for collaboration, as proposed by Simatupang and Sridharan (2008).

Empirical evidence drawn from the MSSP recognizes CP and SSCM as concepts that imply organizational learning and change in firms and within networks of firms. It also

points to MSSP design features such as "learning-by-doing" and network structures, as mechanisms to disseminate preventive environmental practices among firms.

6.5 Propositions for disseminating preventive environmental practices

A major outcome of the MSSP assessment is evidence that cost-benefit had little or no significant influence on implementation and dissemination of preventive environmental practices in suppliers. This finding refutes existing knowledge and has implications for CP and related fields. For over twenty years, CP knowledge has assumed that cost-benefit underlies CP dissemination mechanisms grounded in technical and economic perspectives (e.g., Erkman, 1997; Hirschhorn, 1997; Baas, 1995). Recent literature has proposed the importance of social- and organizational-related perspectives to better understand CP drivers and barriers (e.g., Zilahy, 2004), but little empirical evidence has been gathered. Hence evidence drawn from the MSSP study offers strong reasons for new thinking. Accordingly, a first proposition emerging from this thesis is formulated as follows:

P1. Organizational characteristics, as opposed to technical and economic aspects, are more likely determinants of implementation and dissemination of preventive environmental practices in firms.

Implications of this proposition influence implementation of preventive environmental practices by underscoring the importance of multidisciplinary and multilevel frameworks focused on organizational learning as a central perspective for environmental improvement of firms (Baas, 2006). Moreover, the proposition calls for alternative dissemination methods and guidelines to complement traditional approaches for scaling dissemination of environmental performance of firms.

Placing organizational aspects at the heart of implementation and dissemination of preventive environmental practices influences how participants may be identified and targeted. Research for this thesis shows how a firm's characteristics, and those of its representatives, influence dissemination outcomes – as anticipated by Boons et al. (2011). Proactive firms, with previous experience in environmental and supply chain management initiatives, show higher propensity to adopt preventive environmental practices than less experienced firms. Similarly, this thesis uncovered the myth that preventive environmental practices mainly apply to larger firms, a notion tied into the opportunity for obtaining potential cost-benefits. This leads to formulating two propositions to guide the selection of firms targeted for CP dissemination initiatives:

P2. Previous experience in management leadership, more than firm size, determines the potential for implementing preventive environmental practices.

P3. Firms represented by participants featuring a combination of technical and administrative profiles have greater potential for implementing preventive

environmental practices than those where representatives display solely technical profiles.

New thinking proposed by this thesis also suggests the need for multilevel and multidimensional dissemination mechanisms. To address this need, an integrated CP and SSCM framework is proposed. Assessments presented earlier show how these two fields complement each other; SSCM drives CP through inter-organizational relationships, and creates the context for group learning among suppliers. Additionally, a prevention-oriented concept such as CP helps strengthen inter-organizational relationships as a part of SSCM (Carter and Rogers, 2008), and provides direction for SSCM practices such as resource efficiency and waste reductions.

Moreover, this thesis emphasizes the importance of organizational learning and inter-organizational relationships as fundamental to the dissemination process. Findings concerned with organizational and inter-organizational learning confirm theory proposed by Greenwood and Hinings (1996), who explain how institutional pressures overtake technical requirements as drivers of organizational behaviour in maturing fields. Insofar as CP and SSCM are both mature fields (Gold et al., 2010; Carter and Rogers, 2008; Baas, 2006; Zilahy, 2004), it makes sense to emphasize organizational dynamics to understand dissemination of preventive environmental practices. This suggests new thinking for the study and practice of CP and SSCM, and leads to the following three propositions:

P4. Anchor companies promoting SSCM influence CP organizational learning in a positive manner.

P5. Firms showing evidence of CP organizational capacity feature greater potential for SSCM collaboration capacity.

P6. Anchor companies searching for SSCM influence suppliers' collaboration capacity positively.

An integrated CP and SSCM framework calls for alternative dissemination methods, insofar as traditional approaches such as technical assistance, demonstration projects, practitioner seminars and information supply (Baas, 2006) have proven largely ineffective (Dieleman, 2007; Baas, 2006; Stone, 2006a, 2006b). More complex methods are required to apply the principles of workplace democracy and liberation, such as staff empowerment and organizational learning in a network context (Snell and Chak, 1998). The MSSP experience proposes a model of "learning-by-doing" in the context of network structures. The combined training methods employed by MSSP facilitate the complex multidimensional process of learning that involves explicit and tacit knowledge acquisition (Lam, 2000), as well as change drivers building on inter-organizational relationships (Ashton, 2008). Based on these considerations, two more propositions are suggested:

P7. Dissemination mechanisms focused on "learning-by-doing" obtain higher levels of organizational learning for preventive environmental practices than passive delivery of technical assistance approaches.

P8. Shared, participative dissemination mechanisms that include networking improve collaborative capacity for dissemination of preventive environmental practices, more than do individual approaches.

Outcomes of dissemination become visible in the adoption by firms of preventive environmental practices and consequent improvement of environmental performance. Impact measurement of these preventive actions has been deemed a CP pitfall; Van Berkel (2007:742) notes it is not possible "to measure something that isn't going to occur".

This thesis proposes alternative indicators for measuring organizational learning, developed in Chapter 3. These indicators, together with cost-benefit estimates, provide ground for quantifying benefits of preventive measurements. Similarly, this research stresses the relevance of measuring network relationships, as these provide ground for ongoing learning and collective action (Clark and Roome, 1999). Accordingly, the following two propositions for measuring outcomes of induced dissemination initiatives are offered:

P9. Cost-benefit indicators combined with organizational learning measurements provide more reliable grounding than planned benefits for estimating assessments of dissemination initiatives.

P10. Interactions among firms provide ground for measurements of collective action by means of formal communication and joint activities.

The proposed integrated framework is especially useful in the context of small and medium-sized firms in emerging markets, as it provides strategies for overcoming barriers influencing dissemination. First, by focusing on supply chain relationships as a source for "power dependency" (Greenwood and Hinings, 1996), the framework overcomes an institutional barrier such as weak institutional capacity to enforce environmental regulation (Blackman et al., 2010; Visser and Tolhurst, 2010). Second, emphasis on organizational learning methods strengthens "capacity for action", identified as a fundamental element of change (Greenwood and Hinings, 1996). This enabler is central to overcome such barriers to dissemination as the lack of knowledge, capacity, and commitment by plant staff to adopt preventive environmental practices (Baas, 2006, Zilahy; 2004; Hilson, 2002; Su-Yol, 2008). Following this reasoning, the final propositions of this thesis are formulated as follows:

P11. Dissemination mechanisms using anchor firm power reduce transaction costs in reaching out to SME participating in the experience.

P12. Dissemination methods triggering collective action improve the cost-benefit ratio of induced initiatives for improving environmental performance of firms, as compared to individual intervention methods.

Figure 6.2 presents the newly proposed framework that builds on the earlier work of Baas (2006) and Boons et al. (2011), in addressing the need for initiatives inducing environmental improvement by SME in emerging markets. Propositions 1, 2 and 3 guide design features for induced mechanisms by identifying how firm representatives, firm characteristics and markets might influence CP dissemination. Proposition 4 suggests a combined CP and SSCM approach as a strategy for dissemination. Propositions 5, 6, and 10, explain why organizational learning, collaboration capacity and the role of the anchor company are core elements to be taken into account for CP implementation. Propositions 7 and 8 show how learning by doing and networking are recommended as methods to induce CP and SSCM implementation among firms. Lastly, propositions 9, 11, and 12 note how dissemination outcomes influence collective action towards organizational change and economic and environmental benefits.

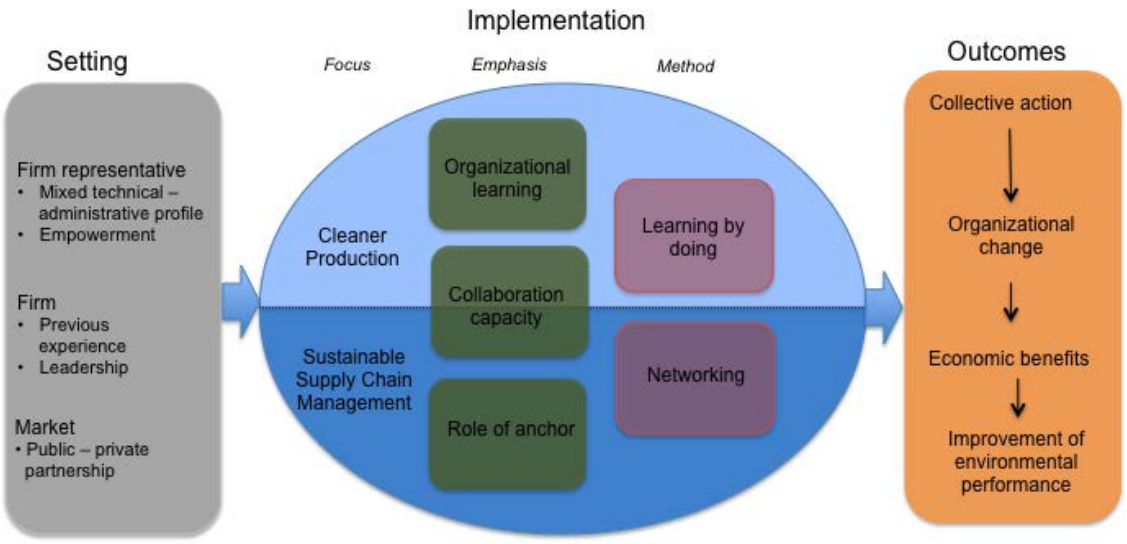


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Figure 6.2 Framework for analysis of induced improvement of environmentalperformance by small firms in emerging markets

6.6 Conclusions

This chapter refutes the long-standing assumption of cost-benefit as the dominant CP driver. Empirical evidence drawn from the MSSP shows no significant relationship between cost-benefit and other concepts examined. On the other hand, organizational learning, role of anchor-company, and collaboration capacity, all estimated by means of independent variables, show statistically significant linkages.

Based on new thinking, this chapter responds to the following overall research question: How can SSCM and CP contribute to dissemination of preventive environmental practices in SME? A new research framework, featuring propositions for analysis, is proposed for assessing dissemination efforts of preventive environmental practices in SME, especially in emerging markets. The proposed framework is also useful to guide the design of induced dissemination initiatives aimed at improving environmental performance of SME.

Propositions set forth above stress a firm's characteristics and those of a firm's representatives as factors influencing outcomes of induced dissemination efforts. CP and SSCM are proposed as a joint dissemination mechanism. Learning-by-doing and networking are identified as methods for strengthening key concepts to ensure dissemination, such as organizational learning, role of anchor company, and collaboration capacity. Outcomes span dissemination of preventive environmental practices, collective action, and improvement of environmental performance of firms.

The new framework is grounded in quantitative evidence of mutually beneficial linkages/relationships between CP and SSCM, fields of enquiry traditionally addressed separately. The integrated framework builds on earlier work by Baas (2006) and Boons et al. (2011), which offer structures to study dissemination of sustainability-related concepts in companies, supply chains, markets and societies. The contribution of this chapter complements their work by focusing on the underlying dynamics of drivers and barriers of dissemination mechanisms.

7. Conclusions

This chapter presents the contributions, conclusions, and recommendations for future research. Scientific contributions derived from the dissemination and improvement of environmental performance of small and medium-sized firms (SMEs), by means of Cleaner Production (CP) and Sustainable Supply Chain Management (SSCM), are reviewed in the light of relevant literature. Answers to research questions are based on findings presented in earlier chapters, drawn from an in-depth study of experience with the Mexican Sustainable Supply Programme (MSSP). Recommendations for further research are noted. Lastly, the MSSP is recommended as a potentially rich source of data for multidisciplinary and multilevel study of environmental improvement by SMEs, especially in emerging markets.

7.1 Scientific contributions

This thesis views the challenge to improve environmental performance in SMEs as a management dilemma. Management is understood as knowledge required for bringing about desired changes in a business-related practice (Barnard, 1959); and management knowledge as that which involves decision-making by humans, administrative coordination of resources, and organization of cooperative systems (Chandler, 1977; March, 1981). Questions posed in this thesis concern understanding these managerial pillars in the context of implementing environmental improvement by and among firms in emerging markets.

Management literature consulted in developing this thesis relates to understanding the dynamics involved in the adoption of preventive environmental practices, from three scientific perspectives:

First, CP-related literature calls for the need to add and integrate a social science perspective to traditional engineering and technocratic approaches underlying theoretical contributions to CP dissemination (Dobes et al., 2011; Dieleman, 2007; Baas, 2006; Stone, 2006a, 2006b; Zilahy, 2004). This thesis represents a pioneer effort to address social perspectives involved in CP, by examining empirical data drawn from a significant number of firms in a leading emerging market.

Second, this thesis also relates to the work of Gladwin et al. (1995), alerting that organizational studies overlook natural environment issues and hence fail to take sustainability into account in management decision-making. Thereafter, significant advances integrate sustainability in management thinking (Hoffman, 2003; Delmas and Toffl, 2008; Porter and Cramer, 2011; Sharma, 2000). Nonetheless, as yet, no theoretical framework integrates technical and social facets along the lines of the "sustaincentric" management paradigm proposed by Gladwin et al. (1995). By building on management literature in CP and SSCM, this thesis advances towards such a multidisciplinary perspective.

Third, this thesis also connects to industrial ecology (IE), an emerging field that groups innovative tools and perspectives related to industrially-oriented human activities and the environment (Erkman, 1997; Geardel and Allenby, 2002), introducing a systematic approach to the analysis of physical material flows, energy, products, by-products, waste and the overall social system in which these are embedded (Boons and Howard-Grenville, 2009). IE aims to curb environmental load by closing material cycles and stimulating symbiosis between industries and stakeholders (Ehrnfeldt, 2004; Boons and Howard-Grenville, 2009).

Both CP and SSCM can be seen as part of IE; CP seeks preventive environmental practices in terms of the ecological metaphor (Socolow et al., 1994). Within IE, SSCM is recognized as an application (Seuring et al., 2009). Hitherto no integrative studies of CP and SSCM have been reported. This thesis contributes to IE literature by studying the interrelationships between CP and SSCM as building blocks of the IE paradigm.

Mainstream IE focuses largely on engineering-oriented exchanges of material flows and energy (Boons and Howard-Grenville, 2009); emerging literature evidences growing recognition of management theory as part of the concept (Boons and Howard-Grenville, 2009; Baas, 2005; Boons, 2002). By drawing on management theory to study CP and SSCM practices in the MSSP, this thesis also contributes to emergent IE literature.

Interestingly enough, Hoffman (2003) noted how IE also contributes to management theory; an IE perspective leads management scholars to employ multilevel analysis and study inter-organizational interactions of industrial systems (Hoffman, 2003; Boons, 2009). Nonetheless, scant IE empirical work on multilevel analysis has been published. Accordingly, the study of both intra- and inter-organizational dynamics of firms participating in the MSSP represents a contribution to knowledge.

Empirical findings from the thesis feature significant implications for the aforementioned scientific perspectives. For instance, dissemination of preventive environmental practices in supply networks does not depend on cost-benefit. This proposition refutes existing knowledge that assumed cost-benefit to be an overriding reason for firms to adopt preventive environmental measures. Other findings show that an organization's capacities, together with the characteristics of participating managers, significantly influence implementation and dissemination. Accordingly, empirical ground is offered for proposals to integrate social science frameworks, including organizational learning, in the study of CP.

Equally as significant are implications for IE. By refuting cost-benefit as the key driver of performance improvement and highlighting organizational capacity, this thesis's findings bear out the significance of multidisciplinary research in gauging efforts towards sustainability in industrial systems. Moreover, the mutually beneficial relationship shown between CP and SSCM makes for a complementary strategy in addressing both fronts; just as SSCM serves as a mechanism for CP dissemination, empirical ground is provided for multi-level analysis of industrial systems.

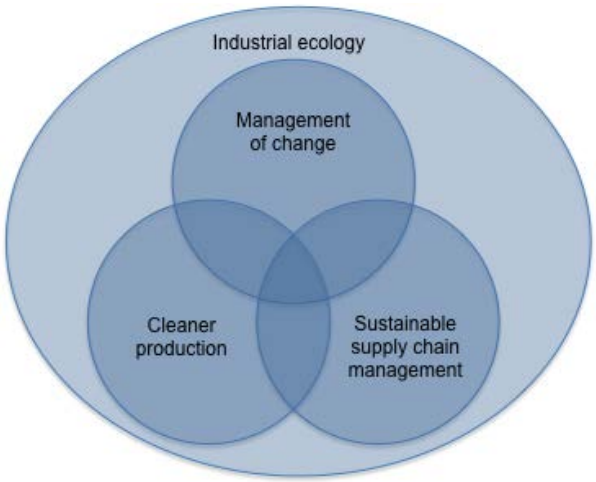

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Figure 7.1 Bodies of knowledge addressed by the thesis.

7.2 Practical implications of thesis contributions

Practical implications of thesis contributions include means for overcoming barriers to implementing CP and SSCM, as noted in the literature. These concern a variety of stakeholders, from policy makers and researchers aiming at dissemination of environmental practices, to managers of firms involved in environmental improvement as well as CP and SSCM service providers.

Propositions derived from the findings contribute to policy development addressed to improving SME environmental performance, especially in emerging markets. For years, initiatives undertaken have been found wanting in terms of scale, impact, and duration (Stone, 2006a; Baas, 2006; Blackman, 2006). Findings suggest the value of public-private partnerships as a strategy for implementing SSCM and CP among groups of SMEs. Supply networks proved an effective and efficient approach to engaging SMEs in environmental performance improvement, overcoming limitations of command and control mechanisms and costly technical assistance programmes.

Organizational capacity and manager involvement, aside cost-benefit, are found to be determining factors in the implementation and dissemination of preventive environmental practices, thus suggesting criteria for the selection of firms and managers targeted for CP and SSCM initiatives. Moreover, firms with a proven supply chain management record are identified as desirable advocates for participation in dissemination initiatives.

Supply networks are also shown to be an effective mechanism for promoting SME organizational learning, fostering change, and ensuring collaboration in disseminating preventive environmental practices. Empirical findings identify peers as important sources of learning, and collaborating plant staff as key players in promoting organizational change, echoing what is proposed by the literature (Lam, 2000; Snell and Chak, 1998; Gray, 1985).

Involving plant staff in learning-by-doing is shown to be a more effective method than external technical assistance for disseminating expertise in preventive environmental practices; the method combines both the explicit and tacit learning required for capacity building, placing emphasis on plant staff empowerment and motivation, the absence of which is often identified as a barrier to CP implementation (Mitchell, 2005; Hitchens et al., 2003; Stone, 2006a).

This method for dissemination initiatives also holds implications for consultants and service providers. Consultants, instead of serving as experts, play a bridging role in delivering technical assistance, by supporting managers in their efforts to design preventive environmental projects. They also help facilitate shaping groups within supply networks. By focusing on the change process in and among firms, instead of technical outcomes, consultants strengthen preventive environmental implementation.

Thesis findings invite general managers of SMEs to integrate environmental performance with continuous improvement strategies. Instead of viewing environmental upgrading as a problem-solving issue, this thesis shows how preventive practices represent opportunities for innovation in operational processes that serve to strengthen relationships among supply chain partners. This shift in paradigm suggests larger firms should designate permanent multidisciplinary teams charged with environmental progress and communicate outcomes to customers, suppliers, and other stakeholders.

Findings also suggest guidelines for assessing dissemination initiatives. Measuring organizational capacity, independently of cost-benefit, provides insights into environmental performance, programmes, and projects. Such measurements should span an extended period, insofar as organizational learning and change processes mature over time. Assessment of preventive environmental initiatives should be undertaken at least half yearly following programme completion, as occurred with this study.

Communicating outcomes of CP and SSCM initiatives represents, as shown by the findings, a significant measure of network development, and contributes to strengthening a firm's collaboration capacity. Moreover, ongoing communication influences continuous improvement in environmental performance.

Scalability of the MSSP pilot is evidenced by the fact that the two sponsoring Mexican agencies successfully expanded the programme across the country from 2008 onwards. Implications presented above should also serve programme coordinators in strengthening ongoing efforts.

7.3 Answering the research questions

Research questions posed in Chapter 1 were reviewed and answered as follows:

RESEARCH QUESTION I:

- How can differential performance outcomes among SMEs in the implementation of preventive environmental practices be explained?

The author analyzed differential performance in the implementation of preventive environmental practices by SMEs in Chapter 2, assessing how project benefits vary as a function of CP application type, company characteristics, and participating manager profiles. Outcomes show that, on average, waste recycling and waste prevention projects yield higher economic and environmental value than do energy efficiency and water conservation projects. Waste reduction applications also show more attractive net present values than technological innovations or those deemed as best practice – generally related to energy efficiency. CP economic and environmental benefits are positively related to firm size and type.

Payback variations across different types of project appear relatively small; most projects feature paybacks of one year or less. Projects identified as new activities, which in most instances involve waste recycling, are, in economic terms, the most beneficial – high return from relatively little investment. Projects classified as technology innovations feature higher economic and environmental benefits than projects classed as best practice.

Findings strongly suggest that firm size is positively related to economic and environmental benefits. Larger firms design projects with greater economic and environmental impacts. The effect of supplier type on environmental benefits is less clear. Few significant outcomes emerge for supplier type in relation to CO2 and water savings. Projects designed by printing firms and indirect supplies feature significantly smaller environmental savings. Firms identified as raw material suppliers generate, on average, projects with greater economic benefits than providers of indirect supplies and services.

To glean additional understanding of the underlying organizational dynamics of differential performance, Chapter 3 examined differential organizational learning in preventive environmental practices. Organizational characteristics influencing organizational learning include firm sector and size. Suppliers of raw materials, parts, and packaging materials feature higher learning levels in comparison to service suppliers. Firm size appears to influence likelihood of organizational learning. Medium-size firms reveal a significantly higher learning propensity than small-size companies.

Research findings also show significant relationships for MSSP participants' professional profile. Managers combining a technical and administrative background attain higher learning levels than single technical or single administrative profiles; also, single profiles tend towards limited CP related learning. Participant characteristics, such as holding higher hierarchal posts or greater work experience, appear not to have significant influence on organizational learning. Moreover, findings corroborate that organizational learning in supplier firms, as measured by CP project implementation, is not influenced by cost-benefit expectations of the CP projects designed.

Lastly, implementation rates of CP projects executed by means of learning-by-doing methods appear to be higher than those resulting from technical assistance approaches. Accordingly, differential performance in dissemination of preventive environmental practices can also be influenced by the choice of intervention method.

RESEARCH QUESTION II:

- How to explain differential dissemination-performance of firms participating in public environmental voluntary initiatives aimed at sustainable supply chain management?

Differential performance of firms participating in SSCM was analyzed by assessing how characteristics of anchor companies and their managers participating in the

MSSP influence suppliers. Chapter 4 examines differences in motivation and perceived benefits for anchor companies participating in SSCM as part of a public voluntary environmental initiative (PVEI).

Findings uncover a variety of reasons for anchor companies to participate in PVEI. The lead reason being “development of supplier performance”, followed by “leadership in sustainability”, and then “corporate social responsibility”. Least important are cost-related arguments, such as “qualifying for subsidies”, or “cost of logistics and raw materials”. Reasons related to pressure from environmental regulators show mixed results: low priority is assigned to regulator pressure, but moderate priority for collaborating with environmental agencies.

Perceived benefits following programme participation show diverse results. Ranking highest are “strengthening corporate reputation with suppliers”, followed by “economic benefits emerging from own CP projects” and “strengthened general corporate reputation”. Ranked lowest are supplier-relationship benefits, such as trust. This apparently contradictory finding may suggest that externally financed supplier development programmes may foster anchor company prestige and power in the supply chain, while overlooking supplier development, such as improved relations and trust. Complementary findings confirm that the cost-benefit of supplier-designed projects is independent of anchor company performance.

Chapter 4 also identifies three criteria to explain differential performance of supply-chain groups linked to anchor companies: (i) number of suppliers that participated in the programme and designed CP projects, (ii) Percentage of suppliers per supply group that implemented CP projects, and (iii) number of suppliers in a group withdrawing from the programme. Together, these criteria describe anchor company contributions to CP dissemination among suppliers. Findings show anchor company learning contributes positively to CP dissemination among suppliers, especially for those with previous experience in supply chain programmes. Findings do not show consistency between anchor company contribution to CP dissemination and pre-programme perceived benefits from participating.

Other anchor company organizational characteristics influencing supplier CP dissemination outcomes emerge from programme participation by purchasing managers. Findings show that anchor companies represented by multidisciplinary teams comprised of ‘purchasing’ and ‘environment, health, and safety’ (EHS) managers obtain poorer results in CP dissemination among suppliers than companies represented by a particular manager. Remarkably, thesis findings additionally confirm anchor firms represented exclusively by environmental managers result in significantly lower dropout. Explanations might be found in possible supply chain manager dependency on certain suppliers (Greenwood and Hinings, 1996), and limited coordination between EHS and purchasing managers. Also cost-focus as prevailing motive of emerging market purchasing managers, might explain the finding.

Another explanation for differential performance may be found in supplier characteristics. Chapter 5 examines supplier collaboration capacity as a multidimensional organizational construct, including the operational, communicative, and cooperative routines required for CP dissemination in supply networks. Findings confirm how type of supply appears to influence a firm's performance: printing industry suppliers display a propensity to perform better than services suppliers; while raw material suppliers show less innovative behavior than packaging suppliers. Findings also suggest that market forces may influence supplier performance.

Certain supplier characteristics seem to influence the firm's performance. Participants with technical profiles show a significant negative relationship with communicative routines, whereas participants with administrative profiles show significant negative relationships vis-à-vis operational routines. Moreover, firms represented by two or more managers attain higher scores on all routines required for high performance. Findings show "soft" organizational characteristics and capacity for learning influence supplier performance. Significantly, performance of suppliers does not depend on cost-benefit expectations of CP projects.

Collaboration capacity of suppliers is also positively and significantly correlated with the role of anchor companies. This suggests that more proactive anchor companies positively influence performance of suppliers participating in PVEI designed as SSCM.

RESEARCH QUESTION III:

- How can initiatives combining CP and SSCM contribute to dissemination of preventive environmental practices in SMEs?

CP contributes to the improvement of environmental performance of firms by offering a preventive approach to reduce energy consumption, water use, raw materials and waste (Hirschhorn, 1997). To adopt these environmental practices, managers must recognize the preventive paradigm and demonstrate organizational capacity to implement the practices proposed (Baas, 2005). Dissemination of preventive environmental practices among firms can also be induced by dissemination mechanisms (Boons et al., 2011).

SSCM is recognized as a concept for improving environmental, social, and economic performance within a supply chain context (Carter and Rogers, 2008). The central idea of this approach refers to the role of supply chain management as a catalyst for generating inter-organizational value and sustainable inter-firm competitive advantage by means of collaboration between the anchor company and its market partners on the supply and distribution sides of the chain (Gold et al., 2010). Additionally, SSCM practices have been shown to contribute to resource efficiency (Cai et al., 2010; Zhu et al., 2008), trigger unique capabilities in relationship management (Walker et al., 2008), and strengthen a firm's reputation (Andersen and Skjoett-Larsen, 2009).

This research studies the integration of CP and SSCM by focusing on the interaction of separately measured concepts and analyzing relationships. Cost-benefit of suppliers' CP projects and organizational learning in CP were contrasted with the role of anchor companies, and the collaboration capacity of suppliers as SSCM concepts.

CP and SSCM findings from this study are noteworthy. Empirical evidence shows cost-benefit is not the only significant argument for the implementation and dissemination of preventive environmental practices, suggesting evidence of increased significance for relationships with other CP- and SSCM-related concepts. Anchor companies significantly influence organizational learning in CP, in turn strengthening organizational capacities to fulfill SSCM needs. This suggests supply chain relationships that are part of SSCM may serve to motivate the learning process involved in the adaptation of preventive environmental practices, such as those offered by CP. Moreover, supply chain relationships fostered by proactive anchor companies spawn peer-references, considered important in acquiring new knowledge as part of the organizational learning process (Lam, 2000).

Organizational learning in CP also relates positively to collaboration capacity, as required for suppliers to contribute to SSCM. This complex process implies dislodging existing routines and perceptions, as well as ensuring new habits are firmly in place (Ancona et al., 1999; Hoffman, 2000). As organizational learning is a dynamic and multidimensional process, learning in networks supports learning in individual organizations; and vice versa (Clark and Roome, 1999).

Findings also show how CP offers opportunities for improving environmental and economic performance among supply chain partners. Preventive projects, such as best practices, technological innovations, and new waste recycling methods, show attractive payback periods as well as significant environmental improvements. As described in Chapter 2, the cumulative impact of a programme such as the MSSP may be compared to that of a medium-size city in Mexico.

In sum, this thesis reveals how CP and SSCM complement each other; SSCM drives CP through supplier-client relationships and by facilitating group learning among suppliers. Additionally, a prevention-oriented concept such as CP helps strengthen inter-organizational relationships in SSCM, and provides direction for SSCM practices such as resource efficiency and waste reduction.

GENERAL RESEARCH QUESTION UNDERLYING THIS THESIS:

- How can improvement of environmental performance of SMEs in emerging markets be achieved achieved?

Answers to the above research questions trigger new thinking about improving environmental performance of SMEs in emerging markets. Together, they provide the foundation for answering the general underlying question of this thesis: How can

improvement of environmental performance of SMEs in emerging markets be achieved?

The findings of this research point to the need for further work on the organizational aspects of SMEs, as opposed to technical and economic aspects as determinants of environmental improvement. This proposition implies that the environmental improvement efforts (emphasizing organizational learning and the change process) for SMEs are in parallel with technical outcomes.

Integrating the fields of CP and SSCM offers a strategy to reach out to SMEs in emerging markets and achieve benefits of scale. Supply chain relationships inherent to SSCM provide an alternative to relying on the weak institutional capacity of environmental protection agencies often found in emerging markets. Similarly, CP breeds opportunities for process efficiency and waste reduction, with attractive cost-benefit outcomes for SMEs. CP implies organizational learning, strengthening the prospects for intra-organizational capacity as well as fostering network relationships and competitiveness. As this thesis shows, outcomes from CP and SSCM tend to be mutually beneficial. Accordingly, their combined approach is recommended as conceptual grounds for disseminating and implementing preventive environmental practices in SMEs in emerging markets.

Placing organizational aspects at the heart of the implementation and dissemination of preventive environmental practices influences the type of firms to be targeted as participants. Organizational characteristics, more than technical and economic criteria, are a key to achieving dissemination goals. Research for this thesis shows how a firm's characteristics, and those of its representatives, influence dissemination outcomes – as anticipated by Boons et al. (2011). Similarly, this thesis dispelled the myth that preventive environmental practices mainly apply to larger firms, a notion tied into the opportunity for obtaining potential cost-benefits.

An integrated CP and SSCM framework calls for alternative dissemination methods, overcoming largely ineffective traditional approaches, such as technical assistance, demonstration projects, practitioner seminars and information supply (Baas, 2006; Dieleman, 2007; Baas, 2006; Stone, 2006a, 2006b). More complex methods are required to apply the principles of workplace democracy and liberation in a network context, such as staff empowerment and organizational learning (Snell and Chak, 1998). This thesis proposes a model of "learning-by-doing" in the context of network structures. The combined training methods employed in the MSSP facilitate the complex multidimensional process of learning that involves explicit and tacit knowledge acquisition (Lam, 2000), as well as change drivers building on inter-organizational relationships (Ashton, 2008).

Outcomes of dissemination show in the adoption of preventive environmental practices, and improvement of environmental performance. Measuring adaptation in terms of organizational learning provides, together with cost-benefit estimates, indicators for quantifying performance improvements. Similarly, findings stress the

relevance of measuring network relationships, as these provide grounds for ongoing learning and collective action (Clark and Roome, 1999).

Figure 7.2 relates the underlying general research question to the three specific questions, and to the answers generated by thesis findings.

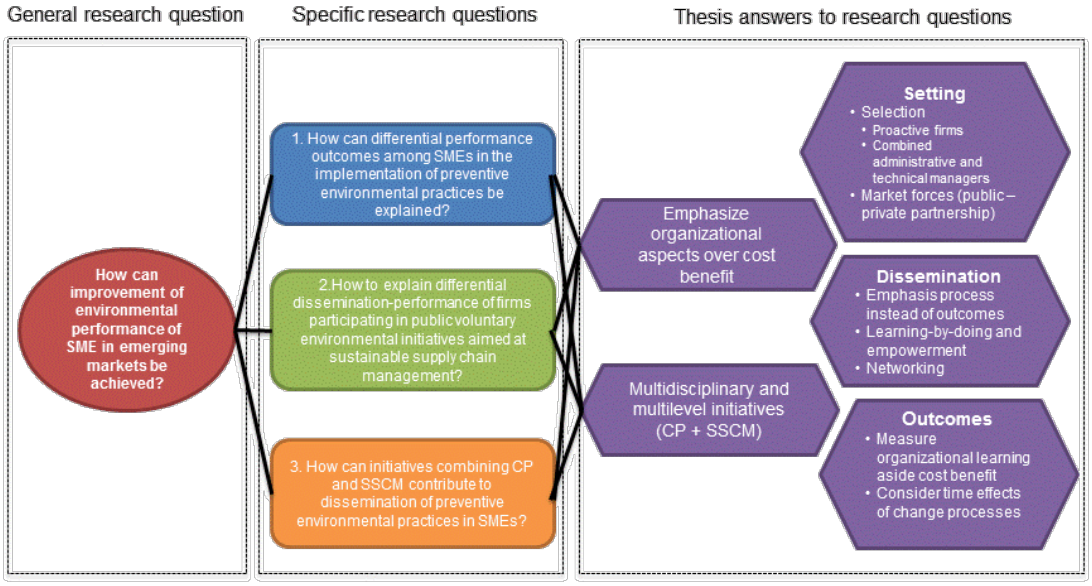

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Figure 7.2 Thesis answers given to research questions.

7.3 Recommendations for further research

This research can be extended in several ways. A first recommendation would be to expand the quantitative database of the MSSP to include outcomes from 2008 onwards. Other research methods may also be deployed, and the scope of research expanded to advance a more general understanding of the means to improve environmental performance of SMEs in diverse emerging markets.

- *Expand database*

During the development of this thesis, the MSSP became one of the largest programmes of its kind in the world. Mexican agencies SEMARNAT and later PROFEPA expanded the programme throughout the country. As the dissemination methodology and programme structure have remained consistent, the programme database represents an opportunity for further research. As noted earlier, from August 2005 to December 2012 about 400 supply chain groups involving 200 different anchor companies, 6.000 (mainly SME) suppliers, 10,000 CP project designs, and 23 service-providers participated in the programme.

This study examined data collected during the pilot study from 2005 to 2008. Thesis delimitations rendered unfeasible undertaking comparisons with other quantitative

studies involving SMEs (Kusyc and Lozano, 2007). Ample opportunity exists to broaden research on the MSSP and other relevant studies.

- *Broaden research methodology*

Information relating to CP project implementation levels and perceived programme participation benefits was compiled by means of follow-up questionnaires completed six months following the final workshop. Companies reporting no implementation might have done so at a later time. Additionally, empirical information is based on self-reporting enquiries. Some companies may have provided misleading responses even when the researcher undertook a site visit to verify CP implementation and reduce response bias.

Further research should complement research methodology, such as employed for this thesis, with in-depth case studies (Eisenhardt, 1989) of particular projects, stakeholders concerned, outliers, withdrawals, and other factors. Such studies could deepen understanding of motives, perceived benefits and underlying dynamics explaining company behavior in the dissemination process of preventive environmental practices.

Also, quantitative analysis could be deepened, especially as respects sample size, including number of anchor companies. Adjustments in the sequence of applying research instruments could improve the validity of data analysis.

- *Widen the scope*

This thesis gleaned numerous insights into factors governing the collaborative capacity of individual suppliers, but only a small part of inter-organizational dynamics was assessed. The collaboration domain is multidimensional and also involves counterpart collaboration by anchor companies and other programme participants, such as service providers that offer training workshops (Huxham, 1993; Gray, 1985). Further research should focus on the collaborative capacity of both anchor firms and convener organizations. Deeper understanding of the role and capacity of all pertinent actors and their characteristics would likely uncover significant information required to upscale multi-stakeholder efforts, such as the MSSP, and allow for replicating and broadening the experience elsewhere in emerging economies.

The study of contextual variables such as energy, water, and waste disposal tariffs, and their influence on the economic and environmental benefits of CP initiatives, is recommended as an important field of inquiry for future CP dissemination efforts. As respects MSSP expansion in recent years, research should probe into learning effects attained and analysis of regional differences. Similarly, dissemination effects should be examined in supply networks beyond first-tier suppliers.

To conclude, it should be noted that the database used in this study concerns firms linked to global supply chains. In the context of an emerging economy, such as that of

Mexico, these types of companies are generally classified as more advanced (Battat et al., 1996; 20). However, microenterprises employing less than 10 workers represent by far and away the largest category of SME in Latin America (Zevallos, 2003). Few of these firms deal directly with global supply chains. Nonetheless, they play an important role in the local economic context, and represent a significant source of environmental pollution. Thus, reaching out to the region's vast number of microenterprises and searching for ways to reduce their operational environmental impacts remains an important challenge for researchers and practitioners (Schaper, 2002). Similarly, cross-country studies may deepen the understanding of how PVEI, focused on SSCM, can contribute to strengthening the economic and environmental performance of SMEs in emerging markets.

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Appendix A

Analytical Approach used in the Net Present Value calculation

Net Present Value (NPV) is a standard financial indicator to analyze the profitability of an investment project, taking into account the time periods of investment and returns, and future cash flows. Its procedure involves aggregating the initial investment cost and a calculation of the overall value of a project as if that value were obtained at once in the present, summing up the annual incomes over the time period that the project will be in place. Discount rates are used to reflect the time value of money (Banks, 2010).

The general formula to compute NPV indicators is (Banks, 2010):

$$\mathrm{NPV} = \sum_{t=1}^{n} \frac{V_t}{(1+k)^t} - I_0$$

in which:

- NPV represents net present value.
- V_t represents the cash flow in period t.
- I_0 is the initial investment.
- n is the number of periods considered in the project.
- k is the discount rate.

As the main reference to establish the appropriate discount rate, we use Villareal (2010), who proposes a consistent methodology for the calculation of the cost of capital in emerging markets such as Mexico. This method, which relies on the Capital Asset Pricing Model (CAPM), uses the following assumptions:

Discount rate = $K_D'(1-\tau) + \beta_L[(R_m - R_f) + CR]$

Where:

$$K_D' = \text{debt costs before taxes} = R_f + \text{intermediation spread} + CR$$

And:

R_f =interest rate without risk
Intermediation spread = margin depending of the country risk of Mexico (BBB)
CR = country risk evaluated by Standard & Poors

τ =tax rate of the Mexican market
$(R_m - R_f)$= risk premium, derived from the differences on the simple averages of the rates in the market and the spot rate for the zero-coupon bonds of the US treasury.

β_L = Beta of leveraged assets, calculated from the average assets of sectors, discounted at the average of the optimum capital structure of the sectors (D/E) and the Mexican tax rate.

The discount rate used was calculated as **10.968624%**

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Appendix B

Descriptive statistics of the MSSP database

Items	Value	Standard Deviation
Number of supply groups		
• Total	119	
Geographic coverage of supply groups		
• Number of Mexican States involved	22	
Number of anchor companies	72	
• Multinationals (origin)	59	
• Mexican (origin)	13	
Number of suppliers	972	
• Micro enterprise < 10 employees	56	
• Small enterprise 11 - 50 employees	271	
• Medium enterprise 51 - 250 employees	360	
• Large companies >250 employees	285	
Type of suppliers		
• Packaging materials	114 (12%)	
• Printing materials	63 (6%)	
• Raw materials	419 (43%)	
• Indirect supplies	105 (11%)	
• Services	271 (28%)	
Number of participants		
• Total	2,025	
• Per supply chain	18.24	7.7
• Per company	1.95	1.36
Number of projects designed by suppliers		
• Total	1,932	
• Per supply chain	16.23	7.56
• Per company	1.99	1.23
Number of projects designed by anchor companies		
• Total	220	
• Per company	3.05	
Planned investments ($ US)		
• Total	$ 48,331,173	
• Per supply chain group	$ 405,971	$ 948,847
• Per company	$ 49,733	$ 255,119
• Per project	$ 25,016	$ 167,570
Number of projects per typology 1		
• Best practice	1,218 (63%)	
• Technology innovation	603 (31%)	
• New activity	111 (6%)	
Number of projects per typology 2		
• Energy efficiency	874 (45%)	
• Water efficiency	300 (15%)	
• Raw material efficiency	236 (12%)	
• Waste recycling	306 (16%)	
• Combined savings	216 (11%)	
Average NPV of projects in year of participation ($ USD)		
• 2006	$ 43,354 (n = 28)	$ 75,264
• 2007	$ 49,987 (n = 41)	$ 144,382
• 2008	$ 98,996 (n= 192)	$ 263,472
• 2009	$ 128,831 (n= 447)	$ 431,335
• 2010	$ 62,548 (n = 877)	$ 262,312
• 2011 (Jan – April)	$ 62,784 (n= 347)	$ 155,200

Appendix C

Estimated coefficients by maximum Likelihood of theordered probit organizational learning model

Variables	Ordered Probit Model Organizational Learning Level
Services	-0.853**
	(0.412)
Printing	0.329
	(0.342)
Raw Material	-0.422
	(0.303)
Indirect Supplies	0.00314
	(0.303)
Medium	0.486**
	(0.231)
Large	0.177
	(0.331)
Administrative Profile	-0.659**
	(0.334)
Technical Profile	-0.552**
	(0.280)
Other Profile	-0.718
	(0.529)
Directive Position	0.151
	(0.403)
Operational Position	-0.235
	(0.337)
Commercial Position	0.356
	(0.312)
Participant Experience	0.00123
	(0.0133)
Thresholds	
α1	-0.855**
	(0.366)
α2	-0.256
	(0.362)
α3	1.309***
	(0.378)
Observations	128
Pseudo R-squared	0.0903

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix D

Distribution of supply firms that assisted to workshop meeting and dropped out of the MSSP

Appendix E

Logit model for supplier dropout assessment

The model shown below controlled for industry sector type and firm size, factors found to be significant by previous research (Dasgupta et al., 1997). “Micro-sized” and “indirect supplies” were used as dummy variables. STATA 7.0 was used to run the regression. For a given withdrawal i, the model estimated was:

$$
\begin{aligned}
&\text{Dropout}_i \\
&= \beta_0 + \beta_1 \text{Invited by GEMI}_i + \beta_2 \text{Previous experience with supply programs}_i \\
&+ \beta_3 \text{Ownership}_i \\
&+ \beta_4 \text{Participation of supply managers in coordination team of anchor company}_i \\
&+ \beta_5 \text{ISO14000 certified anchor company}_i + \gamma' X_i + \varepsilon_i
\end{aligned}
$$