Organizational Learning in Cleaner Production among Mexican Supply Networks

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Abstract

This article assesses the experience of a Mexican program designed to promote organizational learning in cleaner production (CP) among suppliers of large manufacturing and food processing companies. The study proved how organizational double loop learning was achieved in a program employing blended learning methods, with supply networks as a dissemination strategy. Insights were provided on how characteristics of supply firms and their participating managers influenced organizational learning in CP. Concepts drawn from organizational learning theory were used as the framework of analysis.

The study’s findings show how a significant number of supplier firms achieved higher-level organizational learning targets, represented by the implementation of CP measures and new practices. Other findings drawn from the study show how combined technical and administrative profiles of supplier firm participants may contribute to higher-level organizational learning. Conclusions document the benefits of employing a blended learning method as a training approach for promoting CP double loop learning through supply networks. The method fulfilled the principles of workplace democracy and liberation, empowerment, and organizational learning, and resulted in significant evidence for effective dissemination of CP among firms.

Key words: organizational learning in cleaner production, sustainable supply, blended learning, dissemination of cleaner production, small- and medium-sized enterprises

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 containment (Hirschhorn, 1995; Baas, 2006). In 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). Numerous demonstration projects, training and technical assistance programs have confirmed the beneficial cost-benefit balance of the CP promise (Van Berkel, 1994, Nath, 2006; Shi et al., 2007; Dobes & de Palma, 2010). However, widespread application of cleaner production among firms, especially small- and medium-sized companies, has not materialized (Stone, 2006a; Dieleman, 2007).

One reason that may explain why implementation of CP by companies has lagged behind potential improvement levels, suggested by theoretical insights as well as empirical data, is lack of attention to social factors (Zilahy, 2004; Stone, 2006a). Practical adaptation of CP measures, it is argued, requires innovative behavior at different organizational levels, acquisition of new knowledge, collaborative actions, and decision-making by managers (Clark & Roome, 1999; Montalvo, 2006). As long as traditional approaches, mechanisms, and instruments employed to promote CP dissemination remain largely focused on technical aspects, limited implementation is to be expected (Stone, 2006b).

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Organizational learning theory has been employed to study the “missing link” in the adaptation of CP by several firms (Vickers & Cordey-Hayes, 1999, Vickers, 2000; Remmen & Lorentz, 2000; Zilahy, 2004, Baas, 2006; Stone, 2006a, 2006b; Dieleman, 2007). Findings from these studies cite key elements of the learning process implied in CP practices, which include organizational features such as leadership, recognition of culture, organizational structure, information feedback loops, and empowerment. Other authors highlighted insufficient organizational learning as the reason for limited outcomes of CP applications (Clark & Roome, 1999; Stone, 2006a). These authors provided insights and sociological explanations for the “CP-gap”¹, and recommended deploying a more managerial approach to CP dissemination. So far, literature review has focused on theoretical reflections on program design and outcomes. Heretofore, entirely new approaches that fully integrate organizational learning concepts within dissemination mechanisms have not been reported. Knowledge drawn from empirical evidence of organizational learning in CP is limited (Stone, 2006a; 2006b).

This study assesses the experience of the Mexican Sustainable Supply Program (MSSP), designed to promote organizational learning in CP among suppliers of large companies. MSSP employed blended learning methods and supply networks as the dissemination strategy, and results suggest substantial organizational learning was attained. Experience drawn from the Mexican program provides a consistently measured empirical base for statistical research. Principles of organizational learning theory are used as a framework of analysis.

Three research questions guided this study: What learning levels did supply firms taking part in the MSSP achieve? What supply firm and participating managers’ characteristics appeared to have influenced organizational learning in the MSSP? How did organizational learning by supply firms come about? This study contributes to the literature by illustrating how organizational learning in CP emerges from a training program based on a blended learning method deployed in supply networks. Additionally, the study provides new evidence on how firm and participant features influence CP organizational learning in a sustainable supply program in an emerging market.

The remainder of this paper is organized as follows. Section 2 describes the MSSP as a dissemination mechanisms for CP, object under review. Section 3 details the research methodology, and describes data sources. Section 4 presents a review of the literature of organizational learning and cleaner production, and introduces the conceptual framework used for program analysis. Section 5 presents an assessment of the learning process and outcomes of the training program. Section 6 relates research results to the relevant literature, and discusses implications of the findings for CP dissemination. Section 7 presents conclusions and recommendations for further research.

1. Material; Learning approach applied in the Mexican Sustainable Supply Program

This section describes the MSSP and its learning approach as main objective of study. MSSP is a public-private initiative launched by the Commission of Environmental Cooperation in North America (CEC),² established by the North American Agreement on Environmental Cooperation (NAAEC). From the time of program design, efforts centered on employing an innovative mechanism for disseminating CP among, for the most part, small-sized suppliers of large companies in Mexico. This study centered its assessment on the supplier firms and participating managers in

¹ The CP-gap is defined by Zilahy (2004) as the lag between CP implementation rates and their potential improvement levels as suggested by both theoretical CP possibilities and practical solutions obtained in certain instances.
² www.cec.org
the period from September 2005 till May 2008.

Means for executing the program feature blended learning as a pedagogical tool, focused on supply chain networks; the tool employs a combination of different learning methods (Rosett & Vaughan Frazee, 2006), including workshop sessions, online learning, and self-study, to facilitate the learning processes of individuals and organizations (Dalsgaard & Godsk, 2007); Leading Mexican and multinational companies invited groups of about 10-15 suppliers to volunteer as program participants. Additionally, the companies accompanied and supervised advances made in CP initiatives developed by their respective supplier groups. At the end of the training program, the leading companies recognized outcomes of CP initiatives developed by their suppliers in a well-publicized closing ceremony. Hence the supply-network setting sought to trigger CP learning, instill management commitment among supplier firms, facilitate information sharing and collaborative learning, and promote peer feedback. Figure 2 summarizes the program structure.

Figure 2 Learning approach employed by the MSSP to foster organizational learning in CP

The data on the MSSP contained information on 14 supply groups covering 177 companies (12 different leading companies, plus 177 suppliers). Data were gathered from several sources. First, all firms participating in the program filled out an intake form, reporting general features such as their main activity, number of employees, sector they belonged to, and information about the number of participants from their firm taking part in the program. Another important source of information was the final presentation of the project(s) designed during the ten-step training program. These presentations contained detailed information about the type of CP alternatives to be implemented, estimated investments, and expected economic and environmental benefits. To obtain feedback on implementation levels of CP projects, participating companies filled out follow-up questionnaires.
3. Methods and calculation

The central focus of this study was to examine what organizational learning levels were achieved by firms participating in the program, explore how the characteristics of participating supplier firms and their managers influenced organizational learning in CP, and gather insights about how learning came about. Complementary quantitative and qualitative research strategies were used to measure learning at the individual level of the participating managers and at the organizational level of the supplier firms. The combination of research strategies provided insights in understanding of quantitative outcomes (Berg, 2004) and depth in understanding on learning in CP as a complex and dynamic process (Senge, 1999). Following operationalization and methods for data gathering and analysis are discussed.

• Constructs and their operationalization

Organizational learning in CP was assessed by establishing a fit between the theoretical model of organizational learning developed in section 2, and empirical MSSP data. The model built on reasoning proposed by Baas (2006), who related effective CP implementation directly to the company’s level of learning. Learning levels were defined according Argyris and Schön (1996), and ideas of Stone (2006a, 2006b) on epistemological dimensions of learning in CP:

(i) Zero level or non-learning in CP – represented by a supplier firm that initially joined MSSP, but withdrew without completing a CP project. Neither explicit nor tacit in CP was evidenced.

(ii) Single loop learning in CP – represented by supplier firms that participated in MSSP, presented a CP project at the end of the training program, but six months later had failed to provide evidence of implementation. Explicit knowledge in CP was evidenced though the presentation of project designs. Nevertheless, tacit learning wasn’t manifested.

(iii) Double loop learning in CP – represented by supplier firms that confirmed implementation of the CP project designed during their participation in the program within six months after their participation in the MSSP. Tacit and explicit learning in CP were demonstrated and individual knowledge flows through the organization and new organizational routines were established.

(iv) Double-loop-plus learning in CP – represented by supplier firms that confirmed implementation of the CP project they designed, and confirmed planning of additional CP activities developed following participation in MSSP. Research models assumed that these CP activities could be viewed as direct results of the MSSP. We denote this level “double-loop-plus learning” insofar as it does not fulfill the requirements of triple loop learning described in section 2. Both explicit and tacit knowledge in CP were manifested at an advanced level and generated new organizational knowledge bases.

Empirical data was gathered to establish the fit between the theoretical model of organizational learning, and the practice of the MSSP.

• Data gathering

The data on the MSSP contained information for 14 supply groups covering 177 companies (12 different leading companies plus 177 suppliers). Data were gathered from several sources. First, all firms participating in the program filled out an intake form, reporting general features such as their main activity, number of employees, sector they belonged to, and information about the number of participants from their firm taking part in the program. Another important source of information was the final presentation of the project(s) designed during the ten-step training program. These presentations contained detailed information about the type of CP alternatives to be implemented, estimated investments, and expected economic and environmental benefits.
To obtain feedback on implementation levels of CP projects, follow-up questionnaires were sent by mail to all participating companies. Questionnaires were sent to an early group of participating firms in the March–June 2007 period, and a second questionnaire to a later group of participants in August-September 2008. CEC carried out follow-up calls and data collection free from any intervention on the part of the leading companies. Out of the 133 cases, 74 valid responses were collected (56%); of these, representatives who personally participated in the training program contested 89% while other company employees responded the remaining.

A qualitative research approach aimed at gathering insights on individual learning experiences obtained by MSSP participants. A survey instrument was employed to measure participant perceptions regarding learning of CP concepts and tools, competences acquired to apply them, elements influencing learning experience, and other professed outcomes of program participation. Measure used to gauge perceived learning followed Likert-scales of 1 to 5, with 1 representing “do not agree at all” and 5, “completely agree”. The questionnaire provided additional space for participants to express open-ended comments. A similar research approach was used to measure CP learning in supply chains (Ming-Lang et al., 2006; Zhu et al., 2008).

Managers of supplier companies completed the anonymous response (Wilder, 1986) questionnaires during the program’s final workshop. A total of 270 participants responded to the questionnaire, of 291 who completed the training program from 2005 to 2008. Most (75 percent) of the participant population represented small firms. Among respondents, 11 percent held director-level positions at their respective companies, 65% were operations managers, 12% performed administrative functions, and 12% commercial positions. Most respondents held a university degree in professions such as engineering (70%), 26% administration or commerce, and 4% other. About 90% reported working longer than two years in the company or sector they represented, and about 50% claimed not to have any previous experience with cleaner production projects. Responses concerned with learning perceptions are summarized in a database for analysis. Section 5 presents estimates of tacit and explicit learning dimensions.

Data analysis

Data analysis was undertaken by means of frequency distributions identifying firms at each learning level. An ordered probit model was employed to estimate relationships between dependent and independent variables (Greene, 2003). These types of regression models estimate the probability of relationships of binary response models by means of likelihood maximization (Horowitz, 2001, Gujarati, 2004). The ordered probit regression predicts the presence or absence of a firm (with specific features and participant characteristics) at a given CP level of learning, based on dichotomous values for a set of predictor variables; in this study, the dependent dichotomous variable is equal to 1 if the firm evidenced a certain learning level, and 0 otherwise. These types of regression models calculate the probability of relationships of multiple response models by means of the maximization of likelihood (Horowitz, 2001, Gujarati, 2004). Appendix A shows the estimated coefficients by maximum likelihood of the ordered probit model. Similar analysis is used in studies that concern behavior of SMEs in network situations such as those presented by Malhotra (2010); Gulati, Lavie & Singh (2009). Table 1 presents the independent variables of the model employed for this study.

Table 1. Variables influencing MSSP supply firm learning
Outcomes of the questionnaires measuring participants’ perceptions of the learning were summarized and descriptive statistics were calculated. Interpretation of the results involved comparison of quantitative and qualitative findings as underpinning for understanding the process of learning in the MSSP.

4. **Theory: Organizational learning in cleaner production**

This section briefly reviews the literature on organizational learning and cleaner production. By recognizing different concepts of organizational learning, and highlighting the latter’s relation to measures implementing CP in participating firms, it foretells the framework of analysis employed in the study.

This study builds on a sociological perspective of organizational learning. Within this field, some consensus exists 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 learning as an intentional process towards purposeful innovation and adaptation to the environment (Huber, 1991); for learning involves information-processing, accumulation, sense making (Argyris & Schön, 1996), and is interactive, accumulative and auto-generative (Senge, 1999).

Another underlying concept of this study is 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). Examples of CP applications include improvements in efficiency of use of raw materials, energy, and water by means of changes in management, improvements in operational procedures, expanded recycling of wasted 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 the improvement consequences of new operational routines (Vickers & Cordey-Hayes, 1999).

Inter-linkages among the concepts relevant for this research are now described. Firstly,
‘organizational learning theory’ relates to an epistemological dimension of human knowledge, distinguishing between “explicit” and “tacit” knowledge (Lam, 2000). Explicit knowledge is functional and generic. It can be formulated, extracted, and communicated through time and space (Lam, 2000). Explicit knowledge in CP implies know-how on how to handle CP tools for diagnosis and identification of preventive alternatives. This type of explicit knowledge involves understanding and competences to handle CP tools such as 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 practical experience needed to handle “real life” situations. 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 indispensible for successful implementation (Stone, 2006a).

Secondly, ‘ontological dimensions of organizational learning theory’ separates levels of analysis of learning by individuals, groups and communities and examines their interactions (Lam; 2000; Dodgston, 1993). Individual knowledge is seen as part of the organization’s knowledge that resides in the brain and skills of the individual, 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 representing more than the sum of individual learning (Dodgston, 1993). Traditional technical assistance and training programs in CP emphasis individual knowledge (Remmen & Lorentz, 2000) and give little attention to empowerment of the organizational knowledge base (Stone, 2006a).

Thirdly, ‘organizational learning theory’ looks upon organizational learning levels, based on a model proposed by Argyris and Schön (1996), subsequently extended by Hawkins and Torbert (Snell and Chak, 1998). This model considers learning as a process of detection and correction of errors. Distinct systemic levels of learning are established. Zero or non-learning appears when fresh imperatives arise and yet some members fail to take action. For example, ‘zero learning’ would be evidenced by outright resistance on the part of company employees to the implementation of CP measures, even when stakeholders order them to do so (Baas, 2006).

Single-loop learning implies simple, adaptive responses that do not affect underlying values or structures. Had the company experienced a degree of ‘single loop learning’ in CP, little or no progress would have occurred beyond initial phase design of preventive measures as a part of the dissemination program (Stone, 2006b). At the double-loop learning level, members begin to see totally new ways of solving problems and develop new core values. ‘Double loop learning’ in CP is achieved when company staff develops preventive visions towards environmental management, and initiate continuous improvement circles (Stone, 2006b). Triple-loop or duetero learning involves creation of new methodologies, approaches, and routines concerned with “learning how to learn” (Clark & Roome, 1999; Snell & Chak, 1998). ‘Triple loop’ in CP occurs when a company’s employees develop and implement sustainability strategies to solve more complex, shared sustainability issues, as integral parts of business strategy (Senge, 1999).

Fourthly, ‘organizational learning theory’ is used to work with characteristics of a learning organization (Pedler et al., 1991). This model, used by Snell and Chak (1998) in their framework to assess organizational learning, provides a reference for “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 the liberation of human spirit, is especially appropriate as it fits the incremental perspective of CP as a strategy to advance toward sustainability (Clark &
Roome, 1993) and can be used to recognize social preconditions that influence CP implementation (Zilahy, 2004; Stone, 2006b).

Fifthly, ‘collaborative learning in supply networks,’ employed to investigate supply relationships that are deemed to be important enablers of organizational learning, both as purveyors and clients (Simatupang & Sridharan, 2008). As important stakeholders, clients can trigger organizational learning in and among supplier firms (Hult et al., 2003). In addition, supply networks represent opportunities for information sharing, incentive alignment, and decision synchronization (Simatupang & Sridharan, 2008). These are important sources for knowledge acquisition, information processing, feedback and generation of trust in learning–action networks of sustainable business including CP (Clark & Roome, 1999; Hult et al., 2003; Seuring & Muller, 2008).

Combining the above organizational learning theory and its relation to CP, Figure 1 summarizes dimensions, facilitators and outcomes of organizational learning in CP as the framework of this research.

![Figure 1. Selected dimensions of organizational learning theory used in this research within the MSSP](source: Author)

5. Findings relating to organizational learning of supplier firms and managers participating in the MSSP

Findings presented in figure 2 provide evidence to respond the first research question posed in this research as; what learning levels did firms participating in the MSSP achieve? The Figure plots the frequency distributions of firms at each learning level of the proposed research model. Also shown is the accumulated number of companies reaching a certain learning level. As learning entails a cumulative process (Senge, 1999) the research model assumed that firms meeting double loop learning likewise met the single loop level. Similarly, firms identified in the double-loop-learning-plus category also fulfill single and double loop learning measures. The horizontal axis shows
learning levels, whereas the vertical axis records identify the number of participant firms reaching a certain learning level.

The first column in Figure 2 represents firms that withdrew from the MSSP program, without learning. These firms represent 25 percent of the total population of firms that initially committed to participate in the program yet failed to develop a CP project. A closer look at the database shows most of these firms only attended the first three of the 10 workshops. See appendix B for frequency analysis of the moment’s supplier firm dropped out of the MSSP.

The second column represented firms that show evidence of a certain level of CP learning. These firms completing the program, as many as 23 percent attained a single-loop level identified by their capability to design CP projects themselves. 93 companies attained higher learning levels. A group of 93 firms, 53%, implemented their CP measures, represented by double loop learning in the applied research model. The remaining 13% of firms even reported designing new CP projects following the program, recognized as double-loop-plus learning.

The results of the qualitative survey complemented the quantitative analysis by providing insights into individual participant learning experience. Results of the MSSP participant qualitative survey showed positive and unanimous perceptions of individual learning experiences, both as respects acquired CP competences and network relationships, as reflected by ratings presented in Table 3. At the end of the training program, participants showed high confidence in their own capacity to design CP projects. This capacity fit 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 as second-loop learning experiences. Individual motivation concerned with MSSP participation is also noteworthy: most allocated more than the recommended four hours per week to the program, attended most of the 10 workshops, and visited the program website about three times per week.
Regression analysis presented in Table 2 address the second research question: What firm and participant features appear to influence organizational learning among firms participating in the MSSP? Values show how certain features lead a firm or participant to fulfill criteria for a given learning level category. Organizational characteristics examined for influence on learning include the firm’s sector and size. Table 2 shows service suppliers feature a significant positive relationship to belong to the zero loop learning category with suppliers of packaging materials as the control variable. This relationship is consistent at different categories of organizational learning. At the second and second-loop-plus learning category, the coefficient showed negative, illustrating how services 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.

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

Regression analysis also showed significant relationships for participants’ professional profile. Participants combining a technical and administrative background attained a significantly higher learning level. Single technical and single administrative profiles showed a significant positive relationship towards zero learning. In comparison to the control variable (combined professional profile), single profiles showed a higher propensity to drop out of the program. Participant characteristics such as holding higher hierarchal posts or greater work experience appear not to have had significant influence on organizational learning.

**Table 2 Effects of supplier firm and participating managers’ characteristics on organizational learning**
Results of the qualitative survey complemented the interpretation of the findings of the regression analysis. Perceptions of participants revealed network relationships as facilitators of organizational learning in CP. Remarkably, enhanced relationships with other suppliers were valued higher than relationships with the very anchor companies that invited their participation in the program. Participants representing other suppliers were considered an important source of information and exchange of experiences. 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 visit with a specialized consultant. Other comments noted 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. Perceived learning experiences of individual participants in the MSSP

<table>
<thead>
<tr>
<th>Questions asked to participants about their learning experience in the MSSP</th>
<th>Min.*</th>
<th>Max.*</th>
<th>Mean</th>
<th>S.D.</th>
<th>Mode</th>
<th>n**</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP competences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Will you be able to design CP projects in an autonomous way?</td>
<td>1</td>
<td>5</td>
<td>4.5</td>
<td>0.5</td>
<td>5</td>
<td>270</td>
</tr>
<tr>
<td>- Are you confident that the CP project you designed will be implemented?</td>
<td>1</td>
<td>5</td>
<td>4.5</td>
<td>0.5</td>
<td>5</td>
<td>270</td>
</tr>
<tr>
<td>- Are you confident you will continue your work in CP after your participation in the MSSP?</td>
<td>1</td>
<td>5</td>
<td>4.6</td>
<td>0.4</td>
<td>5</td>
<td>270</td>
</tr>
<tr>
<td>Network experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Did you improve relationships with other suppliers?</td>
<td>2</td>
<td>5</td>
<td>4.1</td>
<td>0.5</td>
<td>4</td>
<td>268</td>
</tr>
<tr>
<td>- Did you improve relationships with your client (anchor company)?</td>
<td>2</td>
<td>5</td>
<td>3.8</td>
<td>0.5</td>
<td>4</td>
<td>268</td>
</tr>
<tr>
<td>- Excellence of contribution of your colleague participants</td>
<td>1</td>
<td>5</td>
<td>4.2</td>
<td>0.7</td>
<td>4</td>
<td>264</td>
</tr>
<tr>
<td>Training design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>- The practical module was key for the development of the CP project?</td>
<td>1</td>
<td>5</td>
<td>4.4</td>
<td>0.6</td>
<td>5</td>
<td>270</td>
</tr>
<tr>
<td>- The theoretical module was key for the design of the CP project?</td>
<td>1</td>
<td>5</td>
<td>4.3</td>
<td>0.7</td>
<td>4</td>
<td>270</td>
</tr>
<tr>
<td>- The side visit of the consultant was key for the design of the CP project?</td>
<td>1</td>
<td>5</td>
<td>4.6</td>
<td>0.4</td>
<td>5</td>
<td>270</td>
</tr>
<tr>
<td>Program participation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Average time dedicated to the MSSP (hours per week)</td>
<td>&lt;2</td>
<td>+8</td>
<td>4.1</td>
<td>3.2</td>
<td>3-2</td>
<td>270</td>
</tr>
<tr>
<td>- # of workshops attended (out of 10)</td>
<td>&lt;3</td>
<td>9-10</td>
<td>7.8</td>
<td>3.4</td>
<td>9-10</td>
<td>270</td>
</tr>
<tr>
<td>- Average visits to web-side of MSSP (times per week)</td>
<td>0</td>
<td>&gt;3</td>
<td>2.8</td>
<td>1.0</td>
<td>3</td>
<td>268</td>
</tr>
</tbody>
</table>

* 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 supply firms).

6. How MSSP organizational learning came about

Discussion of the findings of the qualitative and quantitative surveys in the light of reviewed literature provides a deeper understanding on how learning attained by the firms came about. The five selected dimensions of organizational theory were used as references for gauging the learning level.

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

Findings confirmed learning on different ontological dimensions for both supplier firms and individual participants. Alignment among these dimensions was shown by high individual expectations over CP project implementation, and the high implementation attained. This means that individual CP knowledge and skills was distributed and shared within supplier firm organizational routines and knowledge bases (Lam, 2000; Dogston, 1993). Occurrence of this dynamic organizational learning process within the MSSP contrasts with arguments put forward by Stone (2006a, 2006b) noting little attention to empowerment of the organizational knowledge base as shown by degree of CP management commitment, lack of leadership and communication as barriers to CP dissemination.

Organizational learning outcomes assessed followed reasoning set forth by Baas (2006) who relates the effectiveness of CP implementation within firms to levels of organizational learning. Firms that withdrew from the MSSP without presenting a CP project design were classed as zero loop learning. Insofar as most such firms dropped out following the first workshop, zero learning might be attributed mainly to motivation and invitation strategies, rather than to the program’s training mechanisms. Moreover, almost all firms completing the 10-workshop training cycle attained single loop learning by presenting a CP project design.

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 program in New Zealand, her 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 she assumed no organizational learning occurred (Stone, 2006a). The CP dissemination approach employed for 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, program 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).

Firms that designed and implemented their own CP projects attained double loop learning for purposes of this study. This implied that explicit and tacit CP knowledge of individuals was adopted within the organization, spinning new routines and arrangements involving management commitment (Clark & Roome, 1999; Stone, 2006a, 2006b). The 70% high adoption rate of CP projects designed by firms completing the training sessions appeared remarkable when compared with outcomes of other CP dissemination programs; Dieleman (2007) reported implementation rates of about 40% for projects designed under the PRISMA program undertaken in the Netherlands in the 1990s; Sage (2003) reported similar implementation rates for firms participating in the Ecoprofit programs in Austria, whereas Van Berkel (2003) also claimed limited outcomes in terms of CP implementation for technical assistance offered by external consultants.

A small share of MSSP program firms (23%) confirmed they designed additional CP projects following participation, and reported ongoing improvements based on their CP experience. In the research model used, this advanced organizational learning level was identified as second-loop-plus. The type of evidence provided implied adoption of new core values and new ways of solving problems within the firm, even if it failed to fulfill triple loop or duetro learning criteria as specified by Clark & Roome (1999) or Snell and Chak (1998); both authorities 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). Fellow suppliers were viewed as important sources of information, motivation, and social interaction, even to a greater extent than anchor companies who were expected to play a networking leadership role.

Comparison of learning that occurred in MSSP supply firms with characteristics of a learning organization as proposed by Snell and Chak (1998), complemented understanding of how organizational learning in CP came about. MSSP features, such as learning approach strategy, participative policy making, access to knowledge, accountability, recognition of outside information, intercompany learning and self development, clearly fitted the principles of workplace democracy and liberation of human spirit, considered preconditions of higher order, second loop, organizational learning. Other principles related to reward flexibility, enabling structure, and learning climate, occurred at lower learning levels vis-à-vis Snell and Chak’s model.

These principals also offer references to identify alternatives for improvement of the MSSP program design. In the first place improvement of reward flexibility would strengthen the program in terms of CP dissemination. Leading companies could link outcomes of CP projects with commercial preference and this way stimulate higher order learning in supplier firms. The program design could also be strengthen by emphasizing the organization of integrated CP teams of supplier firms and leading companies working together around common CP projects.

Table 3 presents the framework to access organizational learning as proposed by Snell and Chak. Adjustments are made to the authors’ model based on insights drawn from the MSSP study. The highlighted cells (shadowed) identify the fit between the prescriptive theoretical model and our study. The table includes references for triple loop learning; but as noted earlier, this learning dimension was not considered. Further research is required to provide insights into probing MSSP third loop learning levels.

7. Conclusions

This study assesses the organizational learning levels achieved by supplier firms participating in the MSSP. Analyzing effects of firm and participant characteristics on learning outcomes generated complementary insights. Comparison of these research findings with theoretical models of organizational learning provided understanding of the learning process. Empirical evidence for this study was obtained by combining qualitative surveys and statistical analysis.

To our knowledge, few other studies have reported empirical information on continuous improvements in CP based on a significant group of companies. The results of this study contribute to literature by deepening understanding of the complex learning process involved in the implementation and dissemination of CP. Interaction between individual and organizational learning is highlighted, as well as integration of explicit and tacit knowledge related to CP. Collaborative learning, principles of workplace democracy, and liberation of human spirit are proposed as facilitators of organizational learning. Additionally, this study proposes a framework for studying the impact of CP dissemination efforts based on organizational learning concepts.
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 method and supply chain relationships. Evidence of high-level learning shows the approach employed provides an alternative for traditional CP dissemination mechanisms based on technical assistance provided by external consultants.

Theoretical implications of this study highlights integration of management perspectives such organizational learning, as a key element of the sustainability improvement of organizations and industrial systems. This view responds to views of authors such as Baas, (2006), Boons, (2009), Cohen-Rosenthal, (2000), Howard-Grenville & Boons (2009), and Hoffman (2003) who defined this development of as the Industrial Ecology management paradigm. Within this concept, the challenge of sustainable organization is considered within its context and the systems they are part of. Technical analyses of material and energy flows are combined with study of social constructs and relationships as main elements of sustainability. This view advances and integrates over the Cleaner Production strategy which proposed preventive technical measures as alternatives for reducing environmental load produced by industrial processes (Baas, 2006).

The limitations of this study center on the comparatively small size of the database used for [the] quantitative analysis. Even when statistically significant relationships could be identified, more complex analysis involving additional variables was not possible. Moreover, learning is a complex social process. Most of the follow-up questionnaires were filled-out six months following the final workshop. Companies reporting no implementation might have prepared this at a later time. As well as firms that didn’t report,“formulation of new CP initiatives” might have done this later on. In addition, the 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.

References

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Ehrenfeld, J. R., W. Ashton, A. Luque, 2002. Mejores practicas para la produccion mas limpia su fomento e implementacion en la pequena empresa [Best practices for the dissemination and implementation of cleaner production in small firms], Interamerican Development Bank (IADB), Multilateral Investment Fund, Washington, USA.


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Appendix A  Estimated coefficients by maximum likelihood of the ordered probit

<table>
<thead>
<tr>
<th>Variables</th>
<th>Ordered Probit Model</th>
<th>Organizational Learning Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services</td>
<td>-0.853**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.412)</td>
<td></td>
</tr>
<tr>
<td>Printing</td>
<td>0.329</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.342)</td>
<td></td>
</tr>
<tr>
<td>Raw Material</td>
<td>-0.422</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.303)</td>
<td></td>
</tr>
<tr>
<td>Indirect Supplies</td>
<td>0.00314</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.303)</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>0.486**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.231)</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>0.177</td>
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</tr>
<tr>
<td></td>
<td>(0.331)</td>
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</tr>
<tr>
<td>Administrative Profile</td>
<td>-0.659**</td>
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</tr>
<tr>
<td></td>
<td>(0.334)</td>
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</tr>
<tr>
<td>Technical Profile</td>
<td>-0.552**</td>
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</tr>
<tr>
<td></td>
<td>(0.280)</td>
<td></td>
</tr>
<tr>
<td>Other Profile</td>
<td>-0.718</td>
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<td></td>
<td>(0.529)</td>
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<tr>
<td>Directive Position</td>
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<tr>
<td></td>
<td>(0.403)</td>
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<tr>
<td>Operational Position</td>
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<tr>
<td></td>
<td>(0.337)</td>
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<tr>
<td>Commercial Position</td>
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<tr>
<td></td>
<td>(0.312)</td>
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<tr>
<td>Participant Experience</td>
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<tr>
<td></td>
<td>(0.0133)</td>
<td></td>
</tr>
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</table>

**Thresholds**

<table>
<thead>
<tr>
<th></th>
<th>Ordered Probit Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>α1</td>
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</tr>
<tr>
<td></td>
<td>(0.366)</td>
</tr>
<tr>
<td>α2</td>
<td>-0.256</td>
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<tr>
<td></td>
<td>(0.362)</td>
</tr>
<tr>
<td>α3</td>
<td>1.309***</td>
</tr>
<tr>
<td></td>
<td>(0.378)</td>
</tr>
</tbody>
</table>

Observations 128
Pseudo R-squared 0.0903

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Appendix B  Distribution of supply firms that assisted to workshop meeting and dropped out of the MSSP