Women learning alliances for greening manufacturing industries in developing countries

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Abstract

Enough attention has not been given to the role of women in the introduction of cleaner technologies in industries. Cleaner Production (CP) initiatives, also known as pollution prevention, in developing countries are usually oriented to Micro, Small and Medium Enterprises (MSMEs) where these are the most common and important industries for employment generation. Commonly, manufacturing MSMEs are in hands of men. However, an all-women leadership alliance is helping transform Colombia's highly polluting industries into cleaner, greener businesses. Leading women from academia, NGOs, utility companies, public organizations and large and small industries came together to create the first "Women & CP learning alliance", through which women promote partnerships to foster clean production practices. All women have one thing in common – they have already led successful cleaner production projects in various industries. For example, a woman from the electroplating industry, who eliminated the use of cyanide, decreased the use of heavy metals, and reused water, joined the alliance. A woman from a sugar cane sub-product enterprise (trapiche panelero), who eliminated the use of burning tires to run the artisanal oven by switching to an energy-efficient oven, became part of the women's CP alliance. In our experience, women who lead CP projects commonly go beyond the goals of the projects and the fulfilment of the environmental legislation. Women are completely committed to CP and willing to share their experiences and knowledge with others.

Thus, the women & CP alliance has been effectively leading and participating in green industries initiatives in Colombia in priority industries, such as the electroplating, food production, and construction industries. Women actively support environmental training initiatives and the development of CP proposals and projects. In the construction value chain in Valle del Cauca (Colombia), for one large construction firm and 10 of its suppliers, women led the change to: use photovoltaic energy for lighting and pumping rainwater; put proper construction waste recycling programs in place; reuse the water from processes to cut bricks; reuse construction material waste in road improvements; replace wood forms in all the construction processes; replace motorcycles with bicycles for supervising construction projects; and reduce paper consumption in administrative processes. By training the construction industries staff, the women led significant technological changes in the construction processes of the large and small enterprises in order to reduce pollution and address climate change in an industrial activity with a large environmental footprint. Women's alliance work in fighting climate change has been awarded at national and international level.

Women have demonstrated they have an important role to play in greening manufacturing industries, especially MSMEs in developing countries. MSMEs commonly have difficulties to access environmental knowledge and technologies. Women's learning alliances around CP have demonstrated to be an effective methodology to support and encourage more polluting industries to make the shift to cleaner production. Women learning networks are key to transform polluting industries into cleaner businesses.

Keywords: women, Cleaner production, learning alliances.

1. INTRODUCTION

Many obstacles affect technology transfer processes. Inappropriate technology transfer processes between different countries, or even within a country, to the local level result in improvements which are difficult or impossible to sustain. In the case of cleaner technologies, it has been acknowledged that the long-term success of CP demonstration projects has been limited (Van Hoof & Lyon, 2008; Bass, 2007). Firms that enthusiastically start applying CP technologies during CP pilot experiences, easily return to their old polluting practices when the demonstration projects end (Bass, 2007). Thus, the implementation and sustainability of CP actions remains a challenge particularly in MSMEs (Ashton *et al*., 2002; Fernández-Viñé *et al*., 2010; CRPML, 2010).

It's been argued that CP programs often fail in achieving long-term results because these tend to ignore organizational learning aspects (OL) that are relevant to support CP learning processes in the firms (Vasquez, 2014; Bass, 2007; Stone, 2006). Paying more attention to the creation of learning alliances with external CP sources to ease the acquisition, implementation and institutionalization of CP knowledge is one of the OL proposals made by CP researchers (Vasquez, 2014; Van Hoof, 2014). Key organizational features, such as the organizational culture and structure, human relations, personal behaviors and attitudes, and internal policies, deserve greater attention if more effective and sustainable CP transfer process are desired (Stone, 2006; Bass, 2007). Based on empirical data, we suggest gender aspects might also influence the development and results of CP learning processes during CP projects. Learning alliances were also found as key strategies to perform CP transfer processes.

2. THEORETICAL FRAMEWORK

Innovative concepts have been associated with technology transfer in the last years. For instance, the World Bank considered that the transfer project cycle should be re-defined to include phases such as consolidation and expansion in learning environments (Picciotto and Weaving, 1994). Prey stated (1994), the analysis of existing technologies and the transfer process included a series of phases: "identifying, testing, improving or adapting, and using a technology". However, it was also possible to introduce new components through these processes. Prey (1994) also stated that participatory technology development contributes to solve the problem of technology selection and transfer.

In Colombia, specifically for water and sanitation projects, CINARA suggested a change from technology transfer to knowledge dialogue where there is recognition that each actor has useful knowledge, and where research and development play an important role in the adaptation of technology (CINARA-EMCALI, 1997; Quiroga *et al.*, 1997). Based on these concepts, Restrepo (2005) proposed a new model for the technology transfer process named *the knowledge dialogue model for the transfer process,* which was later updated by Restrepo (2015) as it is shown in Figure 1.

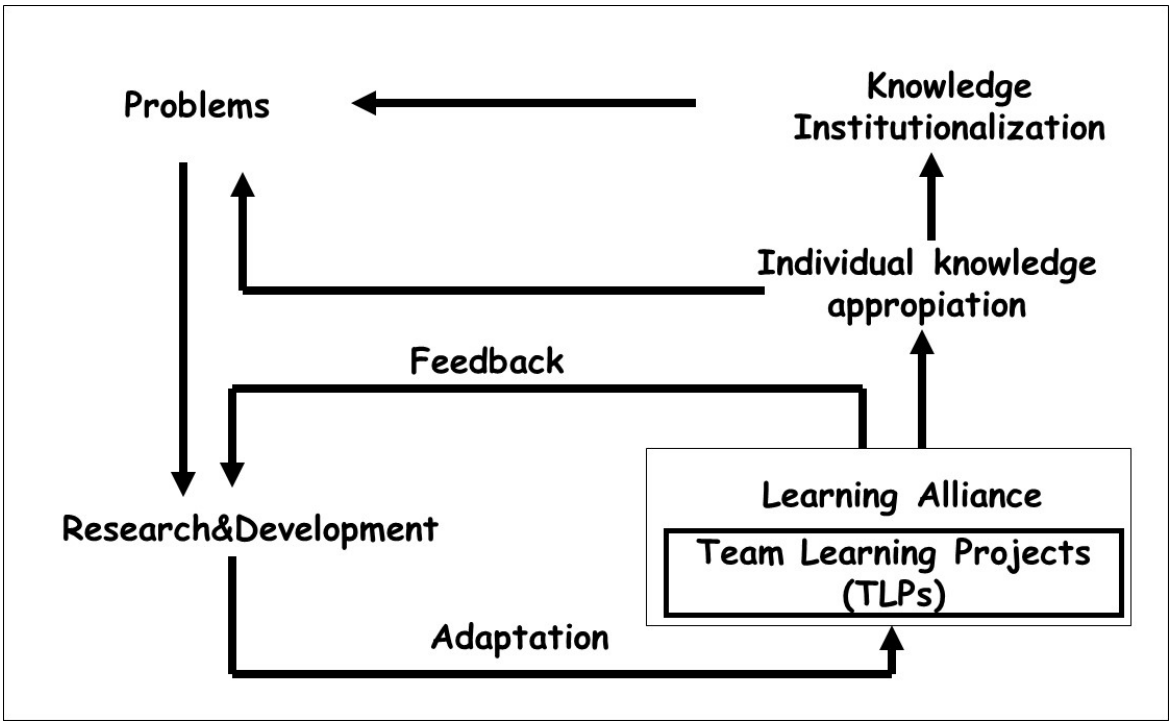

Figure 1. The knowledge dialogue model for the transfer process (Restrepo, 2015).

In order to apply what is developed in the research and development component of the Restrepo (2015) model, team learning projects are proposed to solve specific situations. These kind of projects are developed by the actors interested in solving the situation, which organize themselves in a Learning Alliance. The Learning Alliance is conceived as a group of different kind of organizations, which are interested to tackle a specific problem. Their interest in the problem could be different as well as their functions and missions. One of the institutions in the Alliance coordinates activities, which are mainly around specific projects used to learn how to solve the problem, geared towards action. The Learning Alliance is open, allowing the participation of everyone interested in the problem. However, the responsibility of specific activities within the phases is given to the alliance members, who have to produce the agreed products. In the alliance, all actors practice a leadership and assume a compromise and responsibility. All of them contribute, learn and benefit from the actions.

The Restrepo (2015) model coincides with some authors' arguments that claim that cleaner technology transfer processes require the interaction between different actors who end up creating learning alliances (Van Hoof, 2014; Vickers & Cordey- Hayes, 1999), Vasquez, 2014). These authors argue that the improvement of organizational learning processes around CP necessarily requires the establishment of good linkages with external sources to acquire new CP knowledge and increase CP capacities within the firms. Authors highlight the importance of firms to work in the development of an organizational culture that encourages and allow such interaction with external actors. In other words, an open organizational attitude that continuously promotes a participative approach between key CP external sources and internal actors (Vickers & Cordey- Hayes, 1999; Vasquez, 2014).

Particularly, Vasquez (2014) in her model suggests the CP donors and the CP knowledge providers (as CP consultants, academics and professionals), as the most influential external actors during CP demonstration projects in Micro, Small and Medium Enterprises (MSMEs) in developing countries. Vasquez (2014) states that pilot projects have been the main tool to spread CP in these countries, with an emphasis on MSMEs, which are the majority of industries. MSMEs have particular conditions that hinder them from accessing new knowledge and that in general affect their learning processes, such as: low financial and technical capacities, lack of training, lack of organizational structures, short term goals, and high levels of informality. As a result, most MSMEs are highly dependent on external sources for accessing and generating new knowledge (Jones & Macpherson, 2006). Working on external networking, for establishing strong ties and relations with external knowledge sources, becomes crucial for MSMEs to have access to technological opportunities and innovations (Tomlinson & Fai, 2013), including cleaner technologies (Vasquez, 2014).

In the learning alliance none of the agents (institutions, community, university etc) claims to have or own the solution. They coincide, instead, in that solutions are conjointly constructed. In the Alliance, each actor performs her / his role without losing identity. The approach gives equal importance to academic and institutional knowledge next to knowledge and experience from the firms (Restrepo, 2005). It values the interaction between the technical, socio-economical, and environmental aspects and strongly promotes critical, creative capacity of men, women and children involved in the process (Galvis et al., 1996). The basis to work together is trust and the certainty that each one will received concrete benefits working jointly.

It is possible that the Alliance solves the problem and no new projects are needed, so the Alliance can disappear. Another situation is that once the problem is solved, some members agree to continue solving another problem. The latter was proved by the application of the Vasquez (2014) model in firms (a large company and its small-sized suppliers) of the construction chain in Colombia. A first alliance between an NGO, a research institute of a university and a large construction firm and its suppliers (SMEs) was created to introduce CP actions and raise CP learning capacities in the construction firms. The strategy was a CP certificate program to transfer CP knowledge. The evaluation of the program showed that 88% of the SMEs were able to successfully implement CP alternatives, change habits and raise CP capacities. The results of the alliance were considered remarkable since other authors have reported approximately 70% (Van Hoof, 2014) and 40% as the CP implementation rate in MSMEs in demonstration projects (Dieleman, 2007), or even less especially in developing countries (ECLAC, 2006). However, none of the SMEs was able to

institutionalize the new CP knowledge. Therefore, the members of the alliance agreed to continue working together, designing a second certificate program which specifically aims to help SMEs to institutionalize CP knowledge. The challenge for the alliance is the CP knowledge institutionalization, which is the knowledge incorporation within the organizations' policies, processes and procedures (Restrepo 2015), which inevitably entails a change of habits, beliefs and core values toward CP (Vasquez, 2014).

CP demonstration projects often fail in the institutionalization of CP knowledge (Vasquez, 2014). Many entrepreneurs initiate the CP process, but after completing the programs most of them return easily to their old mentality and routines (Bass, 2007; Van Hoof & Herrera, 2007; CRPML, 2010). However, it has been observed that firms owned or managed by women have been able to institutionalize CP knowledge during or after CP demonstration projects are completed. This has been evidenced in different sizes of enterprises of diverse industrial sectors. CP learning alliances enabled these women to start the shift toward CP, however, particular gender characteristics seems to have positively influenced the effectiveness and continuous improvement results. This paper is concerned about the role of women and learning alliances in the institutionalization of CP knowledge in industries.

3. METHODOLOGY

The observation of CP demonstration projects conducted by a cleaner production center for 10 years (2002 – 2012) and of other CP pilot initiatives in Colombia, showed that women in decisions making positions (owner, manager, technical director) successfully led CP processes in their organizations. These women persevered in their efforts to introduce, implement and sustain CP technologies overtime. Three CP projects in which women successfully led environmental changes in their firms, were selected to be analyzed, acting as case studies that provided the empirical data. *Case Study* was selected as the research method. This method is completely concentrated on the analysis of a selected case, seeking to learn from that single case and to optimize the understanding of it (Stake, 2005). The case is defined as "a phenomenon of some sort occurring in a bounded context" (Miles *et al*., 2014). It's a bounded system, determined by internal and external features, whose boundaries are not always clear (Stake, 2005). "The case is, in effect, the unit of analysis" (p. 28) (Miles *et al*., 2014). In general, case study method allows researchers to explore and analyze a complex real-life phenomenon (the case) in depth (Yin, 2009), using a variety of data sources within their context, which allow the phenomenon to be revealed and understood (Baxter & Jack, 2008). Data sources can be qualitative or quantitative, or a combination of both, which can be collected and analyzed by different research methods, such as mixed methods (Stake, 2005; Yin, 2009).

The three cases were conducted in male dominated sectors: Electroplating, construction and *trapiches paneleros*, in which women's participation is still very low in developing countries. In these particular cases the women were CP early adopters, met the goals defined in the CP pilot projects and went beyond the regulations. For data collection, we reviewed the cleaner production center progress reports of two of these cases, carried out site visits, and interviewed women individually. Reports allowed us to know the technological

implementations and environmental results (i.e., laboratory results), the site visits mainly allowed triangulation processes to verify the cleaner technologies had been sustained, and through the interviews we explored the perceptions of women around CP technology transfer, CP motivators and barriers, CP learning alliances and their role in CP learning processes. Six women were interviewed in total: one from a *trapiche panelero*, one from an electroplating industry, four from a construction firm. Table 1 summarizes the details of the three selected cases of study.

Table 1. Details of the cases of study

Industrial sector and number of firms studied	**Firms' features**	**Women features**	**Women position in the firm**	**Other actors of the CP Learning alliance**
Electroplating, one firm	Type: Medium firm Number of employees: 12 Market: Local and international sales (Latin-American market) Location: urban area	Educational level: University (graduate level) Age: Between 35 – 40 years old.	Owner-manager	Environmental authority (donor), cleaner production center (CP provider), CP consultants and professionals.
Trapiche panelero (sugar cane subproduct production), one firm	Type: micro firm Number of employees: 4 Market: Local Location: rural area	Educational level: primary education Age: Between 35 – 40 years old.	Owner/manager/shop-floor worker	
Construction, one firm	Type: large firm Number of employees: 53 Market: Local and international sales Location: urban area	Educational level: primary education Age: Between 20 – 45 years old.	Technical manager Coordinator of projects Environmental department assistant Occupational Health assistant	Environmental NGO and research institute of a university (CP providers) Large firm suppliers (small and medium sized firms)

4. RESULTS

All firms achieved enormous environmental results, significantly reducing their pollution levels. Women agreed learning alliances helped them to develop their capacities to visualize CP opportunities, test and implement them. External sources provided them with environmental knowledge, opening a whole new frontier to explore. All women acknowledged alliances were fundamental to start walking the CP path, however, such positive results would have not been possible without women's leadership, perseverance and commitment throughout and after the CP pilot experiences were completed. Although women don't think they have more abilities than men to apply CP, they do believe women have particular characteristics that make it easier to promote and sustain CP actions in their industries. Patience for recalling and repeating the new CP guidelines (commands and instructions) to workers is one of those. *"While my father chooses to write a warning letter to those workers that show unwillingness or inability to apply CP new processes, I prefer to use daily face to face interaction with workers to remind and explain them the importance of changing their attitude toward CP. It's a matter of repeating the new CP idea over and over again with respect and patience. I'm not sure if they end up accepting CP because they are convinced of its benefits or just because they are tired of hearing my boring speech every day, but it definitely works. Warning letters are unlikely to work in family firms".*

In addition, all women showed a great commitment with the learning processes around CP. For example, the woman Owner Manager of one electroplating industry, whose job was totally focused on administrative aspects, decided to get deeply involved in the technical aspects of the wastewater treatment plant (WWTP) that was being implemented (as a complementary environmental process to the CP actions). She successfully learned how to operate, control and maintain the WWTP by herself.

> *We are very few people in our firm. Only one shop floor worker trained in the operation of the new WWTP was too risky, what if something went wrong? That's why I decided to learn how to operate the WWTP as well, so I could provide support in case it was required. It was a huge challenge for me, but it couldn't be that difficult, and knew it was possible for me to learn.*

Women have also promoted the development of diverse formal mechanisms for the institutionalization of CP, as they proved to be greatly aware of the importance of retaining new CP knowledge after the CP pilot projects were completed. They successfully designed and applied CP management and monitoring tools such as integrated hazardous waste management plans, general environmental programs and process control forms to monitor the environmental efficiency of the production processes. In particular, plans and programs contain specific environmental goals to be gradually achieved, to promote the continuous improvement around CP. Finally, for ensuring the institutionalization of CP within their firms, women have made radical organizational changes, such as modifications in the organizational structure to create new green positions (i.e., the WWTP operator), and the definition of new green institutional vision, values, objectives and goals. The latter aimed to

ensure any new potential technology or any technological modification is based on pollution prevention principles.

> *I created water and material consumption monitoring forms, and shared them with my workers, to track and control the use of resources in the production process. By using these forms and with the support of workers, the CP implemented actions were routinized and maintained after the project was completed*

In a similar way, women interviewees feel that women have particular communication skills that help them in sharing and disseminating CP ideas. *"Women usually show more sensibility and passion for environmental issues, which is reflected in our words and actions, helping us to convince other colleagues and workers about CP".* Women can easily help in shaping informal communication channels for CP. All women interviewees agreed women play a significant role in greening industries, and have the capacities to develop successful and sustainable projects. Women stated that the lack of financial resources, difficulties in accessing information and training, low self-confidence, wrong beliefs around CP, restrictions on the participation of women in male dominated industrial sectors, and not having decision making positions, are some of the main obstacles women face to start working or work more actively on CP. However, women feel capable of effectively conducting CP processes and believe they certainly are a key factor for greening industries, which they expressed in phrases such as: *"women & cleaner production = business sustainable growth", "women coffee farmers and her leadership in cleaner production have export quality".* Main environmental results achieved through CP processes in the three cases of study are summarized in Table 2.

Table 2. Most significant environmental results of CP projects led by women in industrial sectors.

Case	Indicator	Unit	Baseline (Before CP)	Final result (After CP)	%
Case # 1. Electroplating medium-sized firm.			2007	2015	
	Water consumption reduction	M3	160	32	80%
	Industrial waste water treatment and reuse	M3	0	12 M3	100%
	Cyanide content reduction in industrial waste water	mg/L	1296.7	0.06	100%
	Copper content reduction in industrial waste water	mg/L	1296.7	<0.3	100%
	Zinc content reduction in industrial waste water	mg/L	1292.5	<0.2	100%
	Hazardous solid waste proper collection and disposal	kg	0	1500	100%
Case # 1. Trapiche panelero micro-sized firm.			2009	2015	
	Tires burned as fuel	Tires / month	60	0	100%
Case # 3. Large construction firm			2014	2015	
	Recycling of construction material waste	M3	0	606	31% (recycling)
	Construction waste generation	M3	1953	1347	31% (reduction)
	Reuse of demolition & construction material waste	Kg	0	1347	69% (Reuse)
	Rainwater Harvesting & use	Liters/month	0	720.000	90%
	Use of wooden planks (3 meters long)	Wooden planks / month	600	100	83%

Additionally, other organizational results were achieved mainly by the medium and the large firms, which initiated different activities for promoting CP continuous learning and innovation. The creation of the environmental positions, the continuous negotiation with CP technology providers and consultants, the establishment training agreements with local universities, the creation of new strategic learning alliances, the participation in environmental events and activities (i.e., the first CP & women marathon), and in general the modification of core values, beliefs, procedures and routines adopting new innovative CP approaches, were some of the managerial implications that emerged from the CP learning processes. These organizational modifications clearly show that the institutionalization of CP knowledge within these firms was successfully achieved.

5. LESSONS LEARNED

- Learning Alliances works only based on trust and around concrete situations and solutions.
- CP alliances are created by different institutions, with different interests, backgrounds, missions, and functions. That is the value of the alliance. Participation usually depends on the concrete benefits perceived and received by its members.
- Activities, responsibilities, and products should be very clearly assigned from the very beginning.
- Firms' knowledge is valuable and complemented with the technical knowledge by the institutions. Knowledge is not exclusive. Joint work between actors makes it possible to solve environmental problems considered unsolvable by isolated agents.
- Women, treated as equal, with consideration and respect, participate critically and creatively in the solution of problems related to CP.
- Women have the necessary capacities and unique features to successfully conduct CP learning processes, however they need support to start the transition toward CP. Learning alliances are an effective way to provide women with new CP knowledge, encourage them and support them in the adoption of cleaner technologies.
- Women have proved they are able to green industries leading sustainable CP initiatives. The challenge now is to convince industries and CP stakeholders that women have an important role to play in the adoption and dissemination of CP technologies in all kind of industries, both in rural and urban areas.

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