DOING MORE WITH LESS: BUILDING CAPABILITIES FOR SUSTAINABILITY BUSINESS MODEL

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ABSTRACT

We investigate capabilities developed by firms using waste reclamation to build competitive advantage and sustainability business models. The study identifies these capabilities as innovation and technological development; control of waste material flows; adjustment in human resources; management of environmental constraints; interconnectedness; higher-order learning; and development of new partnerships.
Keywords: waste reclamation, sustainability, capabilities, business model, competitive advantage.

INTRODUCTION

The effects of the global financial crisis that began in 2007–08 make companies much more aware of building organizational capabilities needed to shape strategies to do more with less/more efficient and sustainable use of our limited natural resources (Gardner & Renner, 2009; Potts, 2011). These organizational capabilities are likely to lead to competitive advantage, corporate sustainability, and, more importantly, the ability to withstand major challenges, including talent shortages, price competition, supply irregularities, societal hostile reactions and economic crisis. Slater argued that "There is evidence that companies committed to sustainability are benefiting from these programs when put to the toughest financial test of our times." How did firms operating in the green industry segments develop and internalize capabilities for sustainability business models?

Previous research in environmental management has identified several firm capabilities of doing more with less, including stakeholder integration, pollution prevention, and low-impact technologies (Aragón-Correa & Sharma, 2003; Sharma & Vredenburg, 1998). Nevertheless, most analyses of these environmental capabilities remain too broad, are relatively static, and do not consider the managerial and organizational implications of eco-efficient practices from the standpoint of managers and employees. We study how firms using eco-efficient practices in the green segment of waste reclamation developed and internalized capabilities needed to build competitive advantage and sustainability business models that cope with resource constraints. We focus on firms that use waste reclamation as the basis of their activities because these firms address most of the concerns about the potential of new technologies, innovations, growth of new markets for environmentally sound products and services (DeSimone & Popoff, 1997; Porter & Van der Linde, 1995; WCSD, 2006) and by doing so, they permeate the reaches of the economy. The study expands previous research by identifying key capabilities required to successfully implement innovative eco-efficient practices and build sustainability business models.

LITERATURE REVIEW

Environmental capabilities: resource-based view

Studies on environmental management have applied the resource-based view of the firm to identify resources and competencies that are rare, valuable, and difficult to replicate (Barney, 2001; Eisenhardt & Martin, 2000; Prahalad & Hamel, 1990) for the competitive advantage of environmental practices. These studies have shown that the ability to integrate, to combine, and coordinate these resources through complex routines, competencies, and tacit knowledge are essential to successfully implement organizational effectiveness improvement strategies. Nevertheless, most of these studies have narrowed their focus to the impacts of certain organizational capabilities and moderating factors (industry growth, organization size, etc.) on the competitive advantage that might result from environmental practices and strategies.

Although it has been validated by various empirical studies, the formulations of organizational capabilities from the natural resource-based view have some considerable limitations. First, environmental practices and capabilities that lead to competitive advantage are rarely clearly defined and described by researchers. Second, most studies of organizational capabilities for environmental management are not based on the experiences and interpretation of managers, but rather on quantitative variables. Third, improvements in competitive advantage are generally considered to be an output of eco-efficient environmental practices and organizational capabilities. In this win-win perspective, organizations are encouraged to develop environmental initiatives and capabilities that are ultimately expected to reinforce economic performance. Nevertheless, it would seem simplistic to take for granted that all environmental initiatives based on specific capabilities are profitable. If certain so-called environmental actions are profitable, it may be because they were implemented, at the outset, due to their quite predicable economic advantages, irrespective of their possible ecological benefits. For example, improving energy efficiency generally has obvious positive economic impacts, although this approach is often presented as part of the greening of organizations. The same remark could apply to supposed eco-industrial actions, which may have ambiguous economic and environmental significance inside organizations.

Fourth, the environmental management capabilities of organizations are too often implicitly viewed as being static, even though organizations are increasingly exposed to rapid and unpredictable changes (Aragón-Correa & Sharma, 2003; Eisenhardt & Martin, 2000; Menon, 2008; Newbert, 2007). The process by which capabilities and competencies are developed and combined to induce change is an essential element in sustaining competitive advantage (see Newbert, 2007, on the evolution from a static to a dynamic view of capabilities). Generally speaking, dynamic capabilities drawn from the learning process help to build, exploit, and transform new knowledge inside organizations, thereby facilitating change and enhancing competitiveness (see Menon, 2008, for a review of the literature on dynamic capability).

We offer our revision of organizational capabilities complemented by principles drawn from waste reclamation practices of doing more with less. Because they are conspicuous examples of sustainability business models, the development and integration of these capabilities expand our understanding of how firms can continue to improve competitive advantage and sustainability in the wake of economic downturn.

METHODS

Analyzing industrial ecology activities requires that various dimensions be considered. These include the activity sector, operating context, motivations, levels of internalization of waste material practices, sub-product synergies, commercial and environmental performance, human resource management implications, operations, sales, and the environment. Because of its qualitative, comparative, and multidimensional approach to complex organizational issues, the case study method (see Eisenhardt, 1989; Yin, 1984, on the case of study methodology) appeared to be the most appropriate for analyzing the different dimensions of industrial ecology practices.

Case selection

The selection of the twelve cases was made following meetings with government representatives and experts on this issue. Documentation from reports, newspapers, and publications was also considered in selecting facilities. Two main criteria were considered so as to focus the study on significant practices with potential applicability to various organizations. First, all of the studied facilities were considered to be significantly committed in terms of industrial ecology. Second, the sample was chosen in such a way as to reflect the various initiatives that can be implemented within diverse industrial organizations. Various cases relative to the recycling firm size and activity sector were included (see Table 1). Since they had common, specific, and comparable industrial ecology practices, these cases could be compared in relation to their focus on these practices. Although the case study methodology is not intended to be representative of the entire population of firms, it does make it possible to delve deeper into each organization. Nevertheless, the objective of this study was not to describe in detail the peculiarities of each of the twelve facilities. Rather, it was to analyze their similarities with respect to how they developed competencies, following the argument that “specific dynamic capabilities also exhibit common features that are associated with effective processes across firms” (Eisenhardt & Martin, 2000).

Insert Table 1 about here

Data collection and analysis

Data collection was based on 60 semi-structured interviews with environment, production, human resources, and sales operations managers directly involved in industrial ecology practices. All interviews were recorded and transcribed. Interviews with firm managers were followed by on-site visits to the facilities. Comments gathered during these visits and field notes were used as well. The questionnaire focused on the following issues: general information about the firm and its production modes, reasons underlying industrial ecology practices, implementation processes, levels of internalization of these processes, equipment and reclamation systems in place, and issues and difficulties encountered in promoting eco-efficient initiatives. The documents collected at each facility, as well as interviews with experts not associated with the studied cases, also led to a better understanding of the manufacturing processes, technical aspects of reclamation activities, and their general context.

In order to focus on the experiences and practices of managers, the study's data analysis and case comparisons drew on the inductive approach proposed by "grounded theory." This approach is intended to develop theories grounded in empirical data, such as respondents' statements and experiences (Gephart, 2004; Strauss & Corbin, 1990; Suddaby, 2006). Indeed, this inductive process is not based on preexisting hypotheses for validation, although researchers are not necessarily expected to ignore or deny existing studies and concepts. The questionnaire thus did not actually focus on the core competencies and learning processes supposedly associated with industrial ecology activities. Rather, the importance of these aspects emerged recurrently from interviews and data analysis, especially when respondents explained how industrial ecology practices were developed within their organizations and what their key success factors were. The categorization and analysis of the field research findings followed the basic procedures of qualitative research based on grounded theory. First, all 60 of the interviews recorded were transcribed into computer files and then exported to qualitative analysis software (QSR N-Vivo). Second, the transcriptions were analyzed through a categorization process based on concepts and topics that emerged from the questionnaire responses or results interpretation. Thus, the initial categories were completed, reorganized and sometimes regrouped or subdivided, depending on the recurrence of the empirical data. In all, 84 categories were developed. The process of categorizing and grouping data on the same issues made the cross-case comparison much easier. Structuring the information around specific categories helped to focus the qualitative analysis on significant results and to select relevant quotes illustrating the main lines of these results.

FINDINGS

Table 2 summarizes our findings. It shows the key capabilities of sustainability business models developed by firms using various types of recycling and waste activities. These capabilities are identified as innovation and technological development; control of waste material flows; adjustment in human resources; management of environmental constraints; interconnectedness; higher-order learning; and, development of new partnerships. The development and internalization of these capabilities implies a three-level process: experimentation and innovation; internal operationalization and functional adaptation; and, cross-functional integration and networking expansion.

Most of the interviewed managers believed their waste reclamation activities demonstrated the environmental commitment of the firm. This environmentally friendly image was generally reflected in newspapers and in the statements of environmental officials for whom these facilities constituted a model of green manufacturing and sustainability. The environmentally friendly image helped the firm connected with stakeholders through relations with consumers, risk reduction perceptions from investors, employee team building, and attraction of top talent. All these aspects contributed to delivering cost reduction while creating value for customers for an endless cycle of improvement. In all the cases studied, waste reclamation activities contributed to developing strategies to do more with less while improving both firm competitiveness and environmental sustainability:

> "We try to substitute all the product input used in our processes with waste. This allows the firm to be competitive from an economic standpoint." (Operations manager, Case 6)

The capabilities developed were based more particularly on core competencies (Prahalad & Hamel, 1990) that emerged progressively through a collective, dynamic, and relatively informal learning process. The emergent, specific, and collectively constructed characteristic of this process made imitation difficult in most cases, and thus represented a source of competitive advantage. Each case developed specific capabilities for handling non-conventional materials, adapting internal routines and production process to these materials, and responding to new institutional pressures. These capabilities were developed, adapted, and transformed to address specific and evolving challenges: innovating with new and unique waste reclamation processes, managing the irregularities of waste material flow, reacting to new environmental constraints and consumer demands, etc. This continuous process of adaptation, innovation, and reconfiguration reflected the dynamic capabilities that are required to do more with less.

Eisenhardt & Martin (2000) suggest that, even though dynamic capabilities are idiosyncratic because of their firm-specificities, they also share certain commonalities across firms. These common features were mainly reflected in the main development stages of the organizations' waste reclamation capabilities and the related competencies. Due to the peculiarities of each organization, these stages can hardly be generalized. However, it is possible to distinguish three main levels in the learning and internalization of industrial ecology capabilities as mentioned above: experimentation and innovation; internal operationalization and functional adaptation; and, cross-functional integration and networking expansion.

Insert Table 2 about here

These levels of internalization and learning were not mutually exclusive. Each level included the preceding steps and the corresponding specific capabilities. The first two stages (experimentation and innovation, internal operationalization and functional adaptation) focused on the technical and intra-organizational implementation of industrial ecology. The last stage (cross-functional integration and networking expansion) supposed an expansion of waste reclamation activities and more complex capabilities. The progression through these development stages that occurred when more specific capabilities were combined, integrated, and enlarged clearly reflected the dynamic nature of waste reclamation capabilities.

Waste reclamation experimentation and innovation

The development of technological innovation capabilities is considered in the literature to be one of the main sources of competitive advantage drawn from environmental initiatives.

Green innovation capabilities are generally associated with the adoption of pollution prevention technologies and the continuous improvement of existing practices. Green technologies and innovations are assumed, in the literature, to reduce internal costs by introducing more efficient production processes, reducing inefficient practices, minimizing pollution costs (waste management, water treatment, etc.), and developing proprietary technologies.

Regarding the nature of waste reclamation innovations, the studied cases showed that these innovations were related to specific, non-conventional, and difficult-to-imitate changes in the production processes. Initiatives such as the implementation of a pyrometallurgical process, serpentine electrolysis, and the introduction of toxic products in the manufacturing of high-performance concrete required the mastery of new production processes. These innovative processes were most often very specific or even unique and required continuous technical improvements in order to adapt to the various wastes reclaimed. Although the learning curve varied from one firm to another, it played a crucial role in making the implemented techniques profitable even in tough economic times. In fact, one of the main sources of costs associated with these techniques was not the waste materials as inputs *per se*, but rather the way they were used and transformed. In other words, what was important was the know-how and appropriate technology embedded in the processing technique. This challenge was particularly important when starting new production processes:

> "The problem was a purely technological one that stemmed from the equipment and materials used. It was a question of operating the plant on an ongoing basis, finding solutions to all the identified technological problems and unsettled questions over time." (Technology and engineering operations manager, Case 6)

The method for developing industrial re-use innovations was rarely structured and planned. In a few cases, the technological complexity involved in processing certain types of waste materials required partnerships with others organizations. For example, one of the cement companies (Case 8) developed a complex partnership with a lead and metals recycling company (Case 9), a large aluminum producer, and a Canadian university to develop a unique method for recycling spent pot liner material from aluminum reduction cells, a dangerous waste material. This three-year R&D and industrial partnership led to the development of a new cement-making process allowing Case 8 to significantly reduce its energy consumption and greenhouse gas emissions. The new cement-making process also allowed the aluminum company to cut over 50,000 tons of dangerous waste material previously disposed of at high cost. This type of partnership illustrates the win-win relationship that can emerge between industries seeking to cut waste disposal costs and other industries searching for innovative methods to reduce the costly consumption of energy and raw materials.

Nevertheless, this type of relatively structured technological partnership was much more the exception than the rule. In most cases, innovation was based on an unstructured and dynamic trial-and-error process inside an organization. Indeed, industrial ecology technologies were generally designed to exploit niche markets and specific opportunities rather than large-scale production. As a result, the innovation process was rarely based on standardized technologies or the immediate and radical questioning of existing practices. Rather, they relied on a do-it-yourself rationale involving innovation and internal initiatives that were often less planned and foreseeable. This experimentation was necessary in light of the uncertain composition of some waste and the need for customized processes to ensure waste material recycling activities. For example, to find a solution to the daily production of nearly 500 tons of de-inking sludge, a pulp and paper facility (Case 11) developed a specific process for transforming this sludge into a paper-based compost product used by a local horticultural organization. This product was later produced on a larger scale. Because of the unconventional and changing nature of many waste materials, this innovation process was far from static, requiring a continual adaptation of internal practices. As a result, industrial re-use experimentations and innovations tested the creative and entrepreneurial mindset of employees (see Teece, 2007, on the role of entrepreneurship on the development of dynamic capabilities):

> "We've explored the core aspect of entrepreneurship, that is, trial and error. There are those who dismantle equipment and then put it back together. Some have no idea of the chemical reactions that occur. Others just try things – they're the real creators. This is how this plant got going; by continuously trying new things." (Operations manager, Case 2)

Internal operationalization and functional adaptation

The development of experimentation and innovation capabilities appeared as a first step in successful waste reclamation initiatives. Nevertheless, this step did not represent the most challenging or difficult aspect in developing capabilities for doing more with less. Indeed, transforming hazardous waste materials engendered complex environmental, operational, and sociopolitical implications inside organizations. The studied cases showed that, to be efficient, internalizing new waste reclamation routines and technologies required that certain departments, functions, and activities undergo significant changes and adaptations. Generally speaking, the internal operationalization of waste reclamation activities raised three main challenges which required specific competencies and capabilities including: control of waste material flows; adjustments in human resource management; and, management of new environmental constraints.

The first of these capabilities was the mastery of variations in waste material flow. These variations were entirely specific to the substitution of non-conventional material for traditional supplies, this substitution representing the core of the waste reclamation activities studied. Indeed, contrary to traditional supplies, waste materials were rarely standardized in terms of their composition, dimension, and supply regularity. Such irregularities required continuous adaptations and customized learning of new practices. Generally, waste material reclamation activities tended to appear as a sort of dynamic recipe that continuously evolved according to hard-to-predict supply irregularities, contingencies, and parameters:

> "This is not the kind of activity where we can foresee supply ahead of time. We have to constantly adjust to the operation, supply, and recipe conditions. Adapting all the time requires a lot of energy, it's the most

> challenging aspect of our operation. Simply put, predicting supply under these conditions is hard to do." (Operations coordinator, Case 9)

The second capability was being able to make specific adjustments in human resource management. These adjustments were not only related to the employee participation in environmental programs that is often mentioned in the literature (e.g. Boiral, 2002; Hart, 1995). The diversity of the waste materials used, and in certain cases their toxicity, required that the supervisors and operators who handled them be constantly trained. This training was doubly necessary because of the often lucrative return on processing the most hazardous waste materials. Such was the case, for instance, with certain inflammable materials used in cement manufacturing kilns. The processing of these materials, their transportation, and stocking required special precautions. Furthermore, the uniqueness of the implemented processes and practices required customized training programs. Generally speaking, these programs are longer and more difficult to design, since they are not focused on standardized knowledge. In this context, the retention of well-trained and experienced personnel constituted a real challenge that several respondents commented on:

> "Employee turnover is a real issue here. Lots of manufacturers in the region are looking for workers, and they're attracted by the job offers. The situation creates a high shift-worker turnover rate." (Production manager, Case 2)

The third important functional and operational capability observed was the most paradoxical and unexpected. Environmental improvements are normally considered to be a logical and positive outcome of green initiatives. In the present case study, environmental issues often appeared to be a source of problems and constraints for organizations. Although waste reclamation activities at first glance appeared to be an innovative approach that would produce quite obvious ecological benefits (reduced resource consumption, minimized waste disposal, etc.), solving and implementing them was often hard to do, requiring complex, specific environmental competencies. These activities tended to make the administrative, technical, and societal problems related to environmental management much more intense, complex, and unpredictable. At the administrative level, the shipping, storage, and use of waste material required permits and procedures which the interviewed managers viewed generally as very time consuming and cumbersome. At the technical level, the processing of waste materials generated diverse environmental impacts that had to be measured and controlled as much as possible. At the societal level, industrial re-use activities gave rise, notably in cases 7 and 8, to negative or even hostile reactions from residents. Mastering these problems clearly required legal, interpersonal, and institutional competencies:

> "The most difficult thing today is dealing with the Ministry of the Environment. Environmental regulations can be a real hassle." (Manager of environment issues, Case 7)

Cross-functional integration and networking expansion

The internal operationalization of waste reclamation initiatives clearly required the development of specific competencies involving significant changes in various organizational functions and departments: transporting and controlling the flow of waste materials, training employees to handle hazardous and unconventional materials, and so on. Nevertheless, according to research on the resource-based view of eco-efficiency (see notably Christmann, 2000, for an in-depth study on this issue) the development of a sustainable competitive advantage primarily lies in the combination of complementary or heterogeneous resources and capabilities. From this perspective, the competencies and capabilities needed to implement waste reclamation initiatives may not be sufficient individually to ensure the full success of this approach. Rather, these competencies and capabilities must be collectively integrated, coordinated, and learned. How such a combination of complementary capabilities can emerge in practical terms and contribute to competitiveness remains unclear, especially with regard to waste reclamation. The studied cases shed light on this underexplored issue and showed how the third step of waste reclamation development (cross-functional integration and networking) was based, to a large extent, on this combination and integration rationale.

First, the competencies and capabilities for waste reclamation were to a large extent interconnected and could hardly be handled separately. For example, to be viable, the production of magnesium from serpentine tailings (Case 6) faced several technological, economic, and environmental challenges at the same time. The technology developed by this company was unique and required continual adjustments to be effective. At the same time, the company faced huge social pressures because of the environmental and health toxicity of asbestos waste materials. Moreover, the price of magnesium was brought down by increasing competition, notably from Chinese magnesium facilities that did not face the same environmental constraints. All of these challenges forced the organization to question its practices, improve its technology, reduce environmental impacts, and mobilize employees to find more effective ways of turning serpentine tailings into magnesium.

Second, the expansion of industrial re-use activities tended to reinforce the importance of cross-functional integration and to turn these activities into a strategic development area. Cross-functional integration was reflected in the improved inter-connectedness of competencies specific to waste reclamation activities and the heightened cooperation between functional areas and departments. On the one hand, coordination and integration of functional eco-efficiency capabilities led organizations to learn new and more efficient routines necessary to enhancing competitive advantage. On the other hand, internal improvements reinforced the quest for opportunities to reclaim more diversified, value-added, and unknown waste materials. Several managers thus highlighted the fact that accumulated experience in reclaiming waste materials prompted the organization to process more complex and hazardous waste materials. Building these capabilities required a continuous improvement rationale where existing practices were questioned, enhanced, and enlarged to encompass the new waste material. Because they were specific to each organization and resulted from a long-range collective learning process, the capabilities for enlarging waste reclamation practices and improving cross-functional integration were clearly unique and difficult to transfer:

> “We’re considered to have “world class” processes here. Nobody in the world makes what we make. And nobody in the world is as profitable as we are in this area. With the development of the new combustion system, we were able to use and recycle new products. It’s what I call more

> sophisticated waste. It's more hazardous but, at the same time, more profitable." (Senior vice-president, marketing, Case 9)

The expansion of industrial re-use activities reinforced both the cross-functional integration inside the organization and the networking and interconnectedness between organizations. The success and expansion of waste reclamation activities could not, in fact, be made possible without extensive knowledge of industrial networks upstream and downstream of the value chain that made it possible to recover waste materials and market new products. The networking capabilities were all the more essential when organizations focused their strategy on waste reclamation and depended on it for their survival. The development of waste reclamation activities compelled involved companies to strengthen their networking and interconnectedness with other organizations:

> "We don't have any financial problems. The plant doesn't pollute either. We have raw materials on hand and our firm is in very good shape to meet future challenges. We're going to grow on our own through mergers and acquisitions. We're planning the creation of a new North American firm in this business sector." (General manager, Case 2)

CONCLUSION

The studied cases showed how waste reclamation capabilities were developed and internalized and how they can contribute to improving organizations' eco-efficiency and competitiveness and permeate the reaches of the economy. Analyzing the degree of internalization and learning in waste reclamation activities also provides a roadmap of sorts for organizations dealing with economic recovery (see Figure 1). This roadmap shows how firms engaged in waste reclamation practices pursued sustainability and competitive advantage in a tighter economy.

Insert Figure 1 about here

Experimentation and innovation (Stage 1) constituted the first step taken before deciding whether or not to adopt waste reclamation practices. Because most organizations, especially in industrial sectors, have to manage various types of inputs and waste, finding a way to turn waste material into value-added products is not reserved to specific sectors. In fact, input substitution possibilities are largely underexplored and should be seen as a promising avenue for cost reduction whatever the activity sector, especially for industrial organizations. Because they are primarily based on customized technologies and a do-it-yourself approach, waste reclamation experimentation and innovation are specific to each organization or activity sector. As a result, these capabilities can hardly be imitated and are embedded in specific processes for waste recovery and raw material substitution. Although the literature on the resource-based view of environmental management has stressed the role of innovation capabilities in reinforcing competitiveness, how these capabilities emerge, become internalized, and are interpreted inside organizations has been largely overlooked. The present study shed a new light on these issues by analyzing, from a qualitative perspective, the trial-and-error process underlying innovations in the underexplored area of waste reclamation. Interestingly, while the experimentation stage involved capabilities based on specific technical knowledge, any widening and integration of waste reclamation practices required more global and complex managerial capabilities (see Figure 1).

Internal operationalization and functional adaptation (Stage 2) was necessary to fully integrate waste reclamation technologies and innovations inside organizational routines. This integration required more complex capabilities related to specific functions or activities: controlling waste material flow, adjusting human resources, and managing environmental and administrative constraints. These specific capabilities have clearly been ignored in the literature, probably because no studies have focused on the management of waste reclamation activities and its underlying organizational capabilities. These capabilities cannot be easily generalized to all environmental actions. For example, managing the environmental impacts stemming from the transportation and transformation of recycled material is clearly a specific issue and cannot be extrapolated to all green initiatives.

Cross-functional integration and networking expansion (Stage 3) was made possible by combining the specific capabilities for waste reclamation activities and the long-range organizational learning that made these activities more efficient. Our study showed that, from a technical and functional perspective, waste reclamation could not be managed separately, but rather required complex coordination and integration. Because of its more general nature, this coordination and integration rationale was not, in principle, specific to waste reclamation and seemed to apply to all firms. The literature has already stressed the importance of combining complementary and heterogeneous eco-efficiency capabilities from theoretical and quantitative perspectives (see Christmann, 2000; Darnall & Edwards, 2006). The present study confirmed this point from a new qualitative perspective that focused on a specific set of environmental actions. The findings also showed that the expansion of eco-industrial actions tended to reinforce the cross-functional integration of complementary capabilities. It also strengthened interconnectedness between the organizations involved in recycling networks.

This paper makes three main contributions. First, the paper emphasizes the key factors which were required to successfully implement specific and innovative eco-efficiency practices. The study determined what these practices were, how they were implemented, and how they contributed to competitive advantage and sustainability even in economic hard times. The examples and quotations from the studied cases help to show, in practical terms, how managers experimented with and made sense of specific eco-efficiency initiatives. The managers' experience was definitively grounded in organizational capabilities that helped to improve competitiveness through a doing-more-with-less rationale.

Second, the paper stresses which specific capabilities are most necessary to build competitive advantage. Our case study showed, through a qualitative analysis, how these capabilities can emerge and be internalized within organizations. The qualitative study also identified specific and unexplored capabilities, such as controlling material flow, adjusting human resources, and managing environmental impacts. The success of waste reclamation initiatives in the face of many strategic challenges (Kabongo, 2010) clearly depended on the combination of these heterogeneous capabilities which were inherent to specific routines and processes.

Third, the paper demonstrates the dynamic nature of these capabilities (see Table 2). For example, experimentation with new methods for material recycling was far from rigid and required continual innovation to adapt the production process to the transformed inputs. This ongoing innovation tended to shape the subsequent learning of new routines and capabilities. As stressed by the literature on dynamic capabilities (Teece, 2007; Teece, Pisano & Shuen, 1998), the firms' activities and routines created path dependencies that channelled its learning process and future capabilities. As a result, this leaning process was generally relatively long and the development of new capabilities was shaped by the firm's history. Even though it was not the objective of this paper to analyze waste reclamation activities from a longitudinal perspective, the findings clearly showed that the observed capabilities emerged through an incremental and long-term process. Interestingly, each stage of this incremental process was embedded in the previous development level. The internal operationalization and functional adaptation (Stage 2) thus depended on the waste recycling technologies (Stage 1). Without these technologies, the internalization stage could not go forward. Similarly, the cross functional integration and networking expansion (Stage 3) required the pre-existence of specific functional capabilities (Stage 2), which then had to be successfully combined, integrated, and transcended through the learning of more complex, general capabilities. Because of these dependencies, pitfalls at one stage had direct repercussions on the following stage and could undermine the whole learning process (see Figure 1).

Thus, all stages and related capabilities were clearly not independent but rather interconnected. The more waste reclamation was internalized, the more organizations had to learn complex and global capabilities that included and transcended the previous stages.

Because they are based on a qualitative study and a limited sample, these conclusions are difficult to generalize for all firms. Nevertheless, the diversity of the studied cases indicates that waste reclamation activities and their related capabilities were not limited to a small set of singular organizations. The potential economic advantages of these activities and the development of material or waste exchanges worldwide also suggest that they can be applied over a large range of organizations interested in their own economic recovery. In many industries, especially in times of crisis, the search for cost reductions relative to supply and raw materials can be expected to fuel their development and, thus, raise new and complex challenges for organizational learning.

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Figure 1: Path Development and interdependence of waste reclamation capabilities

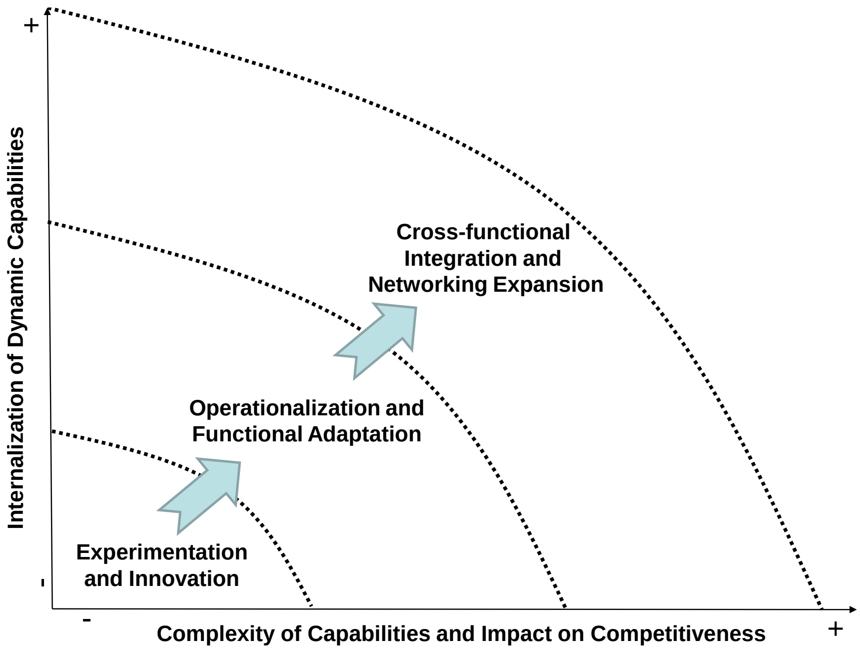

Table 1: Cases analyzed

Case	Main Activity	# Employees	# Interviews
1	Design and manufacturing of rubber flooring	40	4
2	Design and manufacturing of various rubber products	117	6
3	Production of liquid bitumen for road paving and the roofing industry	115	4
4	Production of industrial rubber granules	25	3
5	Production of stainless steel materials for agricultural and industrial use	30	2
6	Production of magnesium	360	8
7	Production of cement	388	6
8	Production of cement	200	4
9	Transformation and production of lead	140	7
10	Production of commercial tallow and protein products for pet food, production of organic fertilizer	60	2
11	Pulp and paper manufacturing	1,000	6
12	Production of titanium dioxide pigment	388	4
Interviews with experts not belonging to the companies			4
Total Interviews			60

Table 2: Development of waste reclamation activities

Stages of Development	Eco-industrial Experimentation and Innovation	Internal Operationalization and Functional Adaptation	Cross-functional Integration and Networking Expansion
Key Capabilities	Innovation and technological development for waste recovery and raw material substitution	Control of waste material flow, adjustments in human resources, environmental constraints management	Interconnectedness, higher-order learning, and development of new partnerships
Specificity or Uniqueness of Capabilities	Customized and difficult-to-imitate recovery technologies to exploit niche markets Innovations primarily based on do-it-yourself and unstructured experimentation	Specificity of managing unconventional and hazardous materials Involvement of specialized and well-trained employees Uniqueness of environmental and institutional constraints depending on the type of materials and externalities	Learning of cross-functional routines related to specific eco-industrial activities Handling of more complex or hazardous waste materials to sustain growth Expansion of partnerships with often small and unstructured recycling networks
Dynamic Nature of Capabilities	Essentially based on a trial-and-error process Continual innovation and experimentation to adapt the production process to the changing and non-standardized nature of recycled materials	Continual adaptation of the supply chain, human resources, and environmental management to meet changes in production process and institutional constraints (regulation, external pressures, NIMBY syndrome, etc.).	Continuous improvement rationale to optimize existing processes Expansion of activities to meet growing and fluctuating demand Combination of dynamic capabilities for internal operationalization
Main Challenges	Finding technologies to efficiently turn waste materials into value-added products Accelerating the learning curve to ensure profitability	Anticipating and managing the complex internal implications of eco-industrial activities Building and retaining internal competencies	Finding new supply sources Handling more complex and hazardous materials Launching new products and production sites
Success Factors	Avoiding costly technologies to exploit remote and uncertain markets Promoting a creative and entrepreneurial mindset	Obtaining the support of employees and managers Mobilization of all departments Customized training programs Employee retention	Promoting a continuous improvement rationale Internalizing cross-functional routines Building sustainable inter-organizational partnerships