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ENVIRONMENTAL ASPECTS OF THE CONSTRUCTION INDUSTRY: FRAMEWORK FOR THE ADOPTION OF ENVIRONMENTAL MANAGEMENT SYSTEM FOR SMALL AND MEDIUM ENTERPRISES OF PROVIDING SERVICES

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Abstract

The construction industry is recognized by triggering significant environmental impacts in undertaking its core and support activities. Small and medium enterprises (SMEs) are responsible for the support services and may also perform part of the main activities. Despite the environmental impacts related to the construction industry, the smaller companies do not usually have environmental management systems (EMS). In general, SMEs consider an EMS as a mere formalization to ensure qualification for hiring and adding additional cost of services for its implementation. This paper aims at identifying the environmental aspects of activities performed by SMEs in the construction industry in order to assist environmental management systems adoption in this Brazilian sector. The exploratory applied research is guided by primary data and document study in a qualitative approach. For recognizing environmental aspects associated with construction activities, we selected two infrastructure projects, a road and a port, as well as their service providers. The main product of this research is the development of a framework for identification of environmental aspects, the technical stage and one of the most complex steps of the EMS. The results of this research can support the development of this technical stage of EMS by small and medium enterprises in the civil construction industry in order to reduce environmental impacts generated in the infrastructure sector and obtain environmental certification for SMEs.

Keywords: Small and medium-sized enterprises; civil construction; environmental management system; environmental requirements; infrastructure.

1. INTRODUÇÃO

Environmental issues are increasingly being included in the companies' financial administrative agenda. Whether to comply with the environmental legislation in force or to fulfil the market demand, the environmental variable is considered during the organization's strategic decisions. Besides using the Minimum Legal Compliance Agenda, according to Barbieri (2007) some companies also take advantage of environmental management tools in order to increase the participation of the environmental component in their activities and consequently benefit from its outcomes.

The construction industry, an economically strategic field and the causative factor of environmental degradation and pollution, will have to overcome enormous obstacles if it doesn't respond to the new prospects of environmental regulations in an increasingly competitive market. This business segment also takes responsibility for significant environmental impacts caused by the use or disposal of natural or manufactured goods, environment degradation and pollution (Sakr *et al*., 2010).

Whether to fulfil legal or market demands, large companies have been incorporating the environmental variable in their activities, also requiring their suppliers to

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commit to a minimum environmental agenda. However, because large enterprises are involved, these companies lean on services offered by small and medium sized enterprises (SMEs), which don't necessarily fully integrate environmental management standards to their activities. Given that, when taking responsibility for a big part of the products supply and services offered by large contractor companies, the environmental impacts related to the services provided by the SMEs are of great importance and should not be reduced.

A civil construction work involves multiple actions that highly interact with the environment the activity occupies. These actions can range from vegetation removal, movementation of soil during the earthwork phase, consumption of natural resources for creating concrete elements, waste production related to many activities, to final finishing processes. Given that, environmental aspects related to construction works should be managed as to minimize negative environmental impacts.

The implementation of the Environmental Management System (EMS) involves a series of routines and procedures. Identifying environmental aspects is a fundamental action used to develop the EMS of any organization. According to Lundberg et al. (2007, p. 385), "[...] the identification of environmental aspects is, however, seen as one of the most complex parts of the EMS' implementation process, also being prone to criticisms, such as lacking transparency and reproducibility."

Zobel *et al.* (2002), claims there is a lack of scientific researches approaching methods for EMS usage that identify and evaluate environmental impacts. Gernuks *et al.* (2007), on the other hand, emphasize that, even though the EMS' standardization only provides general guidelines about the subject, scientific studies approaching significant environmental aspects' evaluation as the basis for identifying the organization's environmental targets have been prioritized.

One of the motivations for this scientific research lies on the fact that, according to Seifert (2008), only a small portion of small and medium sized enterprises located in Brazil has implemented EMS. Another factor resides in the economic representativeness of heavy construction companies, and, consequently in the direct or indirect environmental impacts caused by the service providers hired.

Resultantly, it was settled for this scientific research the following guiding question: how can one identify environmental aspects connected to actions executed by small and medium sized enterprises in infrastructure works?

The main objective of this research was to identify environmental aspects associated with service supply actions, executed by Civil Construction service suppliers SMEs located in Brazil as to contribute with the development of the SGA technical stage.

In order to reach this goal, the adopted methodology was an applied qualitative exploratory research. Two case studies regarding infrastructure construction works in Brazil were chosen; one was located in the southeast region, while the other was situated in the northeast. The evidences used in the studies consisted of embracive field data collection supported by documentary research and scientific literature.

2. LITERATURE REVIEW

This section presents main concepts of knowledge fields related to this research, such as: civil construction and natural environmental, life cycle of large-scale infrastructure projects, environmental management systems, an assessment of aspects and environmental impacts, and, finally, a demonstration of the SMEs' role.

2.1. Civil Construction and the environment

According to Macedo *et* Martins (2011), the national civil construction sector is constantly expanding. The Union of the Civil Construction Industry of the State of São Paulo (2005) recognizes Civil Construction as one of the most important activities for economic and social development, whilst being an activity that results in environmental impacts. Côrtes *et al.* (2011, p. 385) still highlighted the "delay situation of the sector regarding the social environmental responsibility", for which the solution, among many other actions, lies in constructing enterprises seeking to reduce environmental impacts associated with the field.

The growth of the Civil Construction sector has been impacting significantly, reflecting a paradoxical situation, since the improvement of urban conditions through construction work increases the demand for raw materials, consequently generating waste and causing negative environmental impacts (Paschoalin Filho *et al.,* 2011). Kamimura (2012) points out that large-scale enterprises modify the biophysical balance and generates socioeconomic, cultural and environmental impacts of different magnitudes. To Rodríguez *et al.* (2011), besides negative impacts, Civil Construction can also provide positive influences, such as an improvement in the population's quality of life by creating numerous infrastructures.

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Environmental impacts caused by construction works are probably greater in developing countries than in developed nations. However, this does not mean environmental care can be neglected in these. Thus, the construction work challenge in developed countries is to create and develop innovations so they can be prepared to meet the increasing environmental requirements (Sakr *et al.*, 2010).

Regarding the management of environmental issues, the European construction field is behind when compared to many others, such as the industry field (Rodríguez *et al*., 2011).

A scientific research developed by Turk (2008) in the Turkish Civil Construction field demonstrates a need of the country enterprises for an implementation of an EMS system seeking to: reduce potential negative impacts related to construction work activities; seek solutions to dispose construction waste; assist complying with legal requirements related to the environment; offer competitive advantage for national enterprises to operate internationally; and guarantee the environment's protection.

In Brazil, Degani (2003) feels that construction companies only display incipient initiatives towards natural resources 'allocation and waste disposal.

In a general manner, authors look similarly at the way civil construction relates to the environment. Although the field is clearly crucial for economic and social development, it can be noticed a need to confront the area environment issues. The effective management of environmental aspects acts as a focal point in this process.

2.2. Life cycle of large-scale infrastructure projects

According to Zmitrowicz *et* De Angelis Neto (1997), urban infrastructure can be described as a technical system provided with equipment and services necessary for developing urban functions in social, economical and institutional aspects. On the social aspect, it seeks to promote adequate conditions in housing, work, health, education, leisure and security. In an economic approach, the development of productive activities and marketing of goods and services shall be provided. And, referring to the institutional perspective, it should propitiate the necessary means for developing political-administrative activities, which includes managing the city itself.

Sánchez (2006) believes a project's life cycle includes the stages of design and planning; implementation and development; operations and maintenance, and, finally, deactivation and closure. Figure 1 represents a hypothetical enterprise.

Figure 1 - The stages of an enterprise
Source: Based on Sánchez (2006)

According to Sánchez (2006), the stages of an enterprise and their interactions with the environment are:

(1) Planning / Design: Implementation of technical and economic studies. Although this stage's activities have an influence on the biophysical environment, the most noteworthy impacts are related to the anthropic environment.

(2) Implementation / Development: Includes all necessary activities for building facilities or for preparing the enterprise development. In some infrastructure projects (especially the large-scale and linear projects), this phase can cause the most meaningful, indirect and cumulative environmental impacts, also causing the displacement of human populations.

(3) Operations / Maintenance: Consists in fulfilling the enterprise's purpose. It is usually the longest phase of an enterprise's life cycle. Environmental impacts are diversified and subjected to the type of the enterprise.

(4) Deactivation / Closure: Preparing for closing the facilities and definitive cessation of activities. This phase requires specific planning in advance to cause minimum side effects and generate environmental liabilities.

Sánchez (2006) classifies planning and management tools according to each enterprise phase. According to the author, the EMS system can be applied both in the operations/maintenance phase - most recurring use - and in the implementation/development phase.

2.3. Environmental Management System and Environmental Aspects and Impacts' Observation

To Barbieri (2007), an Environmental Management System (EMS) is a set of administrative and operational activities done by an enterprise in order to approach environmental issues caused by its actions and to reduce its outbreak potential. According to González et Ávila, adopting an EMS system should not solely be a state-

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ment, but an effective system used to put the company's environmental strategies into practice.

Oliveira *et al*., (2010) list a number of benefits consequential of adopting an EMS system: eliminating amounts spent on non-accordance to environment legislation fines; reducing natural resources' allocation; environmental awareness coming from organisation partners; competitive advantage; monitoring activities, products and services that generate significant environmental impact.

In accordance to Barbieri (2007), the enterprise can either create its own EMS model or use existing instruments like EMAS (Eco Management and Audit Scheme) or ISO 14.001/2004 series of standards. To Morrow *et* Rondinelli (2002), European enterprises are more inclined to use EMAS, while the ISO 14.001 series of standards has become a worldwide benchmark. Epelbaum (2006, p. 142) says "[...] the ISO 14.001 standard is the most recent, most widely used worldwide, and the better existing standard for the EMS [...]".

The NBR ISO 14.001/2004 determines which standards are required by an EMS to capacitate an organization for developing and implementing policies and targets that take into consideration legal requirements and informations regarding significant environmental aspects. Still according to this standard, environmental aspect is defined as components of the organisation's activities, products or services that are able to interact with the environment. Environmental impact, in its turn, is seen as any environmental modification, beneficial or harmful, resultant from the organisation's environmental aspects, wholly or partly. The use of different raw materials, energy and water consumption, besides waste generation and atmospheric emissions are amongst the environmental aspects' main types. Noise and vibrations, interactions with fauna and flora, and others are also considered environmental aspects. The ISO requirement 4.3.1 - Environmental Aspects, determines organisations should establish, implement and maintain procedures to manage their environmental aspects. However, it is up to each organization to develop its own strategy to satisfy this requirement, since the standard does not detail how it must be fulfilled.

To Perotto *et al.* (2008, p. 518), environmental performance is defined as "[...] measurable outcomes from the organization management' environmental aspects" and "[...] organization management outcomes regarding their environmental aspects". These authors when highlighting the effort many organizations are making in order to understand, demonstrate and improve their environmental performance, emphasize that in order to succeed "it is necessary to evaluate environmental aspects".

Pöder (2006), understanding that identifying environmental aspects is one of the most critical EMS stages, monitored the system's implementation in 22 Estonian companies. The author realized that restricting transparency and reproducibility leads to mistakes during the identification of environmental aspects, often based on complex evaluation systems or on subjective evaluations substantiated by inadequate assessments criteria.

Campos (2012) conducted a scientific investigation about EMS using as sample enterprises located in the south of Brazil. He analysed the way both small sized companies (responsible for providing services and products to the large sized ones) and large sized companies perceived the seventeen requirements small companies need to fulfil in order to be EMS certified. Of these seventeen factors, nine were placed as of high importance. Environmental aspects came second, being overtaken only by environment policy-making demands.

Knowing economics and environment are relevant to the SMEs segment, being responsible for over 70% of the entire industrial pollution (Hillary, 2004 *apud* Seiffert, 2008), and also being aware of the obstacles SMEs face in order to get EMS certified, Seiffert (2008) proposed a method to evaluate environmental impacts caused by SMEs. In this proposal, one of the key components the identification of environmental aspects.

2.4 Small and medium sized enterprises (SMEs) and EMS

The Brazilian Support Service for Micro and Small Enterprises (Serviço Brasileiro de Apoio às Micro e Pequenas Empresas – SEBRAE, 2011), names small sized enterprises the ones that employ 20 to 99 people and operate in the industry field, while the others operating in the fields of trade and services are classified as small if staffed by 10 to 49 employees. In turn, medium sized enterprises need to hire 100 to 499 people to be labelled as "medium" in the industry field, and 50 to 99 employees in trade and services field.

According to recent data from the Institute Brazilian Institute of Geography and Statistics (Brasileiro de Geografia e Estatística – IBGE, 2012), SMEs represent 20% of the Brazilian Gross Domestic Product (GDP) or nearly 700 billion reais (approximately 194 billion US dollars); are responsible for 60% of 94 million jobs in the country, which represents 56.4 million jobs; and act as 99% of the 6 million formal establishments existing in the country,

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or, in other words, 5.7 million SMEs. The majority of businesses are located in the Southeast region (presenting nearly 3 million companies), where the main field is trade, followed by services, industries and civil construction (Portal Brasil, 2013).

To Seiffert (2008), the adversities encountered by SMEs during the implementation of the EMS are particularly related to budgetary and human resources' limitations, which, in its turn, are associated with the enterprises' size. The author highlights, yet, that this condition reinforces the need for an adequate implementation of the SMEs, adding that a major factor for its success relies on competently identifying environmental aspects and impacts. Campos (2012, p. 144) emphasises that "[...] with a growing call to preserve the environment, small sized enterprises also feel the need to adjust to the reality and meet the demands of the market."

Canzoni et al., (2008) realized micro and small enterprises need an EMS suitable to their means, so they demonstrate their environmental compromise without, however, endangering their financial and operational performance.

Santos *et* Mendes (2011) carried out a study on Portuguese SMEs, motivated by the growing number of organizations adopting the EMS tool in the country. It was determined that "most important" reasons for this call are directly related to the enterprise's environmental aspects and impacts management.

3. RESEARCH METHOD

This is an applied research, once it aims to create practical knowledge for a specific problem. A qualitative approach was used, as it favours the interpretation of the phenomena observed in the natural environment, unlike if it was measured. Because it approaches the issues in a widely manner, it is also an exploratory research.

Study cases were used as the research strategy. According to Martins *et* Theóphilo (2009), a study case "is an empirical investigation method which explores phenomena within their real context (naturalistic research), where the investigator has no control over events and variables. Therefore, he must grasp the whole situation and, creatively, describe, comprehend and interpretate the complexity of a concrete study". To attest the study cases, interviews and field data collection were used source of evidence.

Two infrastructure projects in construction, of different typology and locations, were selected for this research. Both had the EMS based in the NBR ISO 14001/2004 (Associação Brasileira de Normas Técnicas, 2004) (Brazilian Association for Technical Standards, 2004) implemented while the construction work was carried out, as follows:

- **Project number 1 -** Road infrastructure, located in the São Paulo state northwest region. The roadway was duplicated and restored extending 40 km. During the 18 months of construction work, three site visits happened, between the years of 2012 and 2013.

- **Project number 2 -** The port infrastructure project is situated in São Luis, Maranhão, and involves constructing ports for activities such as attracting ships and commodities' loading and unloading. During the 24 months of work implementation, six site visits happened, between the years of 2012 and 2013.

Considering that the research's main subject is the SMEs group working for large companies, these were used to: a) determine the service providers' types; b) demonstrate the correlation between a large company and SMEs; and c) identify activities or services provided for large companies by SMEs.

During the research course, subcontracted companies of both projects were used as study objects, each with its own peculiarity.

- **Project Number 1** - Of 43 subcontracted companies, 8 were SMEs, providing various functions, such as catering, pest control, chemical toilets cleaning, amongst others.

- **Project Number 2** - Of 27 subcontracted companies, 9 were SMEs providing various functions, such as are conditioner systems' cleansing, pest control, catering, amongst others.

For the development of this scientific study, bibliographic research, documentary research, field data collection and semi-structured interviews were used as research methods.

In order to help develop the guiding question and research structure, the literature review consisted in consulting research papers cantered on the following subjects: environmental aspects under the perspective of environmental management; environmental aspects and impacts inflicted by infrastructure projects; SMEs that are an expressive number in the civil construction field as service providers for large construction compa-

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nies. Because of its applied nature, during the revision the aim was connecting the themes.

The documentary research was based on the establishment of major legal standards that are suitable for service providers, and, within this context, provide backing to the identification of environmental aspects. Official Brazilian law related websites were used to develop this step of the research, especially the Ministry of the Environment webpage.

Field studies were carried by means of guided technical visits, with the purpose of observing the project's construction work and its environmental interaction. Then, the main environmental aspects and impacts related with the project were identified.

The semi-structured interviews were done with SMEs' company's technicians, engineers, construction site responsible and workers detaining an accurate knowledge of the construction process and related activities. These interviews seek comprehending every stage of the process and/or activity, work equipment and accessories provided, and each process' input and output, in order to establish the major connections between construction work and the environment, and, next, identify its related aspects and impacts.

It can also be pointed out that these interviews occurred while services were being perfumed, so an accurate picture of the environmental aspects related to them could be shown.

Primary data collection and analysis covered the following course of events:

- Identification of constructive sequential steps concerning construction work of different typologies, and then, determining if they will be able to request similar services;
- Developing a sequence mapping, to be used as the only instrument for data collection and analysis, taking into account the similarity between both two construction works.
- Identifying activities or services, usually outsourced by civil construction field SMEs, applying the sequence map established, as to make identification environmental aspects possible.
- To preliminarily identify environmental aspects and major consequential environmental impacts, based on support activities that may be service provision objects for SMEs. This step was developed based in field studies.

They made it possible to identify environmental aspects and impacts related to civil construction work, with an emphasis in support activities. The obtained results from each individual project's semi structured interview clarified doubts about the flow of activities provided by SMEs to large contractors. An integrated data analysis of the field study and interviews made it possible to establish a framework in order to subsidize the implementation of the EMS' technical stage regarding the identification of environmental aspects.

4. DATA ANALYSIS AND DISCUSSION

This section contains the research's main findings regarding environmental aspects' identification of SMEs hired for providing services by large contractors.

4.1 Characterization of projects' related activities

In this research, two projects were taken into consideration, being subjected to periodic visitations during their entire implementation/development stage. Moreover, paperwork about their previous construction works that required environmental and EMS licenses were consulted.

Activities concerning Project 1 development are subdivided into 2 large categories, as seen in Figures 2 and 3. Figure 2 represents the earth-moving work done in order to build a roadbed, resulting, then, in the pavement of roads. Figure 3 summarises the construction process of special structures (bridges and viaducts), also aiming to operate by land.

Figure 2 - Stages of a road infrastructure work - earthwork/ paving
Source: Authors

Project 2 activities involve a port construction aiming to attract ships and load and unload commodities, as shown in Figure 4.

Comparing, by analogy, both projects' construction related activities, it can be inferred that the projects' major steps are similar. This infrastructure work construction map, presented in Figure 5, organizes the environmental aspects identification stage using data collected during visitations to both projects.

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Figure 3 - Stages of a road infrastructure project - special structures/paving

Source: Authors

Figure 4 - Stages of a harbour infrastructure project

Source: Authors

4.2 SMEs' main activities

The construction of large civil works is of great complexity, generally happening under a time schedule directly linked to the cost spreadsheet, demanding, therefore, a series of activities. Many of these are directly handled by the contractor responsible for the project.

During the project construction stage, third parties hire a number of services and supplies (not objects of this research). Usually, large-sized builders do not perform all project's planned activities, especially the ones of support nature, which are usually delegated to small and medium sized services supplier enterprises. Large sized companies can also request SMEs some of the project's main activities, such as pre moulded parts for the concrete structure, earthwork, survey.

According to Araujo *et* Cardoso (2010), activities related to civil work building sites significant impact the environment, making indispensable, in such context, an adequate identification and consequent association between environmental aspects and impacts.

Amongst the requirements needed to qualify small sized enterprises to provide services for large sized enterprises, Seiffert (2011) says being EMS certified might be one of them.

If the SME meets requirements set forth by the environmental legislation (operating license, certificate, permit, among others), large sized companies will probably have more power managing environmental aspects related to the enterprise. This situation can be seen by observing the way Petro bras deals with its suppliers. The state company responsible for qualifying service suppliers verifies the extend of the implementation of the managing system regarding Occupational Safety, Environmental Safety and Occupational Health, in compliance with ISO 14001 and OHSAS 18001 standards and with potential contractors (Petroleo Brasileiro, 2012).

It is worth highlighting that the provision of services by SMEs is not always related to large projects, being their responsibility to manage the activities' environmental aspects without the help of a large size company.

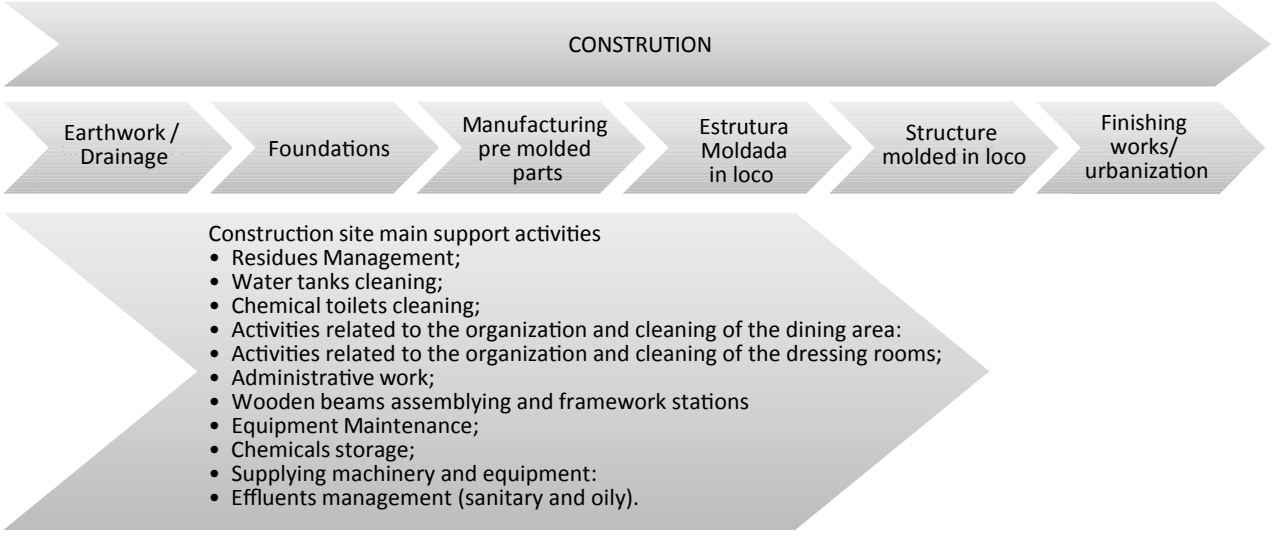

Figure 5 - Activities related to the project construction stage

Source: Authors

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Implementing EMS in SMEs, independently of the context of their service provision, usually improves the management of environmental aspects related all different activities performed, once routines and commitment with environmental issues will be internalised in professional behaviour.

Figure 6 illustrates what activities service providers SMEs' are required to serve when contracted by large civil construction companies. In the event, the 2 infrastructure projects are research objects of this study.

Chart 1 demonstrates services SMEs can execute for the company's major demands, shown in Figure 6.

4.3 Environmental aspects and impacts of Civil Construction and SMEs

According to Gangolells et al. *(2013), there is a shortage in suggestions, and, consequently, guidance's when it comes to researches approaching the identification, analysis and operational control of civil construction environmental impacts.*

Chart 1 - Work demand x services that can be executed by SMEs

Work Demand	Services that can be executed by SMEs
Residues Management	Waste transportation
	Recycling companies
	Waste disposal (recyclable)
Construction site management	Specialized company for cleaning water tanks
	Chemical toilets cleaning
	Chemical-physical analysis laboratories
	Plagues and vectors control
	Catering
	Maintenance of air conditioning systems
Effluents management	Effluents transportation
	Chemical-physical analysis laboratories
Vegetation removal	Vegetation removal
Maintenance of machinery and equipment	Repair facilities for machinery and equipment

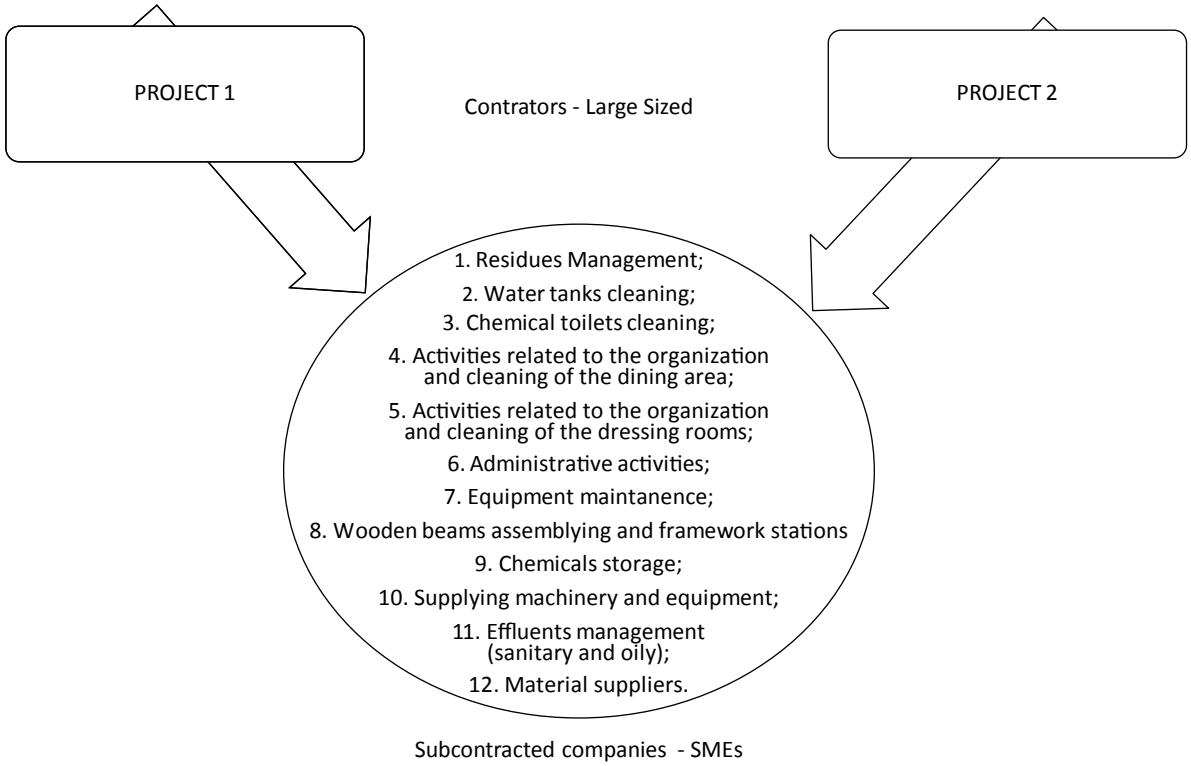

Figure 6 - Required activities by large-scale companies (project 1 and project 2) for subcontracted companies - SMEs.
Source: Authors

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Main construction activities	Manufacturing and supplying concrete pre moulded parts
	Earthwork
	Survey
	Specialized services
	Supplying specialised work team (a specialised labour in concrete, another in weld, etc.)
	Supplying and executing landscaping
General supplies	Supplying general construction work operating supplies

Source: Authors

Seiffert (2008) says there is a need to develop simple and appropriate methods for going through the step of environmental impact analysis based on the EMS. Given that, a framework is presented, following a logical sequence based on primary data, to guide the technical faze of identification of the environmental aspects of the service agreement from the small and medium sized companies to large companies in the construction industry.

The process of environmental aspects identification must consider all the stages of services and activities performed by the company under normal conditions (routine and non-routine) or emergency conditions, that generate or are potential causes of environmental impact. During this stage, services provided in the past that generated impact and are seen as environmental liabilities also need controlling and correction actions. The record of environmental aspects must be reviewed when:

- A stage of a service, process or activity is altered or included;
- The systematic/methodology used in the execution of work is altered;
- Purchase of new equipment/machinery may alter the environmental aspects covered;
- Changes in legislation may alter the environmental aspects covered;
- Previous incidents, not considered before, arise;
- Other environmental aspects are identified by auditors, authorities and clients;
- Environmental aspects emerge around the work location due to new work related activities under the organization's control.

A framework for identifying environmental aspects is presented, based on five major steps: (1) Identification of the phase/stage of the project; (2) Action (3) Activity (4) Environmental aspect associated; (5) Environmental impact.

Therefore, as an example, highway is shown in Figure 2, taken from one of the civil construction phases. For "Earthwork", the guide is as follows:

1. Project stage: Earthwork;
2. Action: Management of construction sites (use of chemical toilets);
3. Activity: Chemical toilets cleansing;
4. Environmental aspect: Sanitary effluents;
5. Environmental impact: Change in the water quality".

Therefore, as an example, port is shown in Figure 2, taken from one of the civil construction phases. For "Structure moulded in loco", the guide is as follows: follows

1. Project stage: Structure moulded in loco
2. Action: concreting
3. Activity: Organization and cleaning; before and after the activity;
4. Environmental aspect: Construction waste (debris);
4. Environmental impact: Change in the soil quality / landfill occupation".

Chart 2 presents the major environmental aspects groups based on the leading construction and support activities, outlined in Figure 6, and on services SMEs are capable of executing for large companies.

Chart 2 - Classification of the environmental aspects' groups

Group	Nature of the environmental aspect
1	Sanitary effluents
2	Atmospheric emissions
3	Solid residues
4	Natural resources
5	Noise and vibrations
6	Flora and fauna
7	Emergencies

Source: Based on Seiffert (2008)

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Activities, which the company can directly control, and also those it can directly affect must be considered during the environmental aspects' identification. Thus, as discussed by Menezes *et al.* (2006), environmental aspects and impacts must be brought up for discussion by experts who are involved in the environmental execution and management of the construction works.

Based on field observations, it was possible to relate the activities presented in Table 1 with the natural environmental aspects, as well as with their consequences (environmental impacts). Consequently, following the framework described, based on primary data and on Table 2, the potential environmental aspects and impacts caused by SMEs while providing services for construction works are identified and presented in Chart 3.

By looking at the information presented in Table 3 and only considering activities that SMEs are able to execute, the considerable number of environmental aspects that must be managed becomes noticeable.

Similarly, Menezes *et al.* (2006), whose object of research refers to Urban Construction Work, also emphasise that a challenge for environmental management is pointing out environmental aspects that companies can control or influence in order to identify significant environmental impacts it may be causing.

5. FINAL CONSIDERATIONS

When implementing infrastructure projects, the Civil Construction Industry generates environmental impacts, which can be either direct or indirect. Due to the role of SMEs as service suppliers for large construction companies and to their customer-supplier relationship, they also contribute in a considerable way with the occurrence of the environmental impacts mentioned in this article.

Although smaller companies might believe that adopting an EMS is merely a cost increasing formalization for ensuring hiring requirements, it brings benefits worth highlighting and that go beyond those described in the literature.

It is considered that the adoption of an EMS by SMEs - not only aiming the environmental adequacy needed by smaller companies to provide services for larger companies - may contribute to an appropriate management of the environmental aspects resultant of their activities, reducing, therefore, the damage caused by them to the civil construction industry.

Both contractors and subcontracting companies are responsible for the management of environmental aspects related to services provision. Thus, this is represented as a co-responsibility between involved parties. Given that, SMEs are more likely to technically develop when partning with larger companies, and then, managing environmental aspects associated with the company's activities.

Construction activities must be carefully analysed in order to properly spot environmental aspects during their identification stage. Therefore, it should be noted that the suggested framework can be used by SMEs as a basis for further analysis. The data presented in Table 3 were collected thought field studies and semi structured interviews. Both methods complete each other in order to represent a solid picture of the most recurring activities and environmental aspects during the implementation of civil works and provision of services by SMEs.

The organization of a project's activities and the identification of associated environmental aspects are crucial for successfully implementing an EMS. In this way, we consider the obtained results may facilitate the adoption of the EMS by SMEs, as the outcomes act not only as a benchmark for the establishment of this EMS stage, but also for the environmental certification of SMEs.

This study demonstrates that the description of environmental aspects associated with small and medium enterprises responsible for infrastructure projects can be done by identifying similar, construction sequence stages of civil works. It is important to highlight that this survey started from the work of SMEs in two specific projects. Therefore, the environmental aspects described in this study are related to the projects' characteristics.

The essential constructive stages of civil works were connected with the work demand, and consequently, with the main support activities, therefore allowing the identification of environmental aspects related to services offered by SMEs to civil construction projects.

Thus, this work is able to demonstrate that the stage of identifying environmental aspects and its resulting impacts, viewed as one of the most complex stages for planning the EMS implementation, can be done in a simply and systematically fashion in accordance to the standard NBR ISO 14.001/2004.

The fundamental framework made from primary data can assist the breakdown process of the EMS' implementation stage in SMEs that provide services for the civil construction field.

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Chart 3. Environmental aspects - Work activities

Group	ACTIVITIES	ASPECTS	CONSEQUENCES (impact)
1	Construction site management/ water tank cleaning	Storage of potable water in boxes, tanks, water through	Changes in the potability of the water
	Maintenance of machinery and equipment	Oily sludge	Changes in the soil/water quality
	Effluents management		
	Maintenance of machinery and equipment	Oily wastewater	Changes in water quality
	Effluents management		
	Chemical toilets cleaning	Wastewater	Changes in water quality
	Effluents management		
	Effluents management	Discharge of chemicals	Changes in the water table
2	Maintenance of machinery and equipment	Black smoke emissions	Changes in air quality
	Main construction activities		
3	Residues Management	Printer Cartridge	Soil contamination
	Main construction activities		
	Residues Management	Agrochemical Packages	Changes in soil quality
	Main construction activities		
	Residues Management	Contaminated PPE	Soil contamination
	Main construction activities		
	Residues Management	Light bulbs, in general	Changes in soil/water quality
	Main construction activities		
	Residues Management	Cans and Paint sludge	Changes in soil quality
	Main construction activities		
	Residues Management	Organic waste (domestic)	Landfill Occupation
	Main construction activities		
	Residues Management	Wood / Sawdust	Depletion / reduction of the availability of natural resources
	Main construction activities		
	Residues Management	: Lubricant oils	Changes in soil/water quality
	Main construction activities		
	Residues Management	Paper / Cardboard	Depletion / reduction of the availability of natural resources
	Main construction activities		
	Residues Management	Batteries and Rechargeable batteries	Landfill Occupation
	Main construction activities		
	Residues Management	Plastic, in general	Depletion / reduction of the availability of natural resources
	Main construction activities		
	Residues Management	Tyres	Changes in soil/water quality
	Main construction activities		
	Residues Management	Brushwood / Grass residue	Changes in soil quality
	Main construction activities		
	Residues Management	Construction work / concrete residues	Change in the soil quality, landfill occupation
	Main construction activities		
	Residues Management	Paints and paint remover residues	Soil contamination
	Main construction activities		
	Residues Management	Scrap metal	Changes in soil quality
	Main construction activities		
	Residues Management	Steel drums	Changes in soil/water quality
	Main construction activities		
	Residues Management	Sweeping	Landfill Occupation
	Residues Management	Healthcare residues	Soil and water contamination
	Residues Management	Chemical Products Packaging (Barrel/ Can/ Plastic Drum)	Soil/ Water Contamination
	Main construction activities		

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	Residues Management	Chemical-impregnated Material	Soil Contamination
	Main construction activities		
	Residues Management	Non-recyclable Waste	Landfill Occupation
	Main construction activities		
	Construction site management		
4	Construction site management (general)	Water consumption	Depletion / reduction of natural resources
	Main construction activities		
	Manufacturing of pre-moulded structures		
	Construction site management	Fuel consumption	Depletion / reduction of natural resources
	Main construction activities		
	General supplies		
	Construction site management	Wood consumption	Addition to deforestation
	Main construction activities		
	General supplies		
	Construction site management	Mineral resources consumption	Depletion / reduction of the availability of natural resources
	Main construction activities		
	General supplies		
	Construction site management	Electrical Power consumption	Depletion / reduction of natural resources
	Main construction activities		
5	Construction site management	Noise	Disturbance to the neighbourhood
	Maintenance of machinery and equipment		
	Main construction activities		
6	Vegetation removal	Pruning / Cutting of trees	Damage to the flora / risk of erosion, landslide and siltation
	Vegetation removal	Felling of the original flora	Damage to the ecosystem / risk of erosion/ landslide and siltation
7	Equipment Maintenance	Spillage/ Leakage of Chemicals	Changes in soil/water quality
	Construction site management	Forest Fire	Changes in air quality
	Equipment Maintenance	Overflows	Changes in soil/water quality

Source: Authors

This minimum set of environmental aspects can be expanded and detailed when better qualifying and quantifying the services offered by SMEs. The environmental impacts list presented in Table 3 must be evaluated as to the application of significance criteria contemplating aspects such as severity and probability of occurrence. Controlling actions for the environmental aspects identified should also be defined in order to reduce the magnitude of the environmental impacts. Combining environmental indicators can help on the evaluation of environmental impacts, and, therefore, on the development of more effective controlling actions.

Finally, this framework was made in the context of implementing EMS in SMEs that provide services for large civil construction work companies. Thus, it is expected this framework can serve as guide, or even as an inspiration, to overcome the obstacles of the EMS technical stage, as well as encourage the adoption of the EMS as a tool that provides actual earnings for organizations and reduces environmental impacts.

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