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Evaluation of environmental management resources (ISO 14001) at civil engineering construction worksites: A case study of the community of Madrid

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ABSTRACT

In recent years, significant advances have been made in business organization and management. The growing demands of clients as well as the globalization of world markets are among the many factors that have led to the establishment of systems of quality control and environmental management as a competitive strategy for businesses.

When compared to other professional sectors, the construction sector has been slower to respond to environmental problems and to adopt Environmental Management Systems (EMS). In the world today the ISO 14001 standard is currently the main frame of reference used by construction companies to implement this type of management system.

This article presents the results of a general study regarding the evaluation of the application of the ISO 14001 standard at civil engineering construction worksites in the Community of Madrid (Spain), specifically pertaining to requirement 4.4.1, *Resources, roles, responsibilities, and authority.*

According to requirement 4.4.1, company executives should appoint people responsible for implementing the EMS and also specify their responsibilities and functions. The personnel designated for supervising environmental work should also have sufficient authority to establish and maintain the EMS.

The results obtained were the following:

- EMS supervisors did not generally possess adequate training and solid experience in construction work and in the environment. Furthermore, supervisors were usually forced to combine their environmental work with other tasks, which made their job even more difficult.
- Generally speaking, supervisors were not given sufficient authority and autonomy because productivity at the construction site had priority over environmental management. This was due to the fact that the company management did not have a respectful attitude toward the environment, nor was the management actively involved in the establishment of the EMS.
- Insufficient resources were allocated to the Environmental Management Unit.

As a result, the application of EMSs in construction projects often appeared to be more of a formality, which was merely a way of maintaining the certification of the Environmental Management System. It was more a means of meeting the requirements for submitting a tender to contracting organisms rather than an indicator of any real commitment to improving the environmental performance of construction companies.

1. Introduction

Construction work can have both positive and negative impacts on the environment. On the positive side, the construction of infrastructures, such as road and railway networks, dams, public utilities, housing, etc., enhances the quality of life in a society (SEOPAN, 1992), and is a means of increasing socioeconomic development (UNEP, 1996).

Nevertheless, at the same time, construction work can also generate negative impacts on the environment. For example, construction is one of the principal consumers of non-renewable resources (e.g. the building sector accounts for 30–40% of global

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energy use, UNEP, 2007) as well as an important source of waste. It also contributes to the pollution of water and air, and leads to deforestation of the land (UNEP, 1996).

In comparison to other business sectors, construction has adopted relatively few measures to make building work more respectful of the environment. In fact, in Europe, the construction sector has lagged far behind others, when it comes to actively responding to and dealing with environmental problems (Griffith, 1996).

Fortunately, construction firms are gradually becoming aware of the need to improve their environmental attitude and policies. They are beginning to realize that they must adapt their work to comply with increasingly strict national and international legislation. Furthermore, they must also respond to the public's growing interest in environmental problems and effectively satisfy market demands (Griffith, 1995, 1996).

Finally, as an increasing number of building developers have begun to include the adoption of EMS as a clause in their contracts, more and more construction companies have opted for incorporating this type of Environmental Management System (Garrote de Marcos and Mosqueda, 2002). In this sense, one of the main factors influencing the adoption of green specifications in construction is stakeholder involvement (Lam et al., 2009).

Today, construction firms are motivated to implement the ISO 14001 EMS as a way of doing the following: (i) adapting to environmental legislation (Fundación Entorno, 2003); (ii) improving the public image of their firm (Turk, 2009); (iii) improving environmental performance (Fryxell and Szeto, 2002); (iv) increasing environmental awareness of employees (Fryxell et al., 2004; Turk, 2009; Matouq, 2000; Valdez and Chini, 2002) as well as to meet market demands.

However, the primary motivation for the implementation of EMS in the construction sector is the demands of a changing market, followed by the desire to improve competitive strategies (Fundación Entorno, 2003; Ofori et al., 2002; Porter and Van Der Linde, 1995). In contrast, the principal obstacle that companies generally encounter in becoming more environmentally friendly is the substantial investment required in both material and human resources (Sakr et al., 2010; Ofori et al., 2002; Fundación Entorno, 2003).

Although, the opposite has also been argued for: improved environmental performance would induce cost savings and increase sales and thus improve economic performance (Schaltegger and Synnestvedt, 2002).

Construction companies admit that they are often reticent to adopt measures for environmental improvement because they do not seem to lead to tangible benefits (Fundación Entorno, 2003).

In addition to, the establishment of EMS by construction firms is decisively constrained by the distinctive characteristics of this sector. For example, it is more difficult to apply an Environmental Management System at construction works because of their temporal and spatial variability.

One of the ISO 14001 requirements for establishing an EMS is the availability of resources and the definition of roles, responsibilities, and authority to guarantee its implementation. Since this requirement is so important for the Environmental Management System, its analysis and assessment can help to detect deficiencies in currently functioning EMSs in construction companies.

From an international perspective, Spain is one of the countries that leads the world in companies with ISO 14001 certifications (Peglau, 2008), and the Community of Madrid, is one of its most important regions.

This justifies the fact that this study focuses only on the Community of Madrid. More specifically, Madrid's geopolitical importance made it possible to regard the results obtained as sufficiently representative and generalize them to both a national and European context.

2. General framework for the establishment of EMS in the construction sector

2.1. Regulations

Currently, Spanish and European companies can establish, certify/register and/or evaluate an Environmental Management System according to one of the following two regulations:

- *Regulation (EC) No 761/2001* (EMAS). This regulation was modified by *Commission Regulation (EC) No 196/2006* taking into account the European Standard EN ISO 14001:2004.
- European regulation EN ISO 14001:2004 (identical to the Spanish *UNE-EN ISO 14001:2004* and to the international regulation ISO 14001: 2004). This regulation is a revision of ISO 14001:1996 although the basic requirements of the EMS are the same in both versions. In other words, this new version (UNE-EN ISO 14001:2004) has the same structure as the previous regulation. Rather than incorporating new requirements, this document further clarifies and interprets those of the previous document. This means that organizations with an EMS system implemented or being implemented according to the ISO 14001:1996 standard should not experience excessive difficulties in the incorporation of new requirements (Hervás, 2005).

2.2. EMS requirements in ISO 14001: resources, roles, responsibilities and authority

ISO 14001 specifies the requirements for the establishment of an Environmental Management System. These requirements are organized in the following sections:

- General requirements
- Environmental policy
- Planning
- Implementation and operation
- Checking
- Review by the management

Regarding the **implementation and operation** of the EMS, the company management should guarantee the availability of resources (i.e. personnel, special skills, infrastructure, funding, and technology) (AENOR 2004). Such resources are essential for establishing, implementing, maintaining, and improving the EMS.

ISO 14001 also requires companies to designate one or various management representatives with well-defined roles, responsibilities, and sufficient authority to guarantee the establishment and maintenance of the EMS (AENOR, 2004).

In any company, environment is a horizontal function, so that the successful implementation of an EMS requires the commitment of all organization employees. Environmental responsibilities should not be restricted to those environmental function responsibles, it must involve other areas of the organization (AENOR, 2004; SEPI, 2000). In fact, one of the strategies to improve the company environmental performance is to introduce environmental responsibilities in all job descriptions. Therefore environment is defined as a criterion for the selection of new employees (Jabbour and Santos, 2008).

Construction sites are places of temporary work. The establishment of an EMS by construction firms requires the application of this Environmental Management System at the worksites where building projects are being carried out.

The correct operation of the EMS at the worksite is conditioned by a wide range of factors, such as the resources available to EMS

personnel, the training and experience of these personnel, and the conditions in which their duties are performed.

For this reason, the previously mentioned variables should be evaluated as a way of determining if EMSs in the construction sector are currently being implemented and operated, according to ISO 14001.

3. Research objectives and methodology

The experience of the authors of this article in the application and implementation of EMSs in construction companies provided them with a clear vision of the problems that can arise throughout the environmental management process (EMS implementation, operation, revision, and maintenance). Apart from our observations, also relevant were the deficiencies highlighted by clients as well as other problems detected during audits. All of these factors influenced our decision to study the current state of environmental management in the construction sector, in accordance with the principles of sustainable development established in ISO 14001.

The Community of Madrid is one of the most important regions in Spain with a high percentage of firms with ISO 14001 certifications (Peglau, 2008). Furthermore, despite the relatively small surface area of this region, it has a high concentration of all types of infrastructure. This circumstance facilitated this research since it enhanced the representativeness of the results so that they could be extended to both a national and European context.

It was thus decided to study the situation of EMSs in civil engineering works that at the time were being executed in the Community of Madrid. The study was part of a funded research project then being carried out in the Department of Civil Engineering at the University of Granada. This research study consisted of the following phases:

1. Data collection and study of relevant information in order to obtain an in-depth knowledge of the general background pertaining to this issue.
2. Definition of general objectives. Although this study also had other objectives, this article presents the results linked to the following general objective:
   - To analyze the operation of EMSs in the Community of Madrid, and evaluate their usefulness as well as deficiencies with a view to identifying corrective measures that would help optimize the models in current management systems.
3. Development of the research methodology. The methodology used involves quantitative techniques (questionnaires) (Arias and Fernández, 1998) applied to a representative sample of the engineering works being carried out in the Community of Madrid at that time. The EMS supervisors at these works were surveyed in May and June of 2005.
   a The selection of the most suitable techniques. Design and elaboration of the questionnaire.
   b Preliminary study (expert focus groups) to guarantee that the questionnaire was in consonance with the objectives of the study.
   c Modification of initial conditions in order to optimize the expected results of the study.
   d Background research: remittance of the questionnaire to all members of the study population. This was followed by the statistical treatment, analysis, and interpretation of the data thus obtained.
4. Formulation of conclusions supplemented by personal input.
5. Future research.

3.1. Study population

The population surveyed consisted of 90 civil engineering construction sites of various types, where projects were being carried out by different contracting organizations in the Community of Madrid (see Table 1). All worksites were in operation at the time that the questionnaire was sent. Worksites that had received approval, but which had not begun operation at the time of this study were excluded, as were those that had concluded operations in the previous three months.

The budget in the tender for the works was over six hundred thousand euros (€ 600,000) in view of the fact that works with lower budgets had shorter execution periods. Moreover, it was found that personnel at smaller sites have a high job mobility. They work simultaneously at various sites, many of which lack a formal worksite office.

3.2. Fieldwork

The initial phase of the field work consisted of compiling the database of operating sites with a budget of over € 600,000. This involved approaching the various contracting organizations which promote civil works in the Community of Madrid (see Table 1). The information received was checked against data in the B. O. E. (Spanish Official Gazette).

In the second phase, the construction companies were contacted so that we could check the data on the works in progress and obtain new data concerning the location of site offices and the individuals in charge of the project. The companies were later contacted by telephone and informed of the main objective and content of the survey with guarantees of confidentiality and anonymity.

Finally, the questionnaire was sent in sealed envelopes to the respondents. Alternatively, respondents could request the documentation to be sent by e-mail or fax, an option which considerably reduced the time involved.

After the questionnaires were coded, the statistical analysis and management of survey data were carried out with the computer program SPSS, version 11.5.1 for Windows.

Table 1
Technical record.

Technical record	Description
Universe	Construction projects in active operation: roads, railways, hydraulic works, airports, housing developments and other civil engineering works with a basic tender estimate of over € 600,000. The developers of these works were: (i) *Dirección General de Carreteras* [General Directorate of Roads and Highways]; (ii) *Dirección General de Ferrocarriles del Ministerio de Fomento* [General Directorate of Railways at the Ministry of Development]; (iii) *Confederación Hidrográfica del Tajo del Ministerio de Medio Ambiente* [Tajo River Basin Authority at the Ministry for Environment]; (iv) Council for Transport and Infrastructures; (v) Canal YII; (vi) Gedesma and Arpegio of the Community of Madrid, and the Madrid City Council.
Territorial area	Autonomous Community of Madrid
Sample size	90 construction sites, representing 100% of the population
Sample type	Sample definition criteria were not established since sample size coincided with the size of the population
Sampling error	±3.7% for sample as a whole
Confidence level	95.5% ($p = q = 0.5$)
Survey type	Interviews by mail (questionnaires were sent by post, e-mail or fax). Questionnaires were filled in by EMS supervisors at construction worksites.
Field work	12 May 2005 → 16 June 2005

3.3. Questionnaire design

The questions were designed following a series of recommendations which are usually applied to monographic surveys, albeit with slight variations (Padilla et al., 1998). The questionnaire singled out various areas content in consonance with the requirements of ISO 14001. Among these areas was the one targeted by this research, namely resources, roles, responsibility, and authority.

Table 2 shows the variables evaluated as part of this content area. One group of variables directly refers to the person responsible for the EMS, whereas another group refers to the Environmental Management Unit (EMU).

3.4. Population sample and sampling error

The study population consisted of 90 worksites. In view of this reduced finite population, it was decided that the whole population should be included in the research. By 16 June 2005, 80 completed questionnaires had been received, indicating a participation percentage of 88.9% with regard to the total number of surveys sent out.

Of the 80 worksites responding to the survey, 82.5% (66) had an operating EMS as compared to 17.5% (14) worksites that did not. All the participating EMS companies had adopted ISO Standard 14001 as a reference model. To determine the sampling error, a level of reliability or probability of 95.5% was considered, in accordance with the normal law of probability.[1]

The sample size was related to sample reliability, in other words, to the margin of error in the calculation of answers and to parameters p and $p \cdot q$ as follows:

$$n = Z^2 p(1-p)/e^2$$

where:

$$e = Z(p(1-p))^{1/2}/n^{1/2}$$

being:

$$n = n_m/(1 - n_m/N)$$

and where:

n_m = sample size (n° of answered questionnaires: 80);
N = population size (90);
Z = n° of standard deviations above and below the average (1.96);
p = distribution parameter (considered as $p = 0.5$, maximum variance);
$q = 1 - p$ (covariance);
e = error.

In accordance with this expression, a sampling error of 3.7% was obtained for a level of sample reliability of 95. 5%. This error was considered acceptable.

4. Evaluation of resources for EMS at construction worksites

4.1. Questionnaire results

4.1.1. On-site EMS supervisor

4.1.1.1. Experience in construction and the environment. Our evaluation of the construction and environmental experience of EMS supervisors showed that only a third had more than five years of construction experience, whereas one out of six had less than one year of experience.

Regarding environmental experience (Table 3), it was significant that a little over a fourth of the supervisors had less than one year of experience. Generally speaking, approximately 40% of the supervisors had between one and three years of environmental experience.

4.1.1.2. Educational background. The vast majority (90%) of the EMS supervisors surveyed had a university degree. Of this percentage, a third were civil engineers and one out of six were public works engineers (see Graph 1). Of the rest, almost half had a degree that was not directly related either to civil engineering and/or to environmental science.

4.1.1.3. Company employing the EMS supervisor. EMS supervisors can be employed by the following organisms:

- A construction company if it is the only one to whom the contract was awarded (main contractor);
- A temporary joint venture (TJV), if the contract was awarded to a group of companies;
- One of the companies of the TJV;
- A company subcontracted by the main construction company.

Table 4 shows that the most frequent situation (more than half of the cases) was for the EMS supervisor to be employed by the main contracting company (sole tenderer) of the construction work. The second most frequent situation (a third of the cases) was for this supervisor to be employed by one of the companies in the TJV.

Moreover, in 10% of the worksites, the EMS supervisor was expressly contracted by the TJV for the construction project. Alternatively, there were also cases in which these supervisors were employed by a company subcontracted by the construction firm.

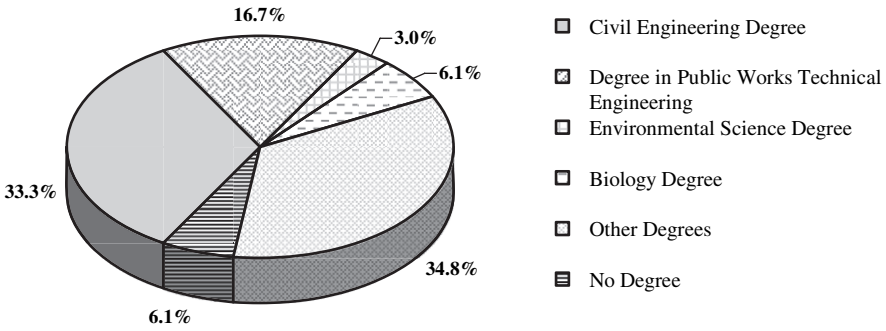
Table 2
Variables: resources, roles, responsibilities, and authority.

Content area	Variables
Resources, roles, responsibilities, and authority	EMS supervisors – Experience in construction and environment – Educational background – Company employing the EMS supervisor – Job location – Other roles of the EMS supervisor – Evaluation of environmental work Environmental management unit (EMU) – Allocation of resources for the EMU – Personnel assigned to the EMU compared to the offer – Authority and autonomy of the EMU – Circumstances in which production has priority over environmental management

Table 3
Experience in the construction sector and in the environment.

Experience	Construction sector		Environment	
	N° supervisors	%	N° supervisors	%
<1 year	11	16.7	18	27.3
1–3 years	15	22.7	29	43.9
3–5 years	17	25.8	11	16.7
>5 years	23	34.8	8	12.1
Total	66	100	66	100

[1] The level of reliability commonly used in samples and research in sociology is two σ, which cover 95.5% of the area of the normal curve (Sierra Bravo, 1998).



Graph 1. Educational background of the EMS coordinator.

4.1.1.4. Job location. EMS supervisors may perform their job in an office at the construction worksite or in an office at one of the construction worksites (if supervisors are working at more than one site at the same time). They can also do their job in an office at the construction company (main office or branch office).

According to Graph 2, in almost nine out of ten of the works studied, the EMS supervisors had their office at the construction worksite. The rest of the supervisors worked at the head office or branch office of the construction firm.

This situation generally occurred when there was one environmental supervisor for many different construction worksites.

4.1.1.5. Other roles of the EMS supervisor. Apart from environmental work, EMS supervisors at the construction site often had other roles to perform (see Graph 3). Effectively, at over half of the EMS works surveyed, the EMS supervisor was also responsible for the QAS (Quality Assurance System), and at 25% of the sites, the environmental supervisor was also in charge of Safety and Health. In low-budget construction projects, the following situations frequently occurred:

- The job foreman was responsible for both the QAS and the EMS (25% of the cases studied).
- The EMS supervisor was simultaneously responsible for more than one construction project (one out of nine cases).

Finally, in a very small number of construction works (seven), the EMS supervisor only performed environmental duties. This occurred at more important projects with a larger budget.

4.1.1.6. Evaluation of the environmental role. Another aspect assessed in the questionnaire was the evaluation of the environmental function at the worksite from different perspectives (Graph 4).

The evaluations given by the supervisors in this study were fixed on a scale ranging from zero (0) to five (5) in which the maximum value was five. A five indicated that the post of EMS supervisor was highly valued, whereas the minimum value of zero reflected that it had a very low rating.

The results obtained showed that these supervisors felt that environmental work was not sufficiently valued by co-workers at the construction site, and also by society in general. This was reflected from an economic perspective in terms of the monetary compensation received.

At the same time, they affirmed that their work was more highly valued by the EMS supervisors themselves, general project managers, and company executives.

Generally speaking, the values obtained were low, which seems to point to the fact that the job of EMS supervisors is not highly regarded, particularly by the other workers at the construction site.

4.1.2. Environmental management unit

4.1.2.1. Allocation of resources for the EMU. The allocation of resources (see Graph 5) of the Environmental Management Unit (EMU) was considered to be insufficient by seven out of every ten supervisors surveyed. In fact, none of the supervisors regarded the allocation of resources for the environmental management of the construction project to be highly satisfactory.

Over all, the EMS supervisors affirmed that the human and material resources provided for the EMU were insufficient for the supervisors to adequately carry out their duties.

4.1.2.2. Personnel assigned to the EMU compared to the offer. In the analysis of resources allocated to the EMU, this study also determined if the staff and material assigned for this purpose at the construction worksite coincided with the resources specified in the tender offer (Graph 6).

The survey data showed that almost half of the companies respected the content of the offer, whereas one out of every five supervisors maintained that the resources had been reduced, from those initially envisaged in the tender phase.

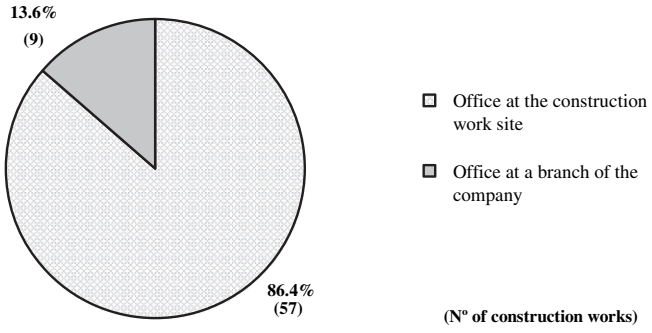
Finally, regarding the construction projects that respected the offer, it was found that the half of the EMS supervisors said that the resources provided were insufficient or susceptible for improvement.

These results seem to indicate that in the tender study, the resources allocated for the environmental management of the

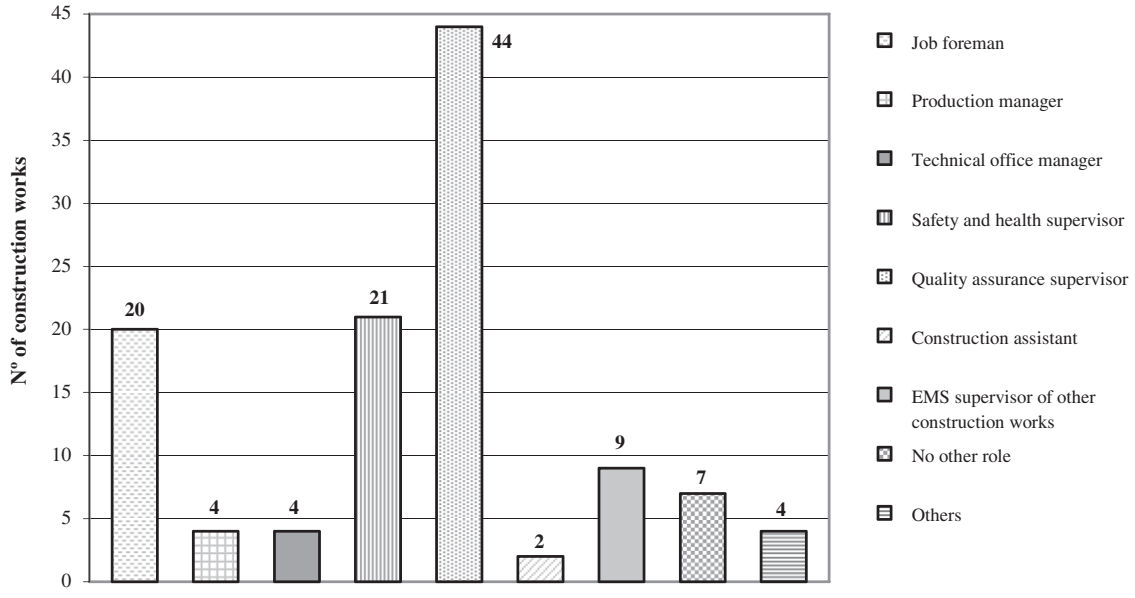
Table 4
Company employing the EMS supervisors.[a]

EMS supervisor	Company				
	Main construction company	Company of the TPV	TPV	Subcontracted company	Total
Nº. supervisors	36	24	5	1	66
%	54.5	36.4	7.6	1.5	100.0

[a] 54.5% (36) of the construction projects surveyed that had an EMS were executed by a company that was the sole tenderer of the construction work, whereas 45.5% (30) of the projected were executed by a TJV.



Graph 2. Job location.



Graph 3. Other roles of the EMS Supervisor.

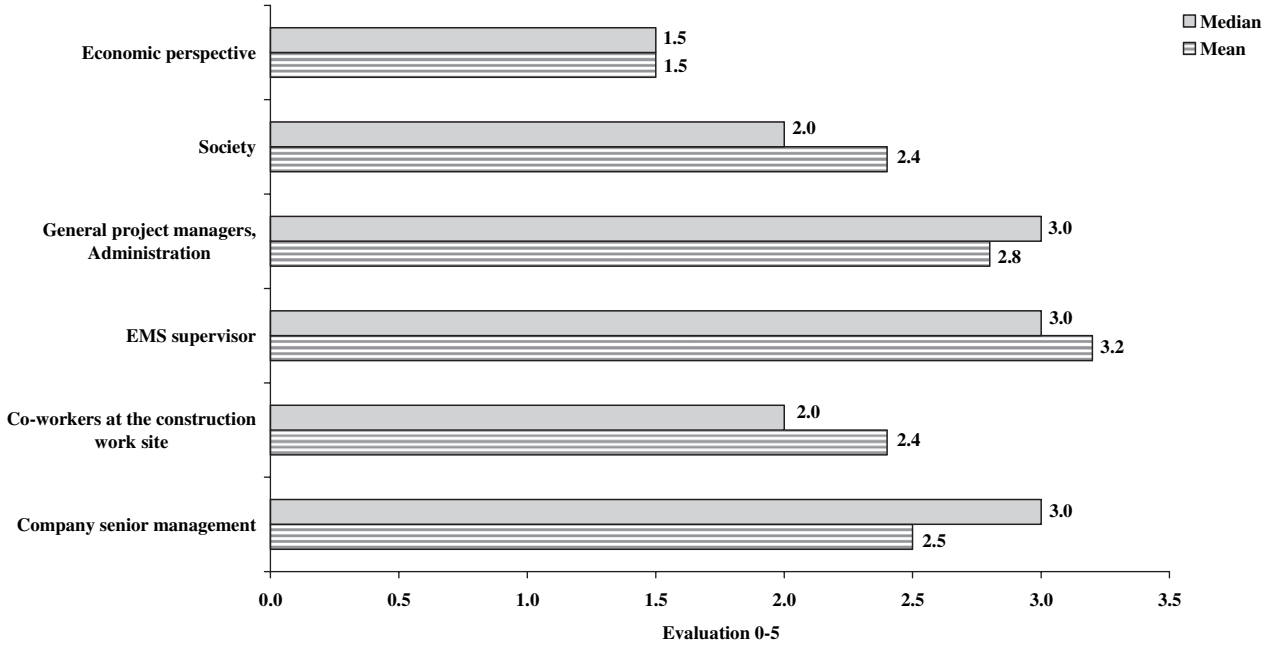
construction project were not accurately calculated. Subsequently, during the execution of the work and with a view to reducing costs, the resources for the EMU were decreased, and were thus inaccurately calculated for its optimal operation.

4.1.2.3. Authority and autonomy of the EMU. The ISO 14001 standard establishes that the company management should appoint EMS supervisors with specifically defined responsibilities and duties. They should also have sufficient authority to guarantee that the EMS can be established, implemented, and maintained.

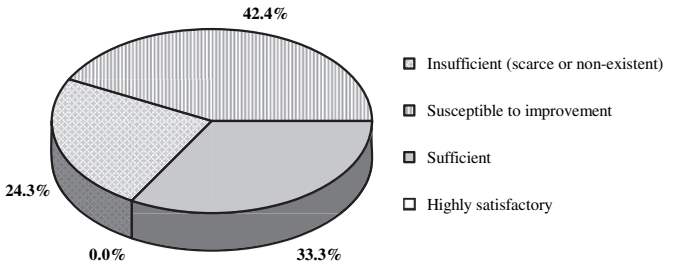
Within the context of temporary work places, such as construction sites, it is also necessary to define the roles and responsibilities of the personnel assigned to the EMU. Accordingly, EMS supervisors should also have the necessary authority to guarantee the effective performance of the EMS.

Consequently, EMS supervisors were asked to give their opinion regarding their decision-making capacity within the scope of the environmental management activities that they most frequently engage in. These included compliance with environmental legal requirements, documentation control, achievement of environmental objectives and goals. All of these decisions affect production, and are often related to the previously mentioned activities. Table 5 shows the data obtained.

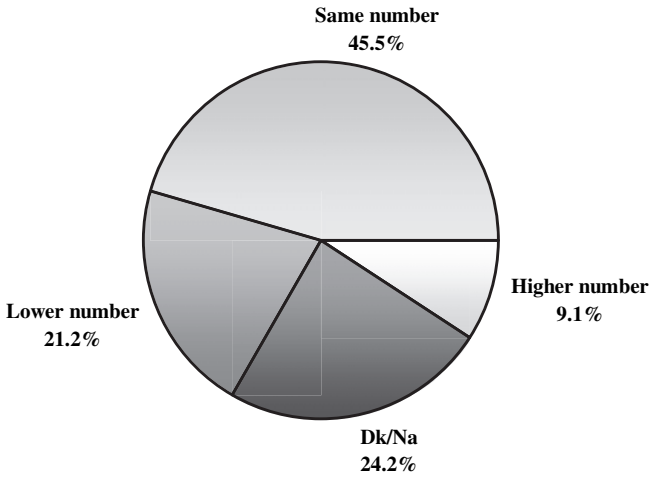
Slightly over half of the EMS supervisors considered that they had sufficient authority and autonomy to carry out their duties. The only exception was when their decisions affected production. In this case,



Graph 4. Evaluation of environmental work.



Graph 5. Allocation of resources for the EMU.



Graph 6. Personnel assigned to the EMU compared to the offer.

only one out of four said that he/she had sufficient authority and autonomy, and over half of those surveyed believed that their authority and autonomy was insufficient or even non-existent.

Finally, it should be stressed that only an extremely small percentage of supervisors said that they had total authority and autonomy at the construction site. The only exception was in the case of documentation control since this task is specific to the EMU, and does not affect the production team.

4.1.2.4. Circumstances in which production has priority over environmental management. In order to confirm the reliability of their previous answers, the respondents were asked about circumstances in which production was given priority over environmental management. Such situations included: tight deadlines, monitoring by construction project directors, important economic losses, irrelevant social impact, and a project that is small and/or of short duration. Graph 7 shows values (on a scale of 0–5) of the mean and median of the evaluations for each of the options.

As can be observed, in all of these circumstances, the median values were higher than or equal to 4. Particularly striking is when there were important economic losses. In this case, the median reached a value of 5. This means that, generally speaking, production is given priority over environmental management in all such situations.

4.2. Discussion of results

According to the ISO 14001 standard, EMS supervisors should have sufficient authority and should have the necessary resources to ensure the establishment, implementation, control, and maintenance of the EMS.

This study found that the construction companies that implemented an EMS specified it in their building projects. For this purpose, they appointed an EMS supervisor at the project site, and assigned him/her resources as well as personnel (EMU – Environmental Management Unit).

The profile of the **EMS supervisor** of a construction project was a person with a university degree, who had less than five years experience in the construction sector and in environmental work.

These supervisors had degrees from widely diverse areas. Many of the diplomas were not directly related to civil engineering or environmental science. Apart from the EMS supervisors' lack of technical knowledge and experience, there were also other circumstances that hindered their on-site work.

More specifically, when the supervisors' office was not located at the construction worksite, they were obliged to make periodic visits to the worksite to control and monitor work activities that might have a significant impact on the environment. This was an obstacle to effective monitoring.

Furthermore, if EMS supervisors did not belong to the principal company, but rather to a subcontracted company, or if they had been contracted specifically by the EMU of the principal company, they would initially be unaware of how the company operated. This also was a hindrance to their work. Still another problem was that these supervisors were generally obliged to perform other tasks that took time away from their environmental duties.

The **roles** that EMS supervisors often had, along with their environmental role, but which were not directly related to their environment functions, were quality control supervisor and/or safety and health supervisor. Unfortunately, this did not necessarily imply that the three management systems were integrated. In other words, the model applied often did not include all of these roles even though this would have simplified management and optimized resources.

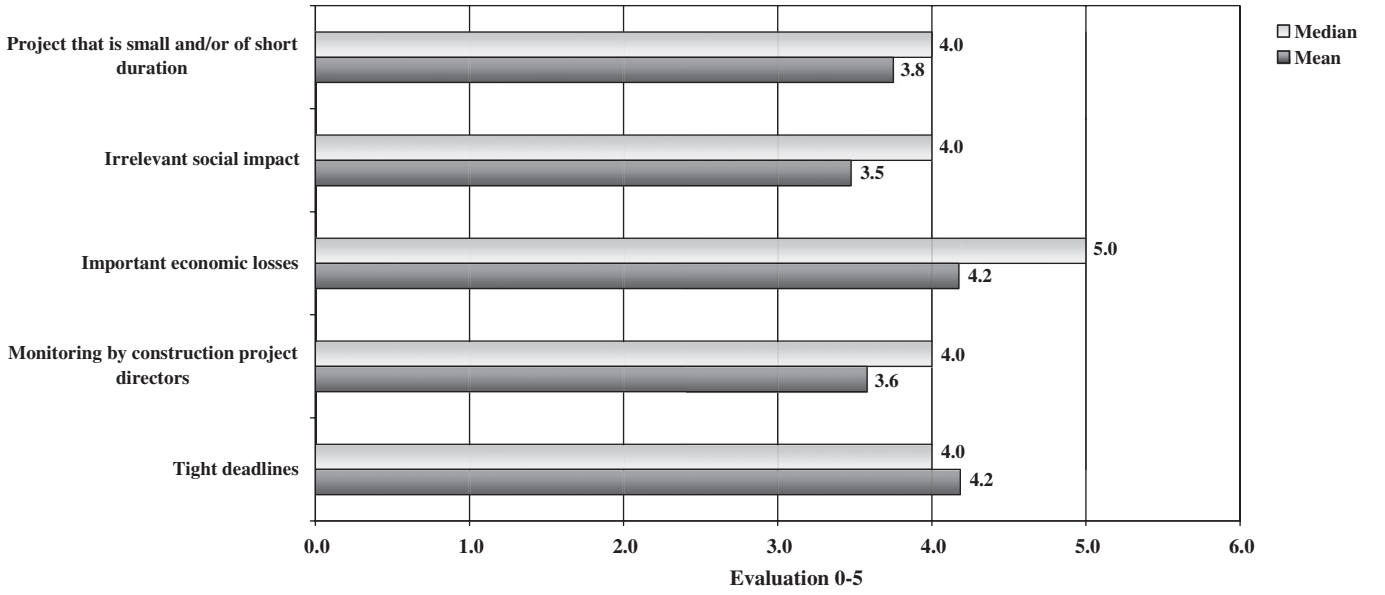
Another issue was that EMS supervisors taking part in the survey believed that their job was not sufficiently valued by their co-workers at the worksite, who did not seem to regard it as useful.

EMS supervisors also said that the **allocation of resources** (personnel, technical resources, funding, etc.) of the Environmental Management Unit (EMU) was insufficient or susceptible to

Table 5
Evaluation of the autonomy and authority of the EMU of the construction project.

Autonomy and authority of the EMU of the construction project	% construction works				
	Non-existent	Insufficient	Sufficient	Total	Dk/Na[a]
Compliance with environmental legal requirements	3.0	16.7	60.6	18.2	1.5
Documentation control	3.0	7.6	54.5	31.8	3.0
Achievement of environmental objectives and goals	1.5	15.2	62.1	16.7	4.5
Operational monitoring	6.1	19.7	53.0	15.2	6.1
Preventive measures for environmental emergencies	3.0	15.2	62.1	12.1	7.6
NC and CA-MP	1.5	10.6	68.2	16.7	3.0
Decisions that affect production	13.6	42.4	28.8	12.1	3.0

[a] Don't know/No answer.



Graph 7. Circumstances in which production has priority over environmental management.

improvement. It was sometimes even found that less staff had been assigned to the EMU than the number stipulated in the offer during the tender stage of the construction project. This signified that the construction project manager had not demanded that the conditions of the offer regarding environmental management be respected. This seems to reflect the low level of importance given to environmental management by construction project managers.

Furthermore, over half of the EMS supervisors said that their **authority and autonomy** was insufficient or non-existent when their decisions affected production. This signified that their monitoring was strongly conditioned by the production team.

Still another factor was the fact that at the construction worksite, production was given total and absolute priority over environmental management in all circumstances and situations (e.g. important economic losses, tight deadlines, and control by the general project manager). The production staff perceived the tasks to be carried out by the EMS as a hindrance to the principal goal, which was to make progress on the main construction work. As a result, they believed the EMS to be an added complexity and obstacle to their duties.

The lack of experience of EMS supervisors and the scant importance given to environmental matters signified that most of these supervisors began their professional activity in this role. For many, it was merely a first step in their professional career until they could acquire sufficient experience to work in other activities that were more closely related to production.

The wide variety of academic degrees held by EMS supervisors seems to stem from the fact that environmental duties are mainly regarded as an administrative task. As such, the supervisors' job seems to primarily involve justifying and providing sufficient documentation that shows that the EMS is being correctly applied, even though this may not always be the case.

Generally speaking, the application of the EMS at construction sites seemed to be considered a formality that must be complied with in order to keep the certification. As such, it appeared to be more of a means to gain access to the tender of contracting organisms, rather than a real commitment to improving the environmental performance of companies in the construction sector.

At the same time, this situation raises certain questions regarding the audits of the certifying entities at construction worksites and the validity of the EMS certification process as a guarantee that this system functions correctly.

5. Conclusions

The results of this survey provided a description of the current situation of construction companies that implemented an EMS, according to ISO 14001. This study specifically focused on the availability of resources, and the definition of roles, responsibilities, and authority granted to supervisors to assure that the EMS was effectively applied at construction worksites.

In this sense, the current circumstances of the construction sector point to a need for certain changes in order to successfully apply EMSs at construction worksites. More specifically, it is necessary to do the following:

- EMS supervisors at the worksite should be required to have the right academic qualifications and complementary training in construction as well as in environmental work. Furthermore, supervisors should have solid experience, and be familiar with the internal operation of their company in order to do their work better.
- If EMS supervisors are in charge of quality control and health and safety as well as their environmental work, it would be a good idea to integrate the specifications for the three management systems in order to simplify work and optimize resources.
- Environmental duties should be carried out by personnel who do not have production duties with a view to maximally protecting the autonomy of EMS staff at the worksite.
- The EMS should be provided with all necessary resources (staff, technical equipment, material, etc.).
- Company management should have an active commitment to the environment and to the establishment of EMS. All company staff should be made aware of the importance of environmental management. At the worksite, production should not have priority over environmental considerations. All company employees should be actively committed to the environment, and environmental responsibility should not be limited exclusively to staff with environmental duties and roles.

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