Assessment and Operational Control of On-Site Environmental Impacts in Constructions

Prof. Dr. Moheeb I. El-Said[1], & Eng. Moemen Ahmed Abd Elfattah[2]

Department of Construction Engineering, Faculty of Engineering, Cairo University

Abstract

Construction operations on-site are recognized as major sources of several environmental impacts. Thus, serious actions have to be considered in both planning and execution phases, in order to control such anticipated impacts during the work period. ISO 14001 standard, among others, gives a distinctive guidance to organizations, to create and implement Environment Management System (EMS) within internal processes. Such application of EMS on construction operations, can form a significant improvement to environmental performance, and it can pay back on economic level on mid and long terms.

Introduction

A significant interest in reach for sustainable development has been found among public and private sectors through the last decades. Sustainability is usually expressed in terms of long term cultural, economic and environmental aspects [18]. Applying the concept on construction industry, shifts the classical approach of measuring projects success in terms of cost, time and quality [18]. And despite the efforts made by the construction sector to adapt an environmental friendly policies, the sector is still considered widely as a major source of negative impacts on the environment [6]. A lot of concerns are still raising, due to the construction sector's influence on natural resources, energy, climate changes, and its direct effects on people's welfare.

Big interest and work were aimed to honor the importance of life-cycle effects of constructions, in recognition to its long term lasting nature. But less research and focus were spotted on the influence of the construction and building processes by itself, and its direct impacts on the environment. As the construction industry is a major source of pollution, and is responsible for about 4% particulate emissions, more water pollution incidents than any other industry, and thousands of noise complaints every year [4].

Different international standards were developed to allow a clear route for organizations, in order to derive business into environmental friendly performance. The international standard for Environmental Management Systems ISO14001 [14] is widely accepted and acknowledged by many academic papers, as a distinctive framework to be followed by constructions companies [15]. Environmental Management System (EMS) is the set of interrelated elements used in the organization to establish environmental policy and to create and

[1]Professor of Construction Engineering and Management, Department of Structural Engineering, Faculty of Engineering, Cairo University, Giza, Egypt

[2] MSc. researcher, Faculty of Engineering, Cairo University. Project Manager at CONSSULT contracts administrators. Email moemen.ahmed@outlook.com

achieve related environmental objectives, and to manage its aspects [14]. Once again, it was found that EIAs of construction projects generally focus on the long term operational phase. While the on-site environmental impacts related to engineering and building works are often overlooked [2].

Construction companies and developers are highly encouraged and forced in some regions to adhere to EMSs, in order to improve their environmental performance [6]. Although it is noted that the number of certified ISO 14000 construction companies are increasing [7], it is generally seen that sector has responded slower than other industries to adaptation of EMS [15]. Different barriers are recognized, which obstructs construction companies from implementing EMS, but the clearest challenge is related to the inherent outdated norms among the sectors' professionals [5]. Environmental goals are considered by most of the construction sector professionals as the lowest important goal for their projects, in comparison to other classical recognized goals like cost and time [9].

The goal of this paper, is to collect and organize the different main sides of the problematic issue of environmental effects of construction on-site work. And to show a practical approach for assessment and control of these effects, which can be used by developers and contractors. The suggested approach is compliant with ISO 14001 guidelines, and shall allow sector's professionals to adapt with the environmental requirements, and to create a real practical value of the enforced documentations, usually produced as per legal demands.

Methodology

The methodology used in this research is based on reviewing recent literature with direct relation to the issue under discussion. It is intended to collect previously founded results, and to re-organize it in a unifying form, in accordance to guidelines of international standard. And to show final results in a format, which can be adopted in practice.

Most of the reviewed literature split the environmental related work into three sections; (a) Identification, (b) Assessment, and (c) Operational Control. The ISO 14001 provides a standard framework, and states specific parts to establish any EMS, those are:

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

Although the identification of key activities that are linked to environmental impacts is a major part of the planning part of the standard, in this research we focus on only two parts in with special consideration of construction on-site work

*(1) Assessment of environmental impacts of on-site construction: T*he assessment is usually considered as a main part of pre-construction planning phase, but it is important to highlight, that continues attention to the process and repetitive assessment through the project execution is very important to allow progressive understanding and better absorption of the environmental risks embedded in the work.

The model presented by Gangolells and associates [1][2][3][4][6][13] forms the foundation for the assessment method presented.

(2) Operational control on-site: The work intended in this part is on-site due. It is aimed to present an operational methodology, to help constructions managers adhering to required environmental guidelines. And to enlighten the scope of application of ISO 14001 guidelines in construction sites.

An ontological model, proposed by [13], in conjunction with risk management approach as proposed by PMI [13] was used to establish the final results.

Applying Risk Management approach processes on environmental aspects in operation, enforces a progressive management style. This continues elaboration is complied with the general management theme of PLAN-DO-CHECK-ACT, as a backbone for implementation of ISO 14001 on-site, and as shown by the standard itself, Figure (1).

Assessment of Impacts

Environmental aspect is any element of an organization's activities or products or services that can interact with the environment [14]. Those elements that cause, or have the potential to cause, environmental impacts must be identified early in the planning phase, and to be presented for further study through the assessment process. It was found that majority of construction professionals, consider pollution, resources consumption, and destruction to habitat are the most significant impacts, to be considered during on-site construction work [4], however such perceptional evaluations cannot be used as a base for rigid assessment, further efforts must be invested, in order to develop an acceptable results.

The initial study and review of environmental impact statement must be done through serious efforts, based on technical background, and baseline data derived by experts. And to apply systematic approach to identify and assess impacts, due to project environmental aspects. The total study and findings must be well documented, and results must be presented in clear format to decision makers [11]. EIA is considered a vital part of required documentations before starting on-site work.

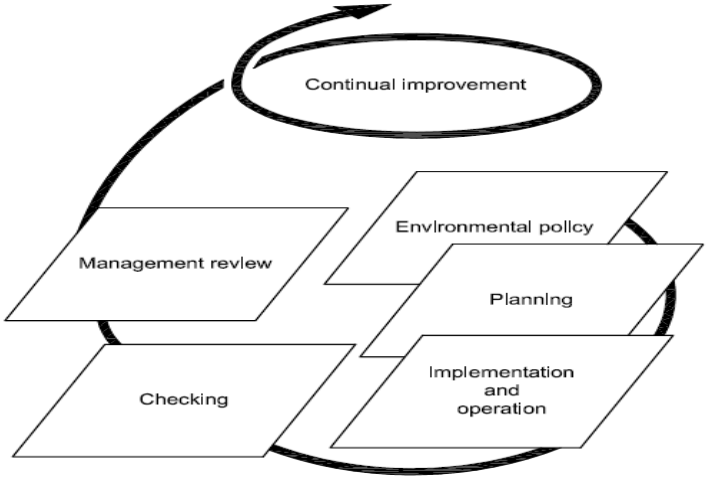

Figure1 - Environmental management system model for standard. Source: ISO 14001

As mentioned in Methodology section, the identification of environmental impacts is not a part of this paper scope, and therefore the research depends on the findings of [13], proposing an ontology-based identification of environmental aspects related to on-site construction. In modern project management era, where most construction projects planning tend to develop Work Breakdown Structure (WBS). WBS is another ontology-based method, which is presented as a hierarchal decomposition of project's scope of work to be carried out to create the required deliverables [13]. Comparing both ontological results; environmental impacts hierarchy and WBS, shall ease the way to identify and list all possible anticipated environmental risks.

Assessment is meant to be a point of measurement for the anticipated impacts on environment elements, due to the project activities and processes [12]. Such early work shall enable a better decision making for the management in relation to environmental friendly policy. It is expected that management shall implement programs addressing those impacts, which have been assessed significant to environment impacts [5] [1].

Assessment shall include all identified impacts, weather those are direct, indirect or commutative [11]. These impacts of on-site construction work can show diversity in nature, therefore can be categorized in different ways. Main categories will typically include; climate, water, land, energy, sound, human aspects [11]. Figure [2] shows main recognized environmental aspects of on-site construction activities, in considerations to findings by [2] and [3].

Due to the noticed wide range of environmental impacts of on-site construction in nature, and in accordance to the ISO 14001 standard, it is recommended to take into account the concerns of interested parties when assessing the significance of environmental impacts [5].

Applying the assessment model produced by [5], two main factors will be evaluated, and used for finding assessment result. Those factors are;

(1) Severity of Impact (Sv), which is meant to measure the amplification of consequences of actualization of any a specific environmental risk, in conjunction with its legal applicable requirements.

(2) Concerns of Interested Parties (Co), which is meant to measure the depth of concerns of different interested parties, in response to any specific environmental risk.

After evaluation of the Severity (SV.) and Concern (CO.) factors for each identified environmental impact, the assessment shall be based on the Significance factor (SG), as shown in equation [1].

$$SG = SV_i \,.\, CO_i \qquad \ldots\ldots\ldots Eq.(1)$$

Where SG_i is the significance factor for environmental impact {i}, CO_i is the concerns factor of environmental impact {i}, and SV_i is the severity of environmental factor {i}. (5)

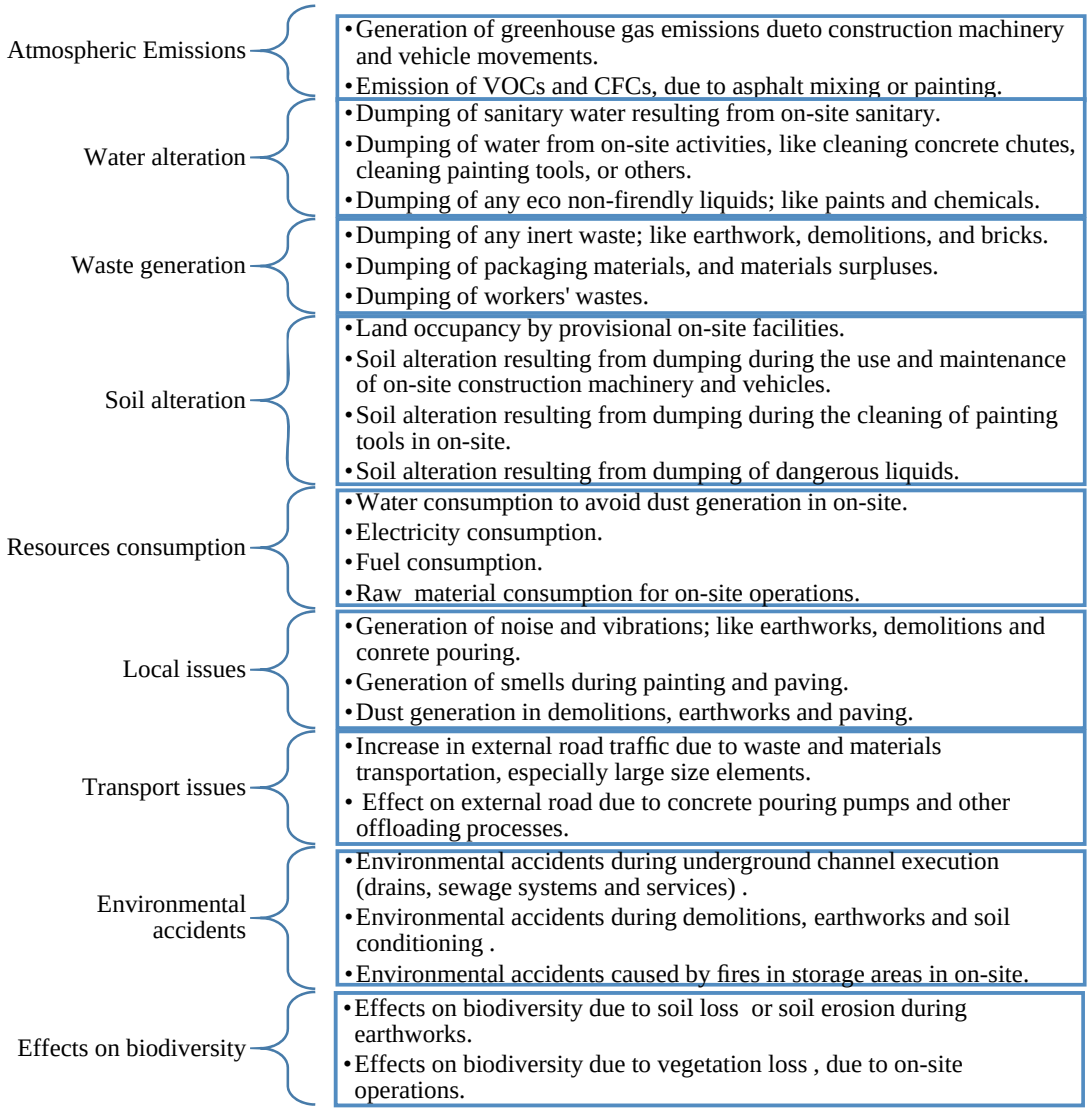

Figure2 - Major recognized environmental aspects of construction on-site activities, categorized in respect ISO 14001.

To quantify the prediction of the severity factor (SV.), and concerns level factor (CO.) of any environmental impact related to the on-site work, indicators need to be developed. ISO 14031 standard implies that Indicators must be target-oriented, balanced, continuous, frequent and comprehensive [3]. In order to develop an objective assessment of impacts, indicators must be specific and measurable [2]. Project's team should depend on the most recent available developed indicators, and which is based on study of similar projects to the one under study. Table (1) shows a sample list of indicators as developed by [3], matching the water alteration aspects as shown in figure (2).

Aspect	Indicator	SV=0	SV=1	SV=3	SV=5	CO=1	CO=3	CO=5
Dumping of sanitary water resulting from on-site sanitary conveniences in municipal engineering works	Average number of workers per day [number of workers]	$P = 0.00$	$0.00 < P \leq 6.37$	$6.37 \leq P < 16.54$	$P \geq 16.54$	Connection to sewage system	Dumping in septic tank and/or existence of previous treatment	Direct dumping to the natural or urban environment
Dumping of water resulting from the execution of retaining walls in on-site municipal engineering works	Use of thixotropic fluid	No use of thixotropic fluid	-	Use of thixotropic fluid	-	Existence of an in situ waterproof settling basin or watertight tank	Connection to sewage system, dumping in septic tank	Direct dumping to the natural or urban environment
Dumping of water from cleaning painting tools in on-site municipal engineering works	On-site surface painted with non-ecofriendly paints [m^2]	$P = 0.00$	$0.00 < P \leq 33.57$	$33.57 \leq P < 1167.83$	$P \geq 1167.83$			
Dumping of water from cleaning concrete chutes or dumping of other basic fluids in on-site municipal engineering works	Volume of in-situ concrete [m^3]	$P = 0.00$	$0.00 < P \leq 252.24$	$252.24 \leq P < 3835.39$	$P \geq 3835.39$			

Table1 - Samplee environmental indicators for water alteration impacts, developed for municipal projects. Source:[2]

For Impacts where Significance factor is found to be equal to, or greater than nine, a call for a decision shall be raised. Such decision can be a request for redesign, finding alternatives, or mitigation plan followed by precise work instructions to be considered on-site, as shown in figure (3).

After assessment of each individual aspect of the project, a total evaluation of the construction work impact can be obtained, by applying equation (2).

$$R = \sum_{i=1}^{n} SG_i \quad \ldots\ldots\ldots\ldots Eq\ (2)$$

Where R denotes the overall environmental impact level of a project and SG_i designates the significance of a particular environmental impact {i}. [2]

The findings of the on-site work environmental assessment must be included in the development of total project EIA.

On-Site Operational Control

The execution phase of construction work, is when planned activities and processes take place on-site, in order to produce the deliverables of the project. [13]

ISO 14001 requires organizations to create and implement specific, well defined, and documented procedures to monitor and measure the environmental performance during execution [14]. If environmental impacts are considered as a vital domain for operational control during on-site phase, then construction processes will show a direct link to the previously identified environmental aspects, and would register agreed mitigation and avoidance strategies, in order to implement the decisions made pre-construction to the actual work on-site [1].

Implementation of EMS on-site requires high level of efforts and determination by the organizations involved in any construction project. Different obstacles may be present on-site, including inherited norms, and false perceptions. The temporal and spatial variability nature of construction projects by itself can form a great obstruction. [15]

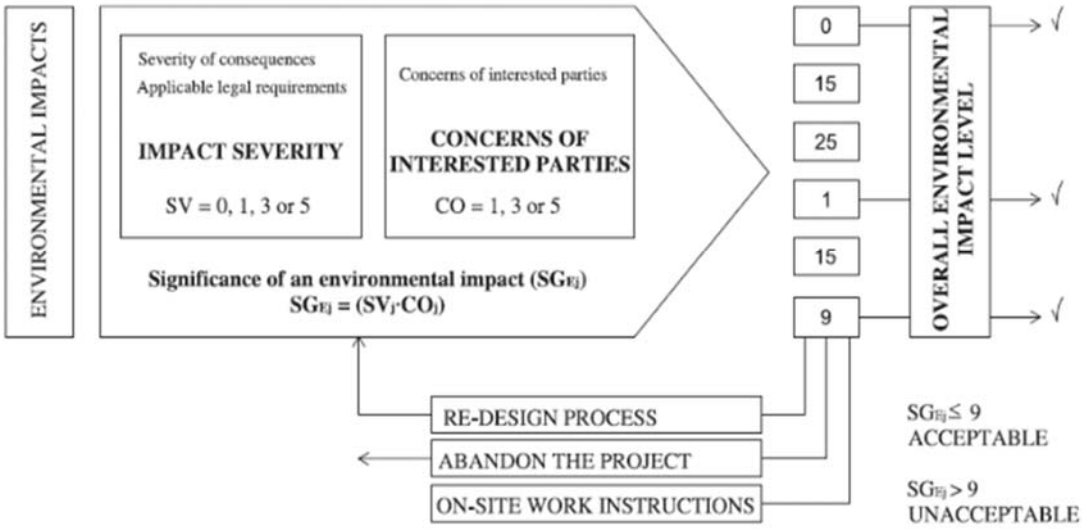

Figure3 - Assessment process of environmental impact of each aspect, and determination of significance factor. Source: [5]

EMS Implementation On-Site

The international standard defined the major activities to be carried out, in order to achieve the required control over environmental aspects through operations [14]. Applying these major activities on construction operations on-site allows to reach for the required level of control over environmental aspects and their anticipated related impacts.

IS14001 implies that organization must appoint personnel for the specific tasks of implementing EMS in operations [14]. Those personnel should have clear responsibilities, and sufficient authority.

Three main issues were found, that hurdle the work of environmental personnel on-site [15];

(1) Appointing environmental supervisor, who doesn't have adequate knowledge, relative experience, or did not receive appropriate training.
(2) Environmental supervisors did not get the required autonomy in work, and did not have enough authority to perform as required.
(3) Not allocating enough resources to the support implementing EMS on-site.

Avoiding these issues in implementation is necessary, in order to achieve required targeted environmental performance. Top management buy-in, continues involvement and support to EMS is crucially required, as it was noticed that different organizations are fulfilling documentations processes only to maintain EMS certification requirements, without paying enough attention to actual conditions on-site, and environmental performance [15].

It is important to clarify, that environmental related work is usually expressed as horizontal processes in organizations, which requires involvement of all employees, including top management. In order to apply risk management processes on environmental impacts, construction team needs to revise identified impacts, and to reassess any aspect, whenever actual job site shows different measurements to anticipated measurements in pre-construction assessment phase. Such reassessment work, and periodic revision of identified environmental risks are vital to implementation of EMS on-site, in accordance to international standard requirements [14], and in consideration to recommendations and guidelines of project management best practices [13].

As previously mentioned, ISO 14001 methodology is based on Plan-Act-Check-Do approach, with consideration to Work Processes concept [14]. Construction processes can be seen as a set of interrelated actions and activities to be done, in order to achieve required targets, and produce deliverables [11]. Such processes should be well documented, with specified inputs, outputs, and detailed techniques to be implemented [13]. Embedding EMS into on-site work processes, and work instructions is mandatory for desired operational control.

Work instructions are meant to be the direct communication tool on-site to get work done. A procedure is defined as a specified way to carry out an activity or a process [14]. Procedures contain the basic process for performing a function at operational level, and are therefore often supported by detailed work instructions. Work instructions must be detailed and clear enough for daily operational performance [11]. The interdependencies and relations between environmental impacts, work processes and work instructions define the level of anticipated success of implementing EMS on site.

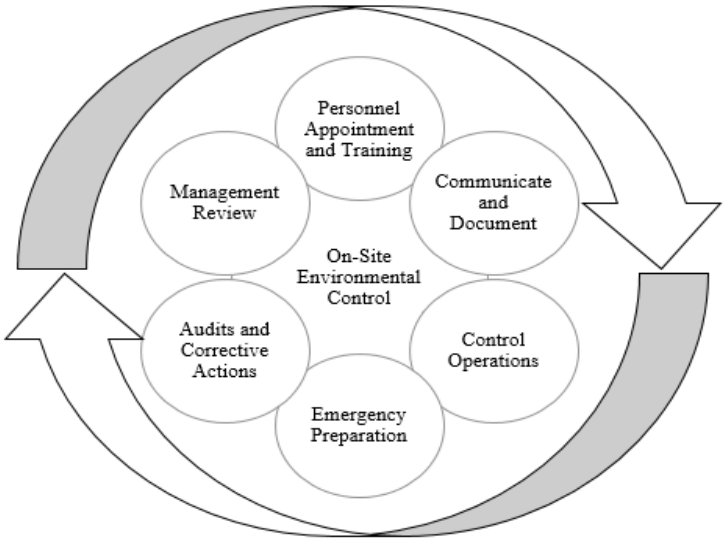

Figure4 - EMS Operational Implementation Major Activities, in respect to ISO 14001

Environmental Audit

Audit is a systematic, documented verification process of measurements to determine whether the environmental aspects of the project complies with determined allowable criteria or not. And to produce feedback reports, which can be used to develop and implement corrective actions [14].

Internal audits should be done on predefined planned intervals, in order to make sure of implementation of EMS as intended on the work site. In accordance to ISO 14001 auditing plan should determine roles of auditors, auditing procedures, and to define audit criteria, measurements and methodology to be applied.

Checklists are one of the most widely adapted tools to perform audits. Thus, it provide auditors with clear defined list of points, and measurements to be checked on site. Many standardized environmental checklists were developed by either researchers or authorities in different regions. Those, can be used by any constructions organization as a baseline, and further internal efforts should follow, in order to develop tailored checklists that address the environmental aspects of undergoing accurately. Table (2) shows a sample checklist, which check if prevention measures were implemented on-site to avoid causing water alteration impacts.

Focus Points for On-Site Operational Control of Environmental Impacts

Applying EMS on construction on-site work requires a comprehensive efforts through both planning and execution phases, such efforts should be based on systematic approach as discussed. Still, due to the dynamic nature of construction work, which requires responsible personnel on site to take immediate decisions and actions on daily base, it is important to develop an environmental sound of awareness among those professionals. Decision makers on site must possess rigid knowledge and experience of dealing with environmental aspects on the fly. Such awareness shall help projects to achieve operational goals, within allowed limits of environmental impacts.

Audit Checklist	Implemented?		N/A	Remarks Specify taken measurements, refer to required standard, define exact evidences and propose resolution.
	Yes	No		
1. Water Alteration Control				
1.1. Are water discharge licenses valid?				
1.2. Are wastewater treatment system being used and properly maintained on site?				
1.3. Are there any wastewater discharged to the surface water channels? Is the wastewater being treated?				
1.4. Are sewage channels and manholes free of silt and sediment?				
1.5. Are sedimentation traps and tanks free of silt and sediment?				
1.6. Are all manholes on-site covered and sealed?				
1.7. Is the public road/area around the site entrance and site hoarding kept clean and free of muddy water?				
1.8. Is domestic water directed to septic tanks?				
1.9. Others (please specify)				

Table2 - Sample checklist to check water alteration impacts on-site.

It was found that majority of environmental impacts are linked directly to core construction processes [6]. For example, the generation of greenhouse gas emissions, the consumption of fuel or the generation of noise are directly related to the use of construction machinery and equipment during the construction activities [4]. Thus, it is important for decision makers on site to consider avoidance of operating several work activities simultaneously, where heavy machinery is required for each; i.e. earthwork within rock layered soil, and concrete pouring activities are major causes of noise, dust and emissions [16]. Carrying over both activities at the same time will be a certain cause of disturbance to neighbors, and the cumulative immediate impacts may have severe effect of both neighbors and workers on site. Such situation should be avoided by decision makers on site, in order to prevent the significant cumulative impact. The noise produced by the construction activities is one of the main acoustic polluting elements in society. However, there is no specific regulation for this activity in many regions [16], therefore internal awareness of this impact is highly required.

Waste Management is evaluated as one of the most important environmental protection measures used in controlling building construction environmental impacts [4]. Construction and Demolition waste is one of the largest global waste streams and makes up an estimated 50 per cent of all waste in some regions [10]. Therefore, waste management has received significant interest of both researchers and professional practitioners. On the public authority level, it was found that in later years many of the EU countries have implied legal measures for construction waste management [8].

Construction wastes can be generally categorized into three types;

(1) Solid Wastes should be deposited in the appropriate container bins, and removed periodically to the municipal dumps.
(2) Inert Wastes forms most of the on-site produced wastes. It includes bricks, concrete remains, stone, sand, gravel and other dry materials. Beside regular disposal of these wastes, it was found that majority of it are reusable on the same site, or on other work sites [17].
(3) Hazardous Wastes; i.e. amianthus, solvents, resins, etc. This type is the most critical, due to its nature, and its significant negative impacts. Generally, this type of waste is the most difficult to store and dispose.

Table (3) shows major sources of wastes in construction. And In order to minimize construction waste, different methods can be applied to these wastes; reuse, recycle or to reduce the generation of these. Researches and case studies show that between 50% and 80% of construction wastes are reusable [17].

Source Of Waste	**Percentage**
Concrete Construction	28.9%
Steel reinforcement bars	21.1%
Formwork	15.8%
Temporary hoarding	14.0%
Scaffolding	7.9%
Others	12.3%
Total	**100%**

Table 3- Sources of construction waste. Source: [9]

Case Study and Findings [20][21]

P&R Plant Hire is a medium size construction company in U.K, which specializes in groundwork, civil engineering and plant hire. In order to be able to compete in market, and under major clients' pressure, P&R needed to adopt ISO 14001 EMS and to show improvement in environmental performance. In 2011, P&R found technical help from SUSTAIN Lincolnshire, an environmental program that aims to support organizations to improve their performance from environmental point of view. P&R and SUSTAIN Lincolnshire worked out a plan to implement EMS into P&R constructions operations. Major Activities were defined;

- Audit of existing environmental management. And defining significant environmental impacts of P&R operations.
- Implementing a sustainable change into P&R, as part of this, P&R also

organized staff diploma training in work-based environmental conservation. It was crucial that employees understand the benefits of making efficiency improvements and how they can help to implement them.
- P&R obtained Green level accreditation, which they used to prepare for their full ISO14001 assessment.

High fuel consumption by company's vehicles was identified as a major environmental aspect, and its resulted impact was assessed as critical to mitigate. Accordingly P&R has taken several actions to lower the risk exposure of this impact, including;

- Investment in trackers for its fleet of vehicles. The trackers ensure no unnecessary journeys are taken and that the closest vehicle to the call out location is dispatched.
- Investment in advanced software, generating stats such as vehicle GPS location, time spent on site and fuel consumption data. They have also employed a new part-time member of staff to manage this data. Fuel card data is also entered into the computer system in order to calculate miles per gallon, saving staff time, as this was previously a manual task.
- The staff have also taken a fuel efficiency driving course, helping them to develop their eco-driving skills.

Other changes were implemented to mitigate influence of other environmental aspects of the company operations, included;

- Reduce Energy Impact: Adopting a switch-off policy. And investment in solar PV for installation on roof of workshops.
- Waste Management & Reduce Resources Consumption: Hiring a concrete crusher and sorting, in order to be able to break down old concrete heavy elements and to reuse it in operations.
- Waste Management: Switching to recycled paper, quality has not been comprised and are now using a 100% recycled resource. Coupled with changing printers usage policies on sites, and usage of scrap papers for drafting.

These change actions have helped P&R significantly to mitigate the previously defined environmental impacts. Calculations showed that around 15% savings on site operational costs is achievable, upon the new changes.

By using the concrete crusher machinery, the company diverted 400 tons of waste from going to landfill in one instance. Reusing the concrete reduced consumption of resources, and achieved economical saving for the company. During 2013, P&R has been certified by ISO 14001, an accreditation that will certainly help the company to have a competitive edge in market, and to get more work.

.

Conclusion

Applying Environmental Management Systems (EMS) to construction on-site operations is found to be of a vital importance, due to the big possible environmental impacts related directly to major construction activities. Assessment in pre-construction phase is mandatory step, in order to develop a comprehensive understanding of the environmental risks anticipated, and their significance. The findings of pre-construction assessment job facilitates a better decision making for top management on early stage, which can be very beneficial to lead construction site work into a peaceful way later on, with minimum risk exposure.

It was clarified that having the right personnel involved in operational control on site is mandatory. Environmental personnel should receive suitable training, and must have autonomy and authority on site, in order to perform required actions in best way.

Different measures to mitigate environmental impacts of construction on site should be implemented and maintained. Construction professionals' awareness of these usual measures and related concerns is crucial to help smarter decision making on site in a dynamic way. Providing construction staff with suitable training is the best way to guarantee development of such awareness among working sites.

Last, it was clear that applying EMS to construction operations can provide organizations with competitive advantage, as its positive influence is not limited to receive international accreditation, and therefore market recognition, but also it can add value to internal processes, and help in direct and indirect ways to achieve better economical results for organizations.

References

[1] Gangolells, M., Casals, M., Forcada, N., Fuertes, A., and Roca, X. (2013). "Model for Enhancing Integrated Identification, Assessment, and Operational Control of On-Site Environmental Impacts and Health and Safety Risks in Construction Firms." J. Constr. Eng. Manage., 139(2), 138–147.

[2] Gangolells, M., Casals, M., Forcada, N., and Fuertes, A. (2014). "Predicting on-site environmental impacts of municipal engineering works" J. Environmental Impact Assessment Review 44, P 43-57.

[3] Gangolells, M., Casals M., Gassos S., , Forcada, N., Fuertes, A., and Roca, X. (2009). "A methodology for predicting the severity environmental impacts related to construction process of residential buildings" J. Building and Environment 44, P 558-571.

[4] Edoka Augustine Ijigah, Richard Ajayi Jimoh, Bamidele O. Aruleba, and Abduiquadri Bilau Ade. , (2013). "An Assessment of Environmental Impacts of Building Construction Projects". J. Civil and Environmental Research, Vol 3, No.1,

[5] Gangolells, M., Casals M., Gassos S., , Forcada, N., Fuertes, A., and Roca, X. (2011). "Assessing concerns of interested parties when predicting the significance of environmental impacts related to the construction process of residential buildings", J. Building and Environment 46, P 1023-1073.

[6] Fuertes A., Casals M., Gangolells M., Forcada N., Macarulla M., Roca X. (2013). "An Environmental Impact Causal Model for improving the environmental performance of construction processes". Journal of Cleaner Production 52, P 425-437.

[7] L. Y. Shen, Vivian W. Y. Tam (2002), "Implementation of environmental management in the Hong Kong construction industry". International Journal of Project Management 20, P 535–543

[8] Mercedes del Río Merino1, Justo García Navarro and Paola Villoria Sáez (2011). "Legal Aspects which Implement Good Practice Measures in the Management of Construction and Demolition Waste". The Open Construction and Building Technology Journal, 2011, 5, (Suppl 2-M2) 124-130.

[9] Vivian W.Y. Tam (2008). “On the effectiveness in implementing a waste-management-plan method in construction”. Waste Management 28, P 1072–1080.

[10] Mahara Inglis (2007), “Construction and Demolition Waste – Best Practice and Cost Saving”. SB07 New Zealand, paper 057.

[11] Robert A. Corbitt (2004). “Standard Handbook of Environmental Engineering, second edition”. Pages 1231-1241.

[12] El-Sayed A. Badr, Ashraf A. Zahran, Matthew Cashmore (2011), Benchmarking performance: Environmental impact statements in Egypt, Environmental Impact Assessment Review, Volume 31, Issue 3, April 2011, Pages 279-285.

[13] Gangolells M., Casals M. (2012). “An ontology-based approach for on-site integrated environmental and health and safety management”. Revista Ingeniería de Construcción Vol. 27 Nº3.

[14]Environmental Management Systems ISO 14001 second edition (2004).

[15] Gracia Rodríguez, Francisco Javier Alegre, Germán Martínez,(2011). “ Evaluation of environmental management resources (ISO 14001) at civil engineering construction worksites: A case study of the community of Madrid”, Journal of Environmental Management, Volume 92, Issue 7, July 2011, Pages 1858-1866.

[16] Ma Jesu´ s Ballesteros, Marcos D. Ferna´ndez*, Samuel Quintana, Jose´ A. Ballesteros, Isabel Gonza´ lez (2010). “Noise emission evolution on construction sites. Measurement for controlling and assessing its impact on the people and on the environment”. J. Building and Environment 45- P 711–717.

[17] Gracia Rodr´ıguez , Francisco Javier Alegre, Germ´an Mart´ınez (2007). “The contribution of environmental management systems to the management of construction and demolition waste: The case of the Autonomous Community of Madrid (Spain)”. J. Resources, Conservation and Recycling 50, P 334–349.

[18] Aminu Darda’u Rafindadi, Miljan Miko, Iva Kovaib, Zoran Ceki (2014), “Global Perception of Sustainable Construction Project Risks”. J. Social and Behavioral Sciences 119, P 456 – 465

[19] PMI (2013), “A Guide to the project management body of knowledge BMBOK; fifth edition”, Glossary Appendix.

[20] SUSTAIN Lincolnshire report

[21]WEB:
Lincolnshire County Council
http://www.lincolnshire.gov.uk/

& SUSTAIN Lincolnshire official website.
http://www.lincolnshire.gov.uk/business/lcc-services-for-business/economic-regeneration/sector-support/sustain-lincolnshire/