



HAL
open science

Improving the environmental performance of Moroccan industries: An assessment study of industrial projects

Amina Laaroussi, Denis Lemaître, Soumia Bakkali, Souad Ajana

► To cite this version:

Amina Laaroussi, Denis Lemaître, Soumia Bakkali, Souad Ajana. Improving the environmental performance of Moroccan industries: An assessment study of industrial projects. *International Journal of Advanced Research in Engineering and Technology*, 2020, 11 (12), pp.750-766. hal-03104023

HAL Id: hal-03104023

<https://ensta-bretagne.hal.science/hal-03104023>

Submitted on 14 Jan 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

IMPROVING THE ENVIRONMENTAL PERFORMANCE OF MOROCCAN INDUSTRIES: AN ASSESSMENT STUDY OF INDUSTRIAL PROJECTS

Amina Laaroussi*

Engineering Research Laboratory, ERFSI,
ENSEM-University Hassan II, Casablanca, Morocco

Denis Lemaitre

Training Laboratory and Professional Learning,
ENSTA Brittany, Brest, France

Soumia Bakkali

Engineering Research Laboratory, ERFSI,
ENSEM-University Hassan II, Casablanca, Morocco

Souad Ajana

Engineering Research Laboratory, ERFSI,
ENSEM-University Hassan II, Casablanca, Morocco

*Corresponding Authors

ABSTRACT

The environmental awareness of Moroccan engineers in charge of industrial projects has become essential to improve environmental performance and, more broadly, to contribute to the environment protection and sustainable development strategy of Morocco. However, it is difficult to measure the level of environmental awareness among engineers and to promote it. Thus, to answer this issue and provide comprehension tools, a field study was carried out among Moroccan company managers from seven different industrial sectors. The manufacturing companies are mostly certified ISO 14001 and ISO 9001, they are nevertheless strongly consumers of raw materials and exercise polluting industrial activities which generate waste. The survey aims to gain a better understanding of the policies of these companies in terms of their environmental management of industrial projects, and expected engineering skills. It covers the projects managed by engineers from different specialties who graduated from Moroccan schools. The study combines on the one side, a quantitative assessment section on the mastery of the environmental footprint in the operational decision-making phase of 174 industrial projects led by Moroccan engineers. On the

other side, it includes a qualitative analysis section of the expectations and recommendations of the industrialists for a better environmental management of projects. The study shows that the level of environmental implication of the engineers in the projects leaves room for improvement. The industrialists' attention was mainly focused on the control of the environmental footprint when completing projects, whilst still contributing to the improvement of the performance of industry and the country.

Keywords: Environmental footprint, environmental performance, engineers, manufacturing industries, project management.

Cite this Article: Amina Laaroussi, Denis Lemaitre, Soumia Bakkali and Souad Ajana, Improving the Environmental Performance of Moroccan Industries: An Assessment Study of Industrial Projects. *International Journal of Advanced Research in Engineering and Technology*, 11(12), 2020, pp. 750-766.

<http://www.iaeme.com/IJARET/issues.asp?JType=IJARET&VType=11&IType=12>

1. INTRODUCTION

Environmental issues have become a main preoccupation on a planetary scale. Protecting the environment is now a key concern of nations. It is a question which is of particular interest to politicians, just as much as to academics and industrialists. Over the last decade, Morocco, fully aware that it needs to protect the environment and answer environmental priorities, has promised a major set of reforms to create the foundations for sustainable economic development, by attributing great importance to the environmental pillar. In particular, the State is encouraging industrial stakeholders to commit to environmental protection measures. Today, the environmental dimension has become a major challenge for Moroccan industries, pushed into integrating the issue of their impact on nature and resources into their daily practices.

Taking on this challenge would require being able to rely on well-trained executives convinced of the cause. Industrial companies in particular need engineers who are versed in the new environment management technologies to pick up the environmental challenges of Moroccan ecological industry, by satisfying the Moroccan Strategy for Sustainable Development (SSD). To be able to recruit well-trained engineers in this field means that training institutions must also satisfy this requirement, by adapting their curricula. The ultimate goal is a strong bond between industrial and academic stakeholders enabling them to combine their efforts. One objective is that the companies and schools unite to draw up a training program which would be the best solution for the professional sector, or that could even anticipate the different challenges of the C21st concerning the best industrial ecology.

This article presents the analysis of a field study via a questionnaire of manufacturing companies in seven different industrial sectors, most of which are following the sustainable development program, to evaluate the achievement of the environmental performance objective. After describing the sample, we will present the analyses of the statistical and qualitative results. The main question is the ability of Moroccan engineers to incorporate the environmental footprint at an operational decision-making level, when leading industrial projects. The aim is to evaluate the improvement in the companies' environmental performance in terms of operation, through the evaluation of the level of commitment and environmental awareness of the engineers managing the industrial projects, whatever their technical expertise, whilst ensuring the profitability of the company. Ultimately, it is a matter of evaluating the skills required by engineers relative to the environmental dimension, as expressed by the industrialists leading the organizations.

This study is based on the hypothesis of a link between the management of industrial projects and the environmental awareness of the engineers, through the different constraints which carry weight in the improvement of industrial environmental performance.

With this in mind, we propose to answer the following questions concerning the integration of environmental indicators in the operational decision-making process of the industrial project:

- What level of importance is given to the inclusion of key environmental indicators in the operational decision-making in project management?
- How satisfied are the heads of industry with the engineers they lead with regard to the mastery of the environmental footprint in operational decision-making in project management?
- What expectations and recommendations do industrialists have of engineers' training institutions, for the environmental management of industrial projects?

2. PROBLEMATIC AND METHODOLOGY

2.1. Context of the Study

This section aims to describe the economic and political context concerning the involvement of industrialists and the organizations in a better environmental management of industrial projects.

2.1.1. Commitment of Moroccan Manufacturing Companies to Environmental Management

Today, the environmental issue is in the heart of all the concerns of public and private actors in Morocco. These actors are forced to rethink and reconsider economic models that might help solve the environmental problems. According to A. Laaroussi et al. this has generated a significant number of plans, strategies, programs, and several initiatives which have been put in effect so as to promote environment [1-2]. The government has recently paid a particular attention to the effective management of resources The COP22, organized in Morocco in 2016, in particular was the occasion to focus reflection and Moroccan industrial strategy on environmental questions [3].

To this end, several ISO 14001 certified manufacturing companies committed to projects integrating the new environmental dimension, through including all their activities. We can name a few examples: the OCP Group, Cosumar, Managem and Lafarge [4]. These industrial groups completed several environmental projects, which enabled them to integrate a circular economy. Today, design and implementation strategies of a global system to minimize environmental impact have appeared, through the Energy Efficiency Strategy, the Green Morocco Plan, and the National Strategy for Sustainable Development between 2015-2030 [5]. We should also mention the Sustainable Consumption and Production Patterns (SCPP) Action Plan in 2015 [6].

2.1.2. Commitment of the Organizations to Environmental Management

The management of environmental issues implies new approaches in terms of engineering, meaning the way in which the engineers must analyze the truth, identify the obstacles to be overcome and imagine suitable technological solutions. As for knowledge, they need to acquire new knowledge in terms of the environment (water, air, earth, the effect of chemical products etc.), manufacturing processes and production organization methods. As for intellectual approaches, they need to acquire new ways of thinking which move away from

the applicationist methods which until recently, governed their engineering procedures (in terms of applying technological innovations in the development of new products) [7-8].

The C20th century imposed a productivist mindset, which consists in using technical progress to imagine new products (objects, tools techniques) to put on the market, in the quest for short term profit. From the point of view of intellectual approaches, this mindset supposes specializing engineers in technical fields and training them to develop new solutions without thinking about the issues surrounding their use or their impact on the environment. This techno-centered productivist mindset, present in Moroccan and European schools, has been called into question today due to the necessity to take into account environmental constraints.

As for the engineers, it is a question of tackling the problems in a broader way, taking into consideration environmental issues from the word go (pertaining to different fields of knowledge), integrating socio-economic realities into the equation (eg.: qualification of operators, work organization, political context etc) and reflecting upon the long term consequences of the new production processes employed (waste management, pollution, water and energy consumption etc.). This engineering approach presupposes specific skills in the construction of problems (problematization), in a break from the techno-centered applicationist approach. It is illustrated by frugal innovation as conceived for developing countries [9]. In terms of training, this approach relies on a holistic approach to the construction of problems, which departs from the applicationist and reductionist approach in that it breaks down problems and reduces them to technical questions related to disciplines in view to developing a product. On the contrary, the holistic approach aims to take a global approach in tackling development problems in their entirety, not just from an economic and technical point of view, by accepting contingency and uncertainty, and starting from the needs generated by society and the environmental constraints.

On an international scale, we can observe that engineer training systems, inspired by this necessity, tend towards rethinking pedagogical approaches for better adaptation to the new needs. This tendency is a break with the academic mindset centered on the transmission of knowledge through scientific disciplines, in a movement towards the transmission of the ability to innovate and bring solutions to the needs generated by society. By breaking with lectures, destined to structure and pass on knowledge, and practical sessions which are designed to apply the knowledge acquired, the new pedagogies developed for engineer training are inspired by engineering practices in companies and more broadly, forms of innovation in society.

In particular, this takes place through problem and project based learning, company internships, the use of agile methods, and the implementation of fablabs [10]. Learning labs, living labs or even design schools [11-12]. These active methods inspired by companies are not new, but they are becoming more widespread in engineer training systems. In the context of globalization, this desire to develop active methods aims to counterbalance the tendency to academize which is stimulated by the systems of international and national professorial theses and accreditation, through recognizing institutions for their research and the academic renown of their teachers (scientific publications, financed research projects etc). Moroccan engineering schools, mainly inspired by French schools, have also seen this movement. Yet, their evolution is slow, and the answers brought by training do not necessarily correspond to the expectations and requirements of companies, in that it is difficult to define them. In this respect, there are problems in pinpointing the skills expected of engineers in the environmental field, and the methods that should be adopted in terms of training. It is to this end that this study of a group of Moroccan manufacturing companies aims to contribute, in order to improve the determination of their policies in terms of environmental management and the skills that these companies expect.

2.2. Methodology and Study Approach

The government has recently paid a particular attention to the effective management of resources, and is encouraging green training for engineers who have the key skills to conduct and assess the major development projects. In this context, we have conducted a global survey and collected data from seven industrial sectors in Morocco. Accordingly, this study takes into account the scientific context of the management of industrial projects managed by Moroccan engineers. Also, it does put the emphasis on assessing the mastery of environmental management in industrial projects.

To be able to capture this level of mastery, the strategy, on the one hand, consists of assessing the environmental footprint in the operational decision-making phase in project management. On the other hand, it includes an analysis of the expectations and recommendations expressed by the industrials. For this reason, this study is based on both quantitative and qualitative approach as defined by John [13]. This will greatly help in examining and assessing the industrial projects, in the aim to improve the sustainable performance of Moroccan industries.

In order to identify the purpose of the research, we used the ISO 14031 Standard 2013 as a guideline for the object of our research. It identifies the measurable results of an organization's EMS (Environmental Management System), in connection with the control of its environmental aspects [14-15]. It provides guidelines on the design and use of an environmental performance evaluation of an organization.

In this regard, many organizations look for a means to comprehend, demonstrate and improve their environmental performance. They can succeed through more efficient management of the elements of their activities, products and services which may lead to significant environmental impact. The current international Standard has established a process called Environmental Performance Evaluation (EPE) which enables an organization to evaluate and communicate their environmental performance.

It aims to examine the company's environmental policy in depth, through its objectives to reduce the consumption of energy, and resources which are difficult or costly to renew. Note that the company can choose its own evaluation indicators according to its strategy.

The evaluation of the performance of the company can be measured by using the following Environmental Performance Indicators (EPI):

- The Management Performance Indicators (MPI), which provide information on the actions accomplished by executive directors to influence the environmental performance operations of the company;
- The Operational Performance Indicators (OPI), which give information on the environmental performance of the operational process within a company [16].

Our method of constructing evaluation indicators was based on the ISO 14031 Standard. Therefore, our assessment of industrial operational performance through the projects revolves around the integration of 3 indicators: water resource management, industrial waste management and energy management. These three themes are considered to be the most problematical in terms of Moroccan industrial policy towards environmental protection by the Energy, Climate and Green Economy Commission (ECGEC) of the General Confederation of Moroccan Companies [17]. The choice of these three strategic themes had to enable the best comparison of the forms of environmental commitment of the engineers and their companies.

2.2.1. Questionnaire Design

The questionnaire was drawn up using the literary review and the ISO 14031 Standard as a basis for the themes covered. It was destined for the industrial managers of the engineers, that is to say, those in charge of the environment, energy and production. The questionnaire was constructed using open and closed questions requiring single answers. In its construction, we concentrated on two types of information: information relative to the managers answering, and the technical background of the engineering teams in the industrial projects.

We chose to analyze the operational decision-making process of industrial projects basing our approach on three indicators, and two measurement criteria. The first measurement criteria aimed to evaluate the degree of importance that the proposed indicator's inclusion in the project management held for the industrial managers. The second criteria expressed the degree of satisfaction that the heads and their engineers held for the mastery of the environmental footprint in project management.

2.2.2. Indicators and Evaluation Criteria

The efficient management of water, waste and energy, major issues for all Moroccan companies, constituted the evaluation indicators that we denoted as C1, C2 and C3.

C1: Efficient water resource management: The taking into consideration of the economic intelligence approach which aims to master the risks concerning water and to reduce the (direct and indirect costs) linked to the industrial project.

C2: Sustainable waste management: The commitment to a process which minimizes and manages industrial waste, which takes into consideration recovery and recycling options.

C3: Efficient management of energy resources: The integration of energy consumption optimization in relation to projects.

These indicators enable the measurement of the efficiency and environmental awareness of the engineers involved in the industrial projects, during the processing phases and validation of the project's decisional process. We based the work carried out for this study on two criteria:

Level of importance: This consisted in measuring the importance of the integration of the three indicators proposed in the operational decision-making process for industrial projects, from the point of view of the managers who supervised industrial projects.

Level of satisfaction: Consisted in measuring the managers' satisfaction in their young, multidisciplinary teams, in relation to the level of environmental mastery in the operational decision-making process of projects.

In the survey, we used the Likert scale with 3 modalities to evaluate the two chosen criteria, that is to say, the Level of Importance and the Level of Satisfaction, by establishing the rating values as follows:

Table 1

Value of the Level of Importance	Value of the Level of Satisfaction
1 : unimportant	1 : not satisfied
2 : slightly important	2 : moderately satisfied
3 : very important	3: properly satisfied

2.2.3. Questionnaire Pre-test

The questionnaire's pertinence was validated thanks to a pre-test on several industrialists who occupied different jobs: Head of Maintenance, Head of QHSE, Head of Industrialization, Head of Quality, and Head of Continuous Improvement. This pre-test enabled us to bring a few modifications to our questionnaire such as the reformulation of several questions and the redefinition of the rating scale.

2.3. Study Process

2.3.1. Unity of Observation

The survey questionnaire was designed to receive data from manufacturing industries on Moroccan territory. The survey aimed to obtain answers from all types of companies: LE (Large Enterprises), ISE (Intermediate Sized Enterprises) and SME (Small to Medium Enterprises).

2.3.2. Geographical Survey Area

The boundary of the chosen field of study was drawn around a pioneering Moroccan region which contains a large number of industries and which generates a significant amount of air pollution. The Grand Casablanca region was chosen as it is home to the highest concentration of factories in the whole of Morocco and a high percentage of Moroccan manufacturing establishments. This region was also selected due to the desire to be able to compare companies found in comparable environments.

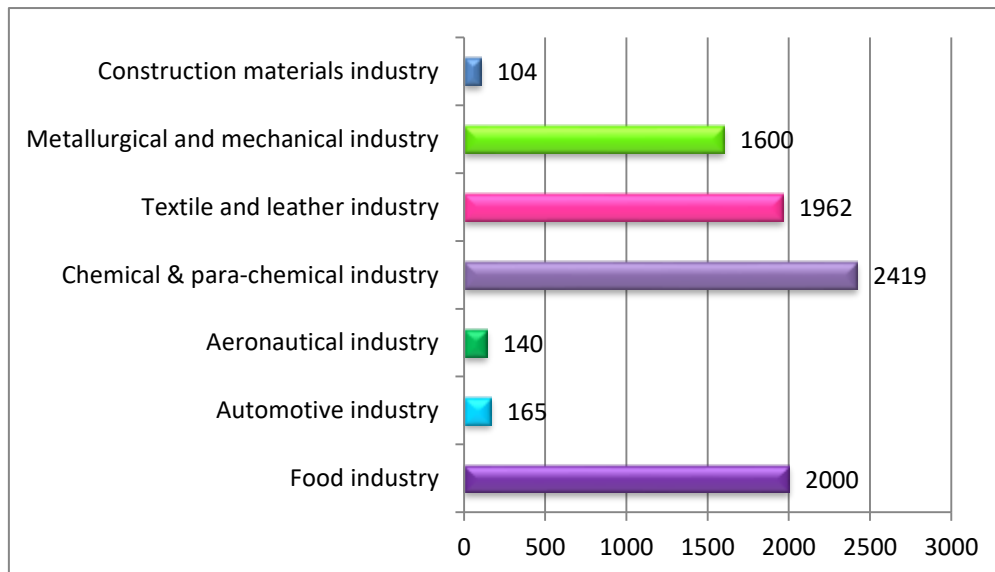


Figure 1 Number of industrial companies operating in Morocco per sector of activity (Author's calculations)

3. RESULTS

3.1. Sample Characteristics

The survey questionnaire was sent to 200 industries, via several means: email, sharing the questionnaire on social networks and visiting the industrialists.

The study presented concerns the analysis of the data gathered in seven Moroccan industrial sectors. This choice is justified by the fact that the latter are major consumers of raw materials such as water and energy, and they have activities which are polluting and generate waste. We received answers from 106 industries from these seven sectors, from industrial

managers having supervised a total of 174 industrial projects. The engineers who worked on these projects had six different engineering backgrounds, that is to say: the environment, industry and logistics, energetics, electrical engineering-electronics, mechanics and textiles. It is interesting to point out that 62% of the companies surveyed had been certified ISO 14001.

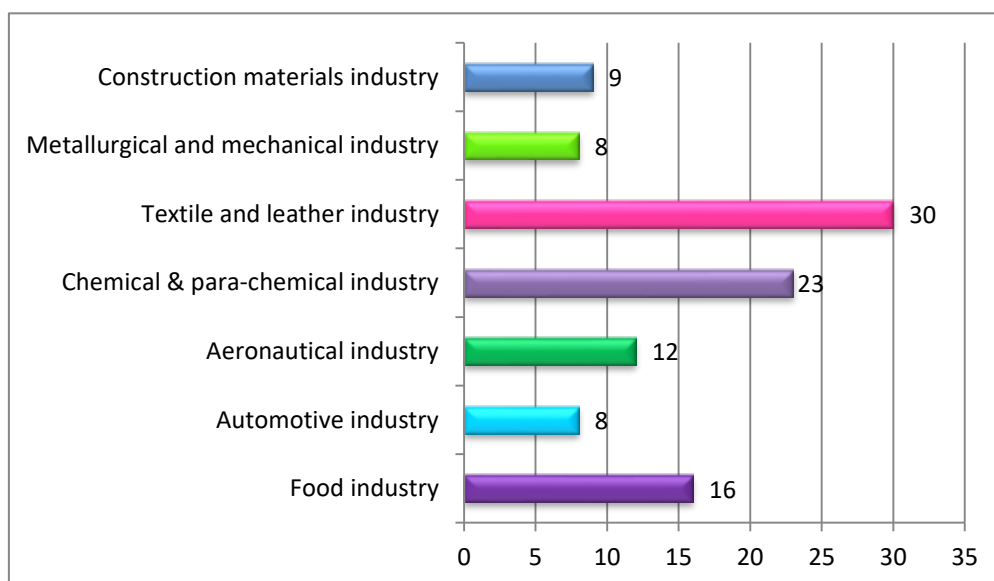


Figure 2 Number of respondents per sector in the Casablanca region (Author's calculations)

It is important to bear in mind the division of the 174 industrial projects per sector of activity and background of the engineers for the 106 companies that took part in our survey. That is what Table 1 below represents.

Table 1 Distribution of Projects Handled per Background and per Sector

Industrial sectors	Distribution of projects per engineering background						Total projects processed per sector Σ	Number of projects processed in%
	Environment background	Industrial & logistics background	Energetics background	Electrical-electronics background	Mechanical background	Textiles background		
Food	11	9	2	0	2	0	$\Sigma=24$	13%
Automotive	4	6	0	8	7	6	$\Sigma=31$	17%
Aeronautical	3	5	0	4	6	3	$\Sigma=21$	12 %
Chemical & para-chemical	10	7	2	0	3	0	$\Sigma=22$	16 %
Textile & leather	3	8	2	0	2	28	$\Sigma=43$	24 %
Metallurgical & mechanical	2	4	6	0	7	0	$\Sigma=19$	10 %
Construction materials	2	1	4	0	7	0	$\Sigma=14$	8 %
Total projects processed per engineering background Σ	$\Sigma=35$	$\Sigma=40$	$\Sigma=16$	$\Sigma=12$	$\Sigma=34$	$\Sigma=37$	$\Sigma=174$	
Number of projects processed in%	20 %	23 %	10 %	7 %	19 %	21 %		

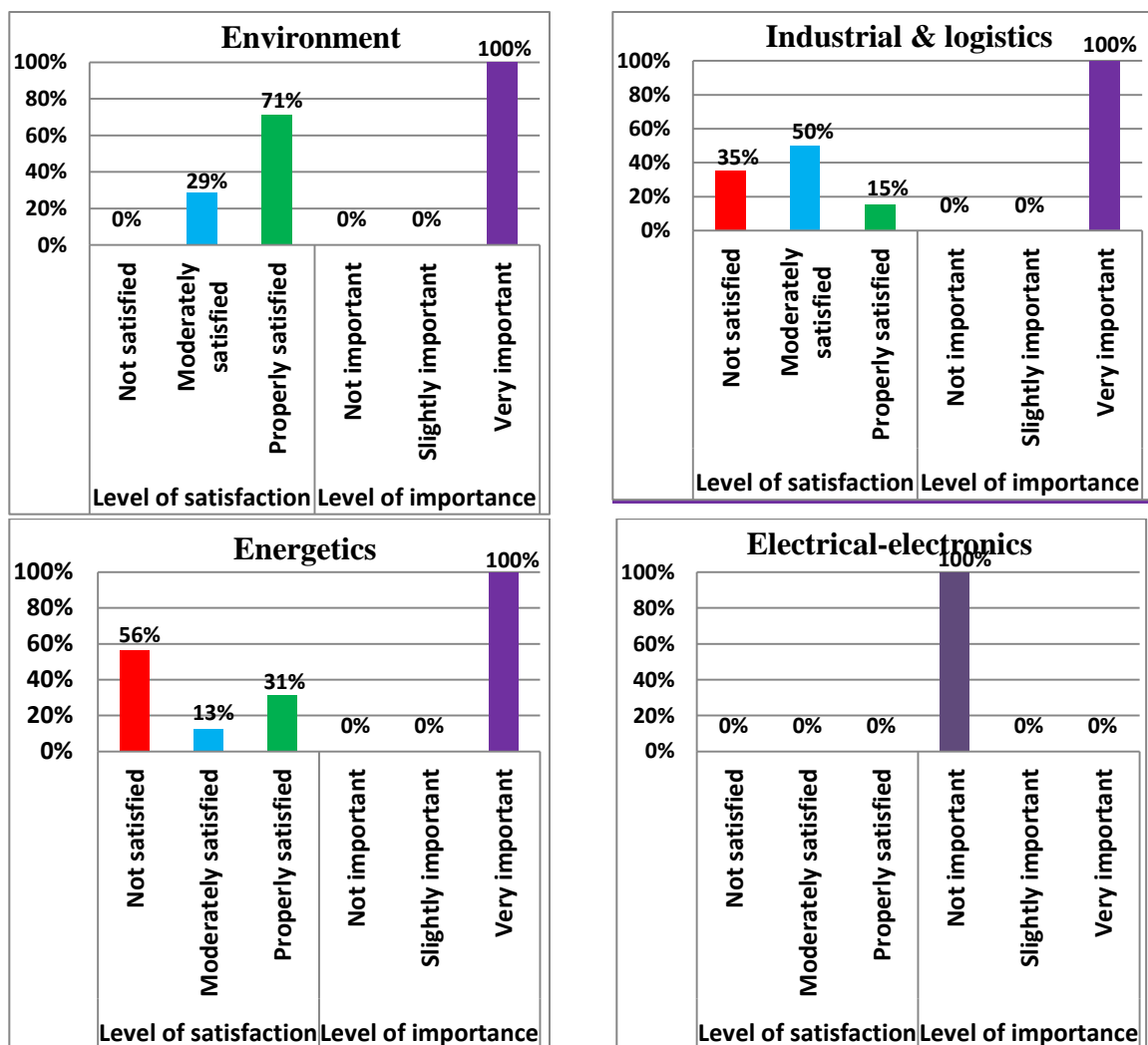
For a total of 174 projects, only 20% were handled by engineers who were specialists in the environment, the rest of the projects were handled by engineers from different backgrounds: industry-logistics, energetics, electrical engineering-electronics, mechanics and textiles.

3.2. Results and Analysis of the Integration of Indicators in the Operational Process of Projects

In this part, we present the results in relation to the two criteria defined, that is to say, the importance and the mastery of the integration of the indicators in the operational decision-making process of projects. We have evaluated the importance of the integration of three types of selected environmental performance indicators in the project management process. Which are as follows: efficient management of water resources (C1), sustainable waste management (C2) and efficient energy management (C3). For more details, the projects are led by engineers from Moroccan schools having different educational backgrounds (the environment, industry and logistics, energetics, electrical engineering and electronics, mechanics, textiles). Thus, we have correlated these results with the satisfaction of industrial managers of their engineers at the level of taking these indicators into account in the operational decision-making process.

3.2.1. Results and Analysis of the Projects Relative to the C1 Indicator

Through the following graphs, we shall illustrate the data gathered from the survey of the industrialists in relation to the efficient management of water resources in the management of industrial projects according to the background of the engineers.



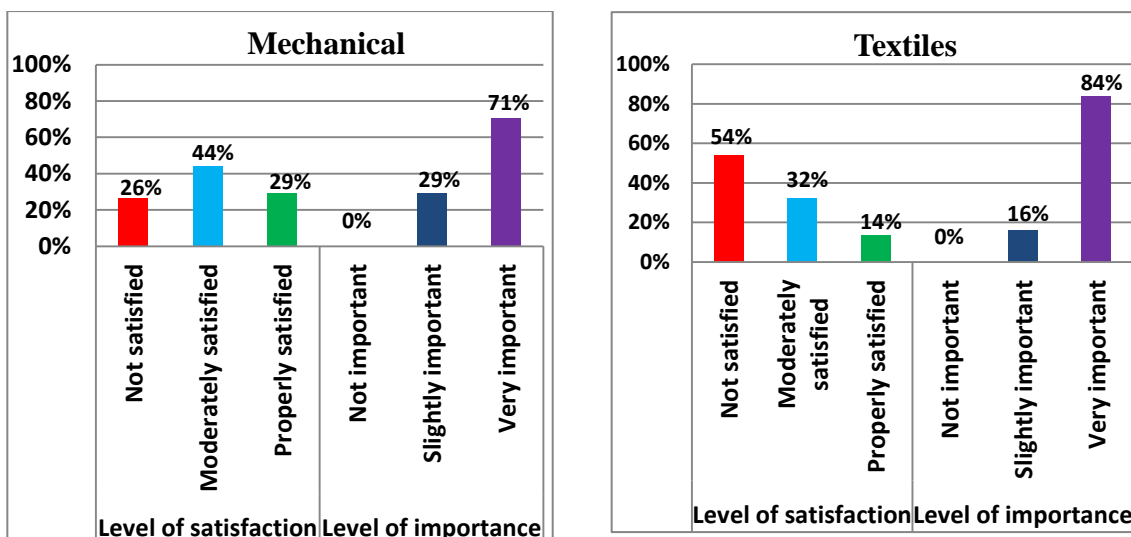


Figure 3 Results of importance and mastery related to the integration of C1

These graphs show that the integration of C1 criteria in the operational decision-making phase of projects remains high, and shows a variation of between 71% and 100%. This confirms that the industrial respondents judge that water management is important in the projects handled by engineers from different backgrounds except those handled by engineers specializing in electrical engineering-electronics. This could be explained by the fact that the projects handled by engineers from this background (operating in the automotive and aeronautical sectors) did not require this resource.

Moreover, the graphs show that the satisfaction measured for the level of mastery of the integration of water management does not even reach average for most of the specialist backgrounds. It is interesting to point out that, for the engineers specialized in the environment, it reaches 71%.

These graphs demonstrate that there is no correlation between the level of importance and the level of mastery of the integration of the water management indicator in the operational decision-making phase of projects, except for engineers specializing in the environment. We can suppose that the latter, having received initial training which made them aware of this question, are thus more concerned by good mastery of water management.

3.2.2. Results and Analysis of Projects Relative to the C2 Indicator

In this section, we shall present the results in relation to the sustainable management of waste in piloting the industrial projects according to the background of the engineers.

The analysis of the below graphs shows that the industrial respondents judge waste management to be important for most projects handled by engineers with different backgrounds. Except those projects handled by engineers specializing in mechanics (operating in the metallurgy and mechanics, construction material and automobile sectors), for whom the importance reached 59%. This can be explained by the fact that the project resolution did not require the proposal of environmental solutions integrating efficient waste management, inasmuch as their projects were based on studies, modeling, sizing and design of the mechanical systems.

Improving the Environmental Performance of Moroccan Industries: An Assessment Study of Industrial Projects

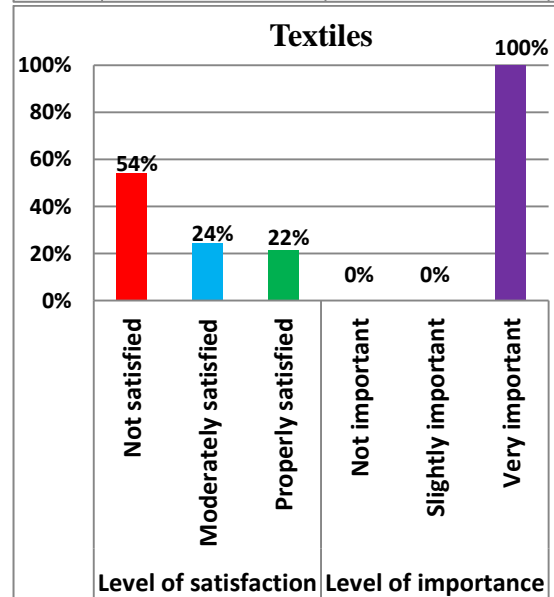
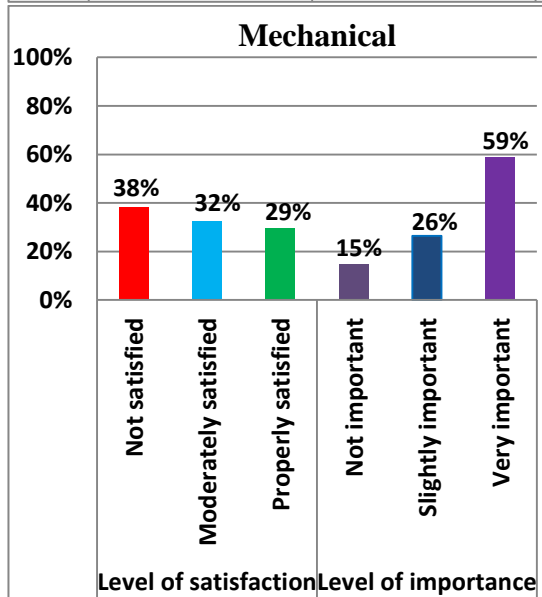
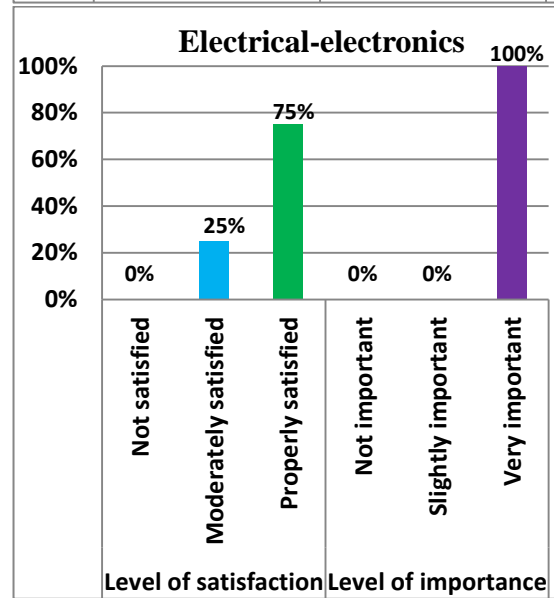
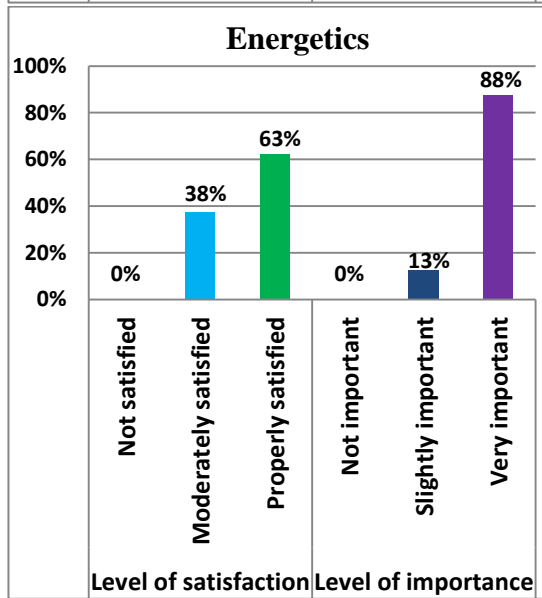
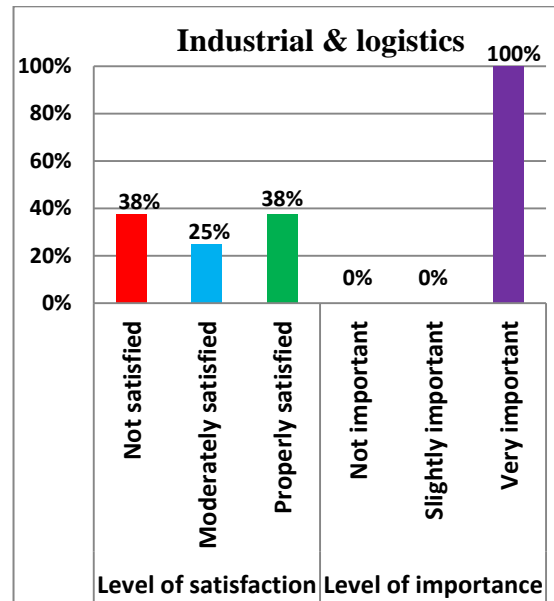
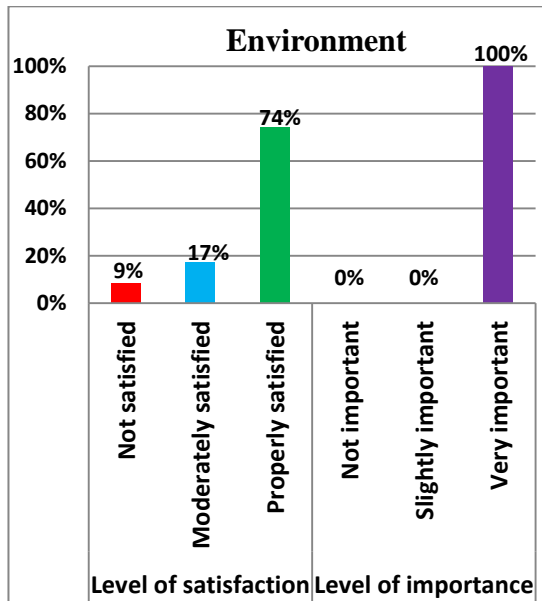


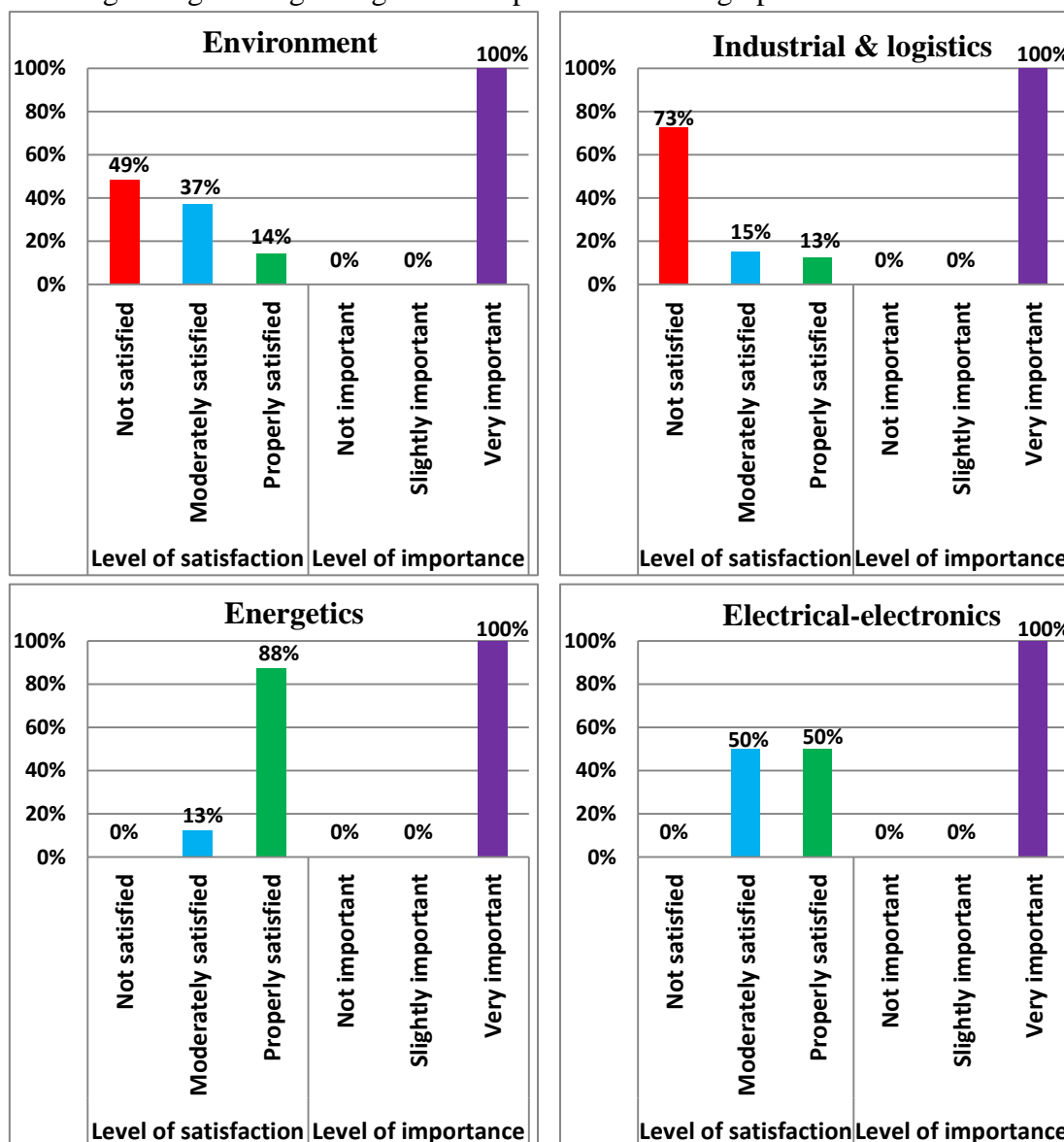
Figure 4 Results of importance and mastery related to the integration of C2

We notice that the level of satisfaction shows a good score for those from environmental, electrical-electronic and energetic backgrounds. This shows a better correlation between the level of importance and the level of mastery.

However, it is interesting to highlight the poor correlation between the level of importance and the level of mastery of waste management in projects handled by engineers. Which are specializing in textiles, industry and logistics (two sectors which generate much waste: pollution and chemical products). This observation calls into question the training given on the environment in Moroccan engineering schools.

3.2.3. Results and Analysis of Projects Relative to the C3 Indicator

The results relative to the efficient management of energy in piloting industrial projects according to engineering background are presented in the graphs below:



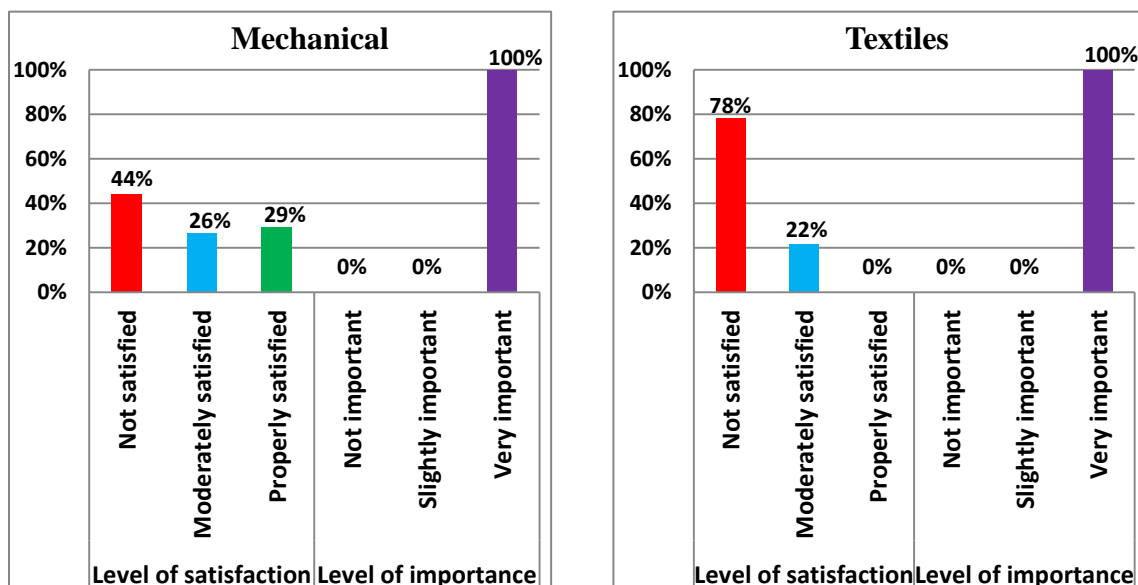


Figure 5 Results of importance and mastery related to the integration of C3

Energy management is very important in the project management process. It represents a concern for all the industrialists who are looking to develop good consumption management to reduce their energy bills.

The analysis of the graphs above show that the level of importance is very high. Thus, it reaches 100% for the integration of efficient energy management in the operational decision-making process of industrial projects handled by engineers, whatever their background.

It is important to point out that the engineers specializing in energetics master energy management well in industrial projects; the results indicate an interesting level of satisfaction with a score of 88%. This confirms a good correlation between the importance and the mastery of energy management integration in projects handled by engineers specializing in energetics.

However, the level of mastery remains poor and shows a level of below 50% for the other backgrounds. Most engineers occupy positions in the most energy-consuming sectors such as textiles and leather, agri-food, chemistry and parachemistry and metallurgy and mechanics. This fact confirms the poor correlation between the two criteria.

These results all show the importance of the initial training received in Moroccan engineering schools, in taking into account the environmental dimension in professional activity.

To finish this study, we propose a simple model that the Moroccan engineers, whatever their background, could adopt in the management of projects for better industrial ecology. It is constructed from the results of the surveys.

The objective of this model is to offer a means of characterizing in concrete terms the extent of environmental awareness of engineers who pilot industrial projects. It takes the form of three environmental performance indicators in the classic project piloting process, that is to say: the management of energy and water resources, and sustainable waste management.

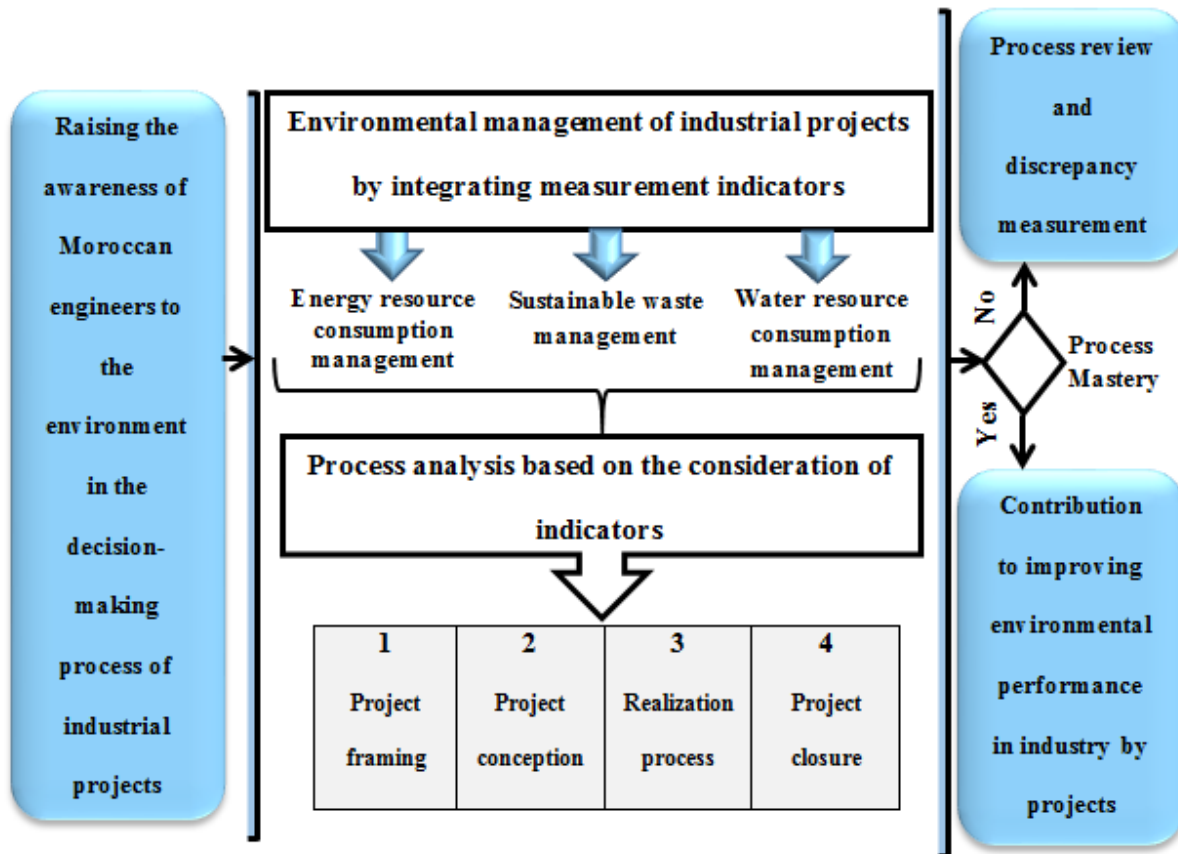


Figure 6 Process model for environmental management of project

The model also enables the evaluation of the level of mastery of the indicators during the project management process and the determination of whether the process still requires revision through measuring the discrepancies. Our aim, through this model, is to contribute to the improvement of industrial environmental performance and thus to answer Moroccan national policy for the mastery of resources.

3.3. Results and Analysis of the requirements for Engineering Skills in Managing Projects in an Environmentally Friendly Manner as Expressed by Industrialists

The last questions asked through the survey were open questions enabling the people asked to express how they saw engineer training. They were asked, on the one hand, to give their recommendations on the quality of the training in relation to the management of environmental issues in projects, and on the other on engineer training in general. Through their answers, the company heads interviewed all insisted on the need to break away from lessons perceived to be too theoretical, to become more practical. This wish is justified by environmental concern and also more broadly by the need for companies to favor recruitment of young engineers whose profile suits the requirements of their job in the company. Especially, respondents stressed the need to involve professionals from the industrial sector in training courses. This is a condition to break away from lectures oriented towards scientific content, and to move towards practice through projects. As one of the respondents stated « Focusing on the practice rather than the theory, consists in focusing on case studies, projects, workshops in partnership with companies, field visits, using advanced technological equipment to help the engineers simulate the industrial processes within companies in an environmental way ». The respondents who were trained engineers talked about the pedagogical methods that they considered desirable. For the content, the industrialists

questioned called for the development of knowledge and know-how, through the integration of certain subjects which they judged to be obligatory, whatever the engineering profile, such as environmental law, and the ISO 14001 Standard. They also wished to develop broader environmental management approaches, through the study and simulation of concrete projects on “environmental issues”.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Different Levels of Requirement

We can perceive a certain tension between the productivity and yield constraint, and that of taking into consideration the environmental necessity in broad terms. In certain cases, the industrial heads interviewed interpreted consideration of the environment to be respect for the instructions given by the company, for example: “the policy to reach the goal to reduce CO2 by optimizing travel, and meetings held between branches and agencies by videoconference”. It was thus a matter of «respect for the environmental indicators», and the standards, sometimes with the aim of certification. In other cases, the engineers in companies stated the need for broader awareness, as expressed by an interviewed manager: “Moroccan industrial engineers always aim for operational excellence though the optimization of the process. They forget that through considering the environmental issues, they are following a sustainable approach which will conserve the resources that they are using today”. It is no longer a matter of being skilled in knowing the rules and constraints. It is also a question of acquiring sensitivity, a way of thinking and an awareness which are part of a general approach. These different types of requirement thus suppose in training terms, different levels of skills need to be developed.

4.2. Skills to be Developed in the Engineering Curriculum

The different levels of skills in terms of know-how required by the professional environments have thus emerged. Firstly, it is a matter of acquiring knowledge and know-how, such as legislation and standards for example. On another level, industrial professionals are calling for the development of skills and know-how in project management, industrial management, process management enabling, for example, the “development of innovative solutions for renewable energies”. Beyond that, it is a matter of the development of an ethical awareness geared towards sustainable development, an ability to understand problems in their entirety, to guide their activity.

4.3. Decompartmentalized Approach

The industrial professionals interviewed spoke about initiatives that they themselves had set up in their companies, such as awareness sessions each month for team leaders, communication campaigns via the intranet, or even events such as an annual tree-planting campaign to celebrate World Environment Day for example. These initiatives could be strengthened by training sessions that they could set up in their companies, and by the training initiatives that they offer and that they can carry out in engineering schools. We thus observe that these professionals have a decompartmentalized vision of engineer training. Their proposals to have professionals participate in the initial training of engineers, to hold joint workshops, field visits, joint projects or even awareness projects from the very first year of school, all head in the same direction of forming a better association and bond between the industrial and academic worlds in terms of environmental performance and beyond. The environmental management of projects in training programs should be continuously reworked between the school and the company. These are the perspectives for the evolution of engineering school curricula in Morocco.

ACKNOWLEDGEMENTS

The authors of this article would like to thank the Moroccan industrialists who took part in this survey. They also thank the National Center for Scientific and Technical Research (CNRST) of Morocco as well as the PHC Maghreb Project managers for financing this research work.

REFERENCES

- [1] A. Laaroussi, S. Bakkali, and O. Cherkaoui, Role of industries and higher school of engineering towards green industrialization and green economy: Morocco case study, Conf. on Research in Education and Science, Ephesus-Kusadasi, Turkey, 2017, 67-71.
- [2] A. Laaroussi, S. Bakkali, S. Ajana, and O. Cherkaoui, Qualitative Analysis of Environmental and Technical Practices Mobilized in North Africa: Case Study of a Moroccan Textile Company, *International Journal of Academic Engineering Research*, 4(11), 2020, 16-30.
- [3] M. Houzir, De la COP21 à la COP22 : Bilan et perspectives pour le Maroc, 2017. Retrieved from https://ma.boell.org/sites/default/files/cop_21-22.pdf. Accessed 8 June 2020.
- [4] L. Barmaki, and D. Aitcheikh, Développement durable et management : Quel lien ? Pour quelle performance ? Cas de six entreprises industrielles marocaines, *Revue Congolaise de Gestion*, 22(1), 2016, 11-44.
- [5] UNESCO, *Stratégie nationale de développement durable 2030, 2017*. Retrieved from <https://fr.unesco.org/creativity/policy-monitoring-platform/strategie-nationale-de>. Accessed 11 Mars 2020.
- [6] SwitchMed, *Plan cadre national pour la consommation et production durables Maroc, 2016* Retrieved from <https://www.switchmed.eu/fr/news/actualites/le-maroc-lance-son-plan-cadre-national-sur-le-mcpd-et-deux-plans-sectoriels-sur-le-batiment-durable-et-l'alimentation-durable>. Accessed 3 Janv. 2020.
- [7] D. Lemaître, (Ed.), *Training Engineers for Innovation*. London: ISTE & Wiley, 2018.
- [8] G.E. Cardona, L. Gardelle, and B. Tabas, *From Technological Innovation to « Situated » Innovation: Improving the Adaptation of Engineering Training to the Societal Challenges of the 21st Century*, In D. Lemaître (Ed.), *Training Engineers for Innovation*. London: ISTE Editions & Wiley, (2018) 3-20.
- [9] N. Radjou, and J. Prabhu, *Frugal Innovation: how to do more with less*, London: The Economist, 380, 2015.
- [10] C. Bosqué, History of FabLabs: Origins, purposes, development and new directions. In M. Menichinelli (Ed), *FabLab. Revolution Field Manual*, Rome: Niggli Verlag, 272, 2017.
- [11] T. Kelley, and D. Kelley, Reclaim Your Creative Confidence. *Harvard Business Review*, 90 (12), 115-124, 2012.
- [12] K. Mulder, D. Cheryl and C. Karlson, Sustainable development as a meta-context for engineering education. *Journal of Sustainable Development of Energy, Water and Environment Systems* 1(4), 304-310, 2013.
- [13] J.W. Creswell, *Research Design Qualitative, Quantitative, And Mixed Method Approaches*, SAGE, 273. 2014.

Improving the Environmental Performance of Moroccan Industries: An Assessment Study of Industrial Projects

- [14] M. Hora, and R. Subramanian, Relationship between Positive Environmental Disclosures and Environmental Performance: An Empirical Investigation of the Greenwashing Sin of the Hidden Trade-off. *Journal of Industrial Ecology*, 23, 855-868, 2019.
- [15] M. Martin, Evaluating the environmental performance of producing soil and surfaces through industrial symbiosis. *Journal of Industrial Ecology*, 24(3), 2019, 1-13.
- [16] H.Tajri, M. El Hammoumi, and B. Herro, Mesure de performance d'un système de management environnemental (SME). Cas de la maintenance industrielle. Xème Conf. Conception et Production Intégrée, Tanger, Maroc, 2016.
- [17] A. Belhaj, La problématique environnementale, une question de compétitivité économique, 2016.