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Analysis of the relevance of the location of quarrying surfaces by using a multi-criteria decision support tool taking into account the sustainable territorial development (Case of Settat – Morocco)

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ABSTRACT

The cohabitation between the material extraction activity and its receiving environment requires a conciliation between the three dimensions of sustainable development, namely the economic, social and environmental aspects. Given that the reasons for the existence of this extractive industry are economic, it feeds the pillar sectors of the economy (civil engineering, buildings ...) or, social it creates employment and contributes significantly to the revenue of local communities through taxes but it has disadvantages on the receiving ecosystem. The problem is to know how to make this sector a vector of economic development without compromising the environment in order to guarantee and ensure simultaneously economic growth and social equity and environmental protection and to make the territory more attractive and sustainable to investments in this field. Therefore, it has become necessary to take into account these three pillars when locating this activity. The said location is an essential decision, the fact of favoring one of the three aspects over the other aspects will undoubtedly have consequences on the environment where the activity is hosted (either more positive or more negative, conditioned by its choice). Indeed, the choice of quarry sites is a multi-criteria issue since we must reconcile the three imperatives of sustainable development which are often contradictory. In this sense this work has opted for a decision-making approach designed from a decision-making tool process of hierarchical analysis (AHP), said approach is based on the three axes of sustainable development (economic, social and environmental) which are subdivided into 16 criteria and apply on options (15 careers). The choice of criteria families, criteria and options was made while respecting the imperatives of sustainable development and according to their distributions and typologies at the level of the study area. Once these decision elements were identified, the attractiveness of the options on each criterion was evaluated, weighted according to the concerns and preferences presented by the decision-makers and then aggregated by the AHP method in order to produce a hierarchy of the criteria and options. The implementation of this method allows for the evaluation of existing quarry operations in the study area and the forecasting of future optimization of quarry facilities.

Key words : *Environmental consideration, Sustainable territorial development, Location of quarrying, Decision-making approach AHP method.*

Introduction

The importance of the extractive industry in the socio-economic development is certain since it supplies the fundamental sectors of the economy (civil engineering, buildings, etc.). It also generates significant additional revenues for local authorities through taxes, in addition to creating employment and contributing to the consolidation of the local economic fabric thanks to the increase in the purchasing power of the local population.

However, due to its nature and the means and methods of extraction used, this activity produces negative effects on the receiving territory, but thanks to the relevant selection of the exploitation sites according to certain conditions (conciliation between the three axes of sustainable development) can help enormously to reduce its possible negative impacts and to consolidate those that are positive.

In this regard, a decision-making approach integrating the three components of sustainable development (economic, social and environmental) must be adopted to strengthen environmental protection.

Decision makers faced with decision problems, especially when there are many alternatives and various perspectives to consider, may need to adopt a multi-criteria approach to evaluate different scenarios (Ben Mena, 2000). The design and implementation of a value system, within which decisions are to be made, is a critical step in multi-criteria decision analysis (MCDA) (Belton and Stewart, 2002).

This system will reflect the order of attractiveness of the options chosen by the decision makers, as well as the difference in their relative attractiveness (the strength of the decision maker's preference for one option over another). They are then scored and ranked to generate a scale for each criterion (Von Winterfeldt and Edwards, 2007).

In this context, we have seen the emergence of decision support tools in recent decades and many methods have been developed (ELECTRE, AHP, MACBETH, PROMETHEE, etc.). The use of these tools allows decision-makers to find the most suitable solutions to problems faced when the points of view are contradictory and must be taken into consideration.

Indeed, and to meet the need to integrate these three aspects in the decisions to evaluate this activity we proposed a decision-making approach consisting of a tool to assist in decision-making hierarchical process analysis (HPA) for the selection of sites favorable to the establishment of quarries in the study area (Settat province Morocco). The methodology used is based on three families of criteria, namely economic, social and environmental, which are subdivided into 16 criteria applied to 15 quarries (alternatives).

In this sense and for the same purpose, the objective of this work is to provide decision makers with a decision support tool to evaluate the opening and operation of quarries in the study area (Settat Province). The tool chosen will allow the integration of the three dimensions of sustainable development (economic, social and environmental) and this to choose the best sites for the establishment of quarries that represent less disadvantage.

The research methodology of this work was carried out through a literature review, followed by tools and methods, and finally applied on the territory of the province of Settat (study area) in Morocco.

All this leads us to ask the following questions How can material extraction be reconciled with sustainable socio-economic development and environmental protection?

2) What are the criteria to better choose the location of the quarries?

How can we assess the current situation and consider the possibility of optimizing future locations?

The originality of this work lies in :

Prove the importance of the three dimensions of sustainable development as factors of development and growth;

The weighting of the pillars of sustainable development in order to highlight the impact of these pillars in the act of investment and as a trigger for a sustainable economic dynamic.

Materials and Methods

Presentation of the study area

The study area (Settat province) is part of the Casablanca - Settat region (According to the latest administrative division of 2015). In the center of Morocco, it covers an area of more than 7200 m ^{2} and has 46 local authorities. The capital of the province is the city of Settat.

Geologically it has a very important deposit potential subdivided into three structural subfields

The area of the Coastal Meseta covers the western part and the northern part;

The plateau of Settat - Ben Ahmed is part of the phosphate plateau; the Rehamna massif constitutes the southern part (Hattabi *et al.,* 2020; Hattabi *et al.,* 2022).

This asset makes this territory one of the most attractive territories for investors in the field of quarrying, and its proximity to the large consumption basin makes it very privileged for investment in this sector.

Given the 61 quarries operating in the study area, it is an appropriate sample for this study

Context, problematic

The importance of the quarrying sector in the socio-economic progress of the territories is undeniable, since it feeds by raw material the pillar sectors of the economy. It contributes significantly to the increase of revenues and constitutes important budgetary resources for local communities through taxes and taxes of extraction of materials, in addition it generates direct and indirect employment that allows increasing the purchasing power of the inhabitants and improves the economic dynamics and constitutes one of the most important vectors of local economic development. But it negatively affects the receiving environment by various nuisances.

Therefore, it has become necessary that stakeholders in the exploitation of quarries act to address this malfunction in order to achieve sustainable development, adopt a rational and sustainable management, and combine the three conditions necessary for this development to consolidate the protection of the environment, in order to achieve economic viability, the creation of wealth, while maintaining social equity and without disadvantaging the natural environment.

For this approach to be successful, appropriate measures must be taken (the precautionary principle) and tools must be put in place to assess the impacts of activities that could harm the environment (the preventive principle).

State of the art

The emergence of the use of decision methods whose objective is to help decision makers formalize an adequate choice (ELECTRE, AHP, MACBETH, PROMETHEE, etc.). The use of one of these methods facilitate decision makers to make the best choice decisions (Piton *et al*., 2018).

Yu (1992) showed the importance of the ELECTRE TRI method and the main difficulties that the traditional approach could face. He also proposed a conceptual scheme of multi-criteria analysis in the context of sorting, and some basic concepts and also illustrated the scope of the synthetic outranking approach in a more concrete way.

Saaty (1995) presented five examples of applications of the AHP hierarchical analytical process to select the best benefit/cost mode in a variety of situations.

Maystre, L.Y. (1997) justified the application of an approach to deal with environmental problems and showed the usefulness of ranking methods and their importance as suitable and relevant instruments in negotiation processes with the aim of ensuring consensus while giving an illustrative example using the ELLETRE III method.

Bana E Costa *et al.* (1999) presented the main foundations and ideas on which the MACBETH decision support method is based.

Saber-Mouhssine Rhazi *et al. (*2006) used remote sensing and geographic information systems to assess the dynamics of the landscape in a wooded area of the province of Ben Slimane (Western Morocco). This is to explain the causes, and to provide elements for management and sustainable conservation of this natural heritage.

Ishizaka *et al.* (2009) applied the AHP method to model problems, using, pairwise comparisons, judgment scales, derivation methods, consistency indices, weight synthesis and sensitivity analysis and the limitations of AHP.

Franek *et al*. (2014) examined the effects of using various judgment scales in the AHP method, as well as analyzing their impacts on the priorities obtained and consistency with the default scale proposed by Saaty.

Erdogan *et al.* (2017) proposed the use of AHP method and choice expert software to identify and solve the main problems of construction management (choosing the right contractor, risk management).

Piton *et al.* (2018) proposed the use of the AHP method for integrated river management and flood protection in the Grand Büech watershed (Hautes Alpes). This tool is based on socio-cultural, economic and environmental criteria, in order to evaluate the different scenarios of watercourse management, to allow the project owners to choose the best development scenarios and to orient the intervention of financial partners in the projects.

Rakotoarivelo, J. Ba (2018) used the multi-criteria method AHP to identify the risks of operations of credits and financial investments presented by banks or financial institutions to customers and to deploy the know-how on the identification of different types of risks related to this activity.

In this sense, this work aims to provide decision-makers with a decision support tool, the hierarchical analysis process (AHP), to assess the opening and operation of quarries in the study area (Settat province). The chosen tool can integrate the three dimensions of sustainability (economic, social and environmental) to select the most favorable quarry sites and the least restrictive for the receiving environment.

The assets relating to the deposit potential make the area one of the most attractive for investors in the quarrying sector, and in addition its proximity to the large consumption basin of materials makes it a major asset for investing in this sector. With 61 quarries operating in the study area, it constitutes an appropriate sample for this study.

Construction of the AHP Decision Making Model

The AHP (or hierarchical multi-criteria analysis) method (Saaty, 1995) is a vigorous and comprehensive tool created to assist in informed decision making using both empirical data and subjective judgments of the decision maker. It participates in the decision-making process by providing decision-makers with a structure that allows for effective organization and evaluation of the importance of various objectives and preferences of alternative solutions for a decision. And this through the calculation of a synthetic score (value between 1 and 9) that will be aggregated and calculated according to the ranking and weighting of all criteria considered in the decision.

This approach consists of four steps: In the first step, the problems must be identified and possible solutions or scenarios defined. In the second step, the consequences of the actions are analyzed, criteria are developed and each action is evaluated on the criteria (performance table). In the third step, we establish a model of the global preferences and procedures for aggregating the performances (criteria to be retained as well as their relative importance) and finally the last step constitutes the multi-criteria synthesis (analysis of results, sensitivity).

In his 1995 paper Thomas Saaty specified that the Analytic Hierarchy Process (AHP) is based on four principles (Figure 1):

Decompositions: a complex problem is decomposed into a hierarchy, each hierarchy consists of several manageable elements, each element is also decomposed in turn, etc.

Hierarchy: the impact of the elements of the hierarchy is assessed by making pairwise comparisons separately with reference to each element of the previous level.

Synthesis: an overall assessment of the available alternatives is provided and the priorities are gathered through the principle of hierarchical composition.

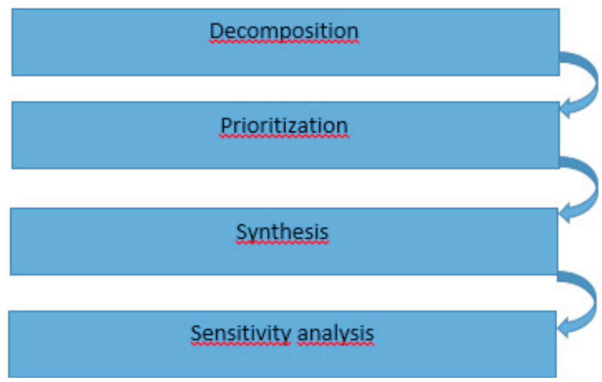


Fig. 1. Showing the four principles of the AHP method stated by Thomas Saaty (1995).

Sensitivity analysis: The stability of the results in the face of changes in the importance of the criteria is determined by testing the best choice in the face of what changes in the priority of the criteria.

The decomposition of the problems under a hierarchical structure (the AHP hierarchical tree) that illustrates the four different levels of this phase (Figure 2):

Level 0: Defines the objective or target;

Level 1: Consists of the evaluation and analysis criteria;

Level 2: Composed of the sub-criteria of the analysis and evaluation;

Level 3: Consists of the alternatives or options to be evaluated that have been previously selected.

An objective is some

Prioritization: this is the pairwise comparison of the relative importance of all the elements of the same level of the hierarchy, compared to the element of the level immediately above and the structuring of priorities;

Synthesize Priorities: When priorities are determined for all criteria displayed in the hierarchy, the AHP provides an overall assessment score for each of the identified alternatives;

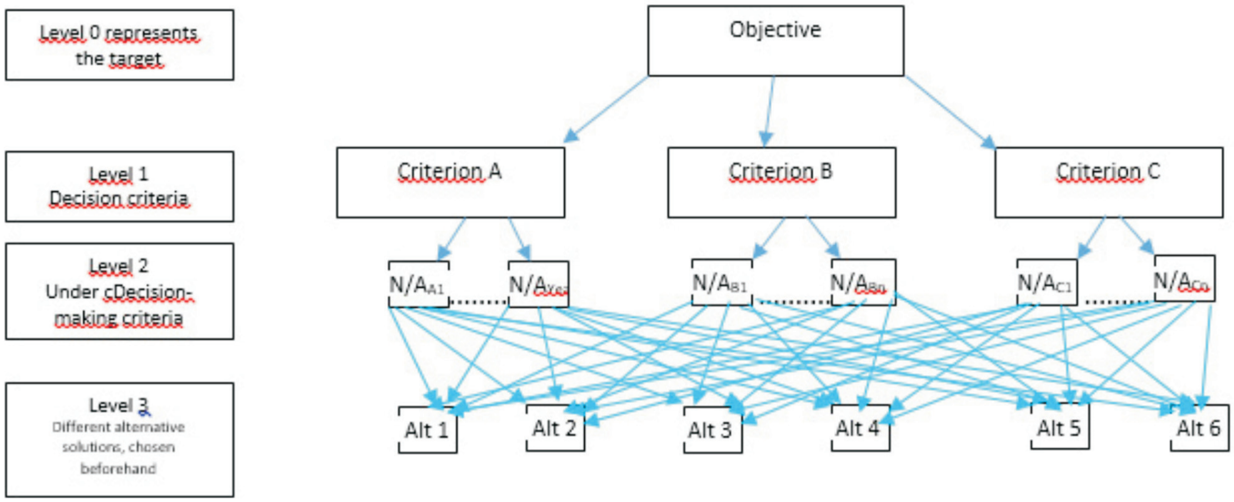


Fig. 2. AHP hierarchical tree.

Sensitivity analysis: Logical consistency of judgments.

To make pairwise comparison judgments, the AHP uses basic scales of absolute values from 1 to 9 and their reciprocals. The numbers used correspond to the strength of preference of one element over another, it is preferable to use a verbal judgment rather than numerical values, when the process of pairwise comparison concerns intangible elements, the evaluation consists of judging how many times one is better than the other (Table 1).

Table 1. Scale for pairwise comparisons

1	Equal importance
3	Moderate importance from one to the other
5	Strong or essential importance
7	Very strong or demonstrated importance
9	Extreme importance
2, 4, 6, 8	Milestones
Reciprocal for inverse comparison	

Case Study

The construction of the AHP model began with the selection of three families of criteria: economic, social and environmental, which form the three pillars of sustainable development. Each set of criteria is composed of several criteria, which were selected with reference to the imperatives of this development, reflecting the importance and concerns expressed by the assessor. These families of criteria and criteria constitute the principles or standards by which the objectives are judged. The reasons for selecting these 16 criteria are as follows:

Economic

Transport unit ton/kilometer: The traffic has an impact on the cost of finished products, that's why the location near the point of consumption is very privileged;

Surface area: the larger the surface area, the larger the quarry

Local government budget: Quarries inject significant royalties into local government revenues, contributing to their socio-economic development;

Investment Amount: The larger the investment amount, the more the quarry is requested;

Deposit potential, annual production and duration: The richness of exploitable deposit potential of a territory makes it more attractive for the quarrying sector.

Social

Residential zone: The establishment of a quarry at a distance of less than 10 meters is prohibited;

Urban Orientation: Safety radii have been established prohibiting any exploitation of quarries;

Monuments, places of worship and tourist areas: at a distance of less than 200 meters the establishment of quarries is prohibited;

Vital infrastructure (hospitals, schools, administrations...): at a distance of less than 50 meters, any quarry implantation is prohibited;

Number of jobs: These projects create jobs, they are classified according to the number of jobs created.

Environment

Water: Vital source, which must be protected, safety radii have been established according to the size of the resource;
Roads: The traffic of machines working in the quarries can increase the impact and nuisance on the road infrastructure.
Forests: Safety perimeters have been established or extraction is prohibited;
Slope: Areas with a slope greater than 45° are excluded.

Visual impact securing rehabilitation of the site: the exploited sites must be rehabilitated and secured.

Atmospheric impact: a classification was established according to the existence of a protective barrier or not, the wind direction and the distance.

The choice of the alternatives (quarries) to be evaluated, as well as their performance, was made in order to be the most representative of the extraction activity both for the local communities within the study area and for the types of materials extracted.

In this work we used the AHP method which includes the following steps

Decomposition of the problem: The problem is decomposed in the form of a hierarchical AHP tree (Figure 3). At the level of this decision tree we define different levels: Level 0 related to the main object or target of this study which is the selection of the most favorable sites for the establishment of quarries in the study area. Level 1 represents the families of economic, social and environmental criteria (3 criteria). Level 2 includes the criteria of the economic, social and environmental criteria families (16 criteria). The last level represents the alternatives or options (15 careers). Indeed, the choice of these elements is a very important step in the implementation of the value system in the name of which the decision must be taken.

There are three ways to introduce the judgments into the program: either verbally, numerically or graphically. To introduce these judgments (pairwise comparison) one can either start with the objective and go down to the alternatives or start with the alternatives and go up to the objective.

In this work we opted for the graphic way to make the judgments and we started with the objective and we went down to the alternatives. To establish this comparison by pair we used the software expert choice to help us to make these judgments by pair on a scale from 1 to 9 which are as follows:

Criteria families: Pairwise comparison between criteria versus criteria;

The criteria: the comparison is done in the following way:

For the economic criteria, the pairwise comparison is done for these criteria according to the family of the economic criterion;

For the social criteria, the same pairwise comparison is made again, but this time between the social criteria for the family of the social criterion;

In the same way for the environmental criteria,

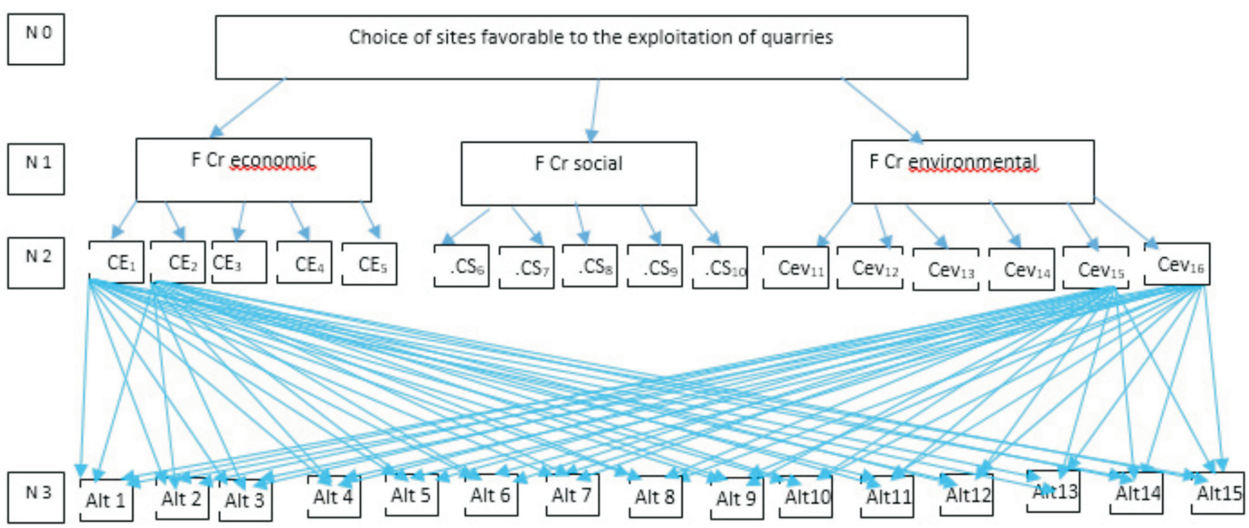


Fig. 3. AHP hierarchical tree.

we compare these criteria in pairs with the family of the environmental criterion.

Finally, the alternatives are compared two by two at each level of the decision tree for each criterion based on the local government budget criterion (Fig. 4).

In this example the judgments are graphical and are expressed by changing the length of the two bars until the lengths of the bars reflect the judgment that best describes our preferences and determines how many times one item is more attractive than the other. We can see that the upper part of the window shows the two items compared against the local government budget criterion. The lower part of the window shows the numerical representations of the graphical judgments.

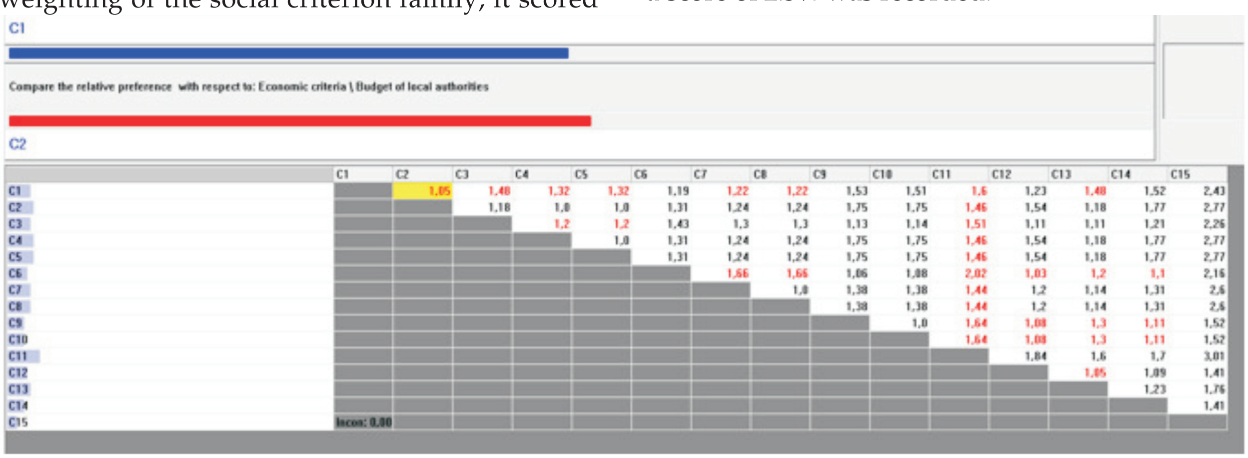
Results and Discussion

Results

Once the judgments are expressed the decision maker in the expert choice software this last one displays the results as follows:

For the families of criteria (Figure 5): We note a slight domination of the weight of the family of the economic criterion with a score 38.8% this weighting can be explained by the fact that the decision makers give a great importance to the economic profit because for them it represents the creation of wealth and also constitutes a vector of development. While the weight of the family of the environmental criterion it registers a score of 33,1% it is due perhaps to the rise of awareness for the protection of the environment so it became necessary that the decision makers take into account the negative effects of the activities on the receiving environment. As for the weighting of the social criterion family, it scored 28.1%. This result can be explained by the concerns of decision-makers regarding the social dimension, which is often not taken into consideration.

For the criteria (Figure 5): Regarding the results relating to the weight of the criteria, it is noted that the criterion transport unit ton /Kilometers records a slight dominance over the other criteria with a weight of 13.10% this can be explained by the effect of transport on the costs of finished products which represents a decisive character in the location of industrial activities hence their establishment near the basins of consumption. For the area criterion we note a score of 10.80%, it stands out from the other criteria in the eyes of the decision-makers since the availability of surface is reflected by the importance of the deposit potential and also by a long life of the exploitation and due to the fact that the investment in the sector of extraction of materials is a very heavy investment the small surface has no interest. The criterion of atmospheric impact registers a score of 10.30%. This score can be explained by the recognition of the importance in the eyes of the decision-makers to preserve the air against pollution as well as the negative consequences on the health and well-being of the neighboring populations. While the weight of the slope criterion is 1%, this result is related to the absence of large elevations in the study area, due to the absence of important monuments, tourist area and places of worship in the study area we have a weight of the criterion related to these elements of score 1.1%. Regarding the criterion of the local government budget, and due to erroneous declarations on the quantities extracted by quarry operators, the contribution of this sector in the revenue of local governments is not significant, and therefore a score of 2.3% was recorded.



	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
C1		1,05	1,48	1,32	1,32	1,19	1,22	1,22	1,53	1,51	1,6	1,23	1,48	1,52	2,43
C2			1,18	1,0	1,0	1,31	1,24	1,24	1,75	1,75	1,46	1,54	1,18	1,77	2,77
C3				1,2	1,2	1,43	1,3	1,3	1,13	1,14	1,51	1,11	1,11	1,21	2,26
C4					1,0	1,31	1,24	1,24	1,75	1,75	1,46	1,54	1,18	1,77	2,77
C5						1,31	1,24	1,24	1,75	1,75	1,46	1,54	1,18	1,77	2,77
C6							1,66	1,66	1,06	1,08	2,02	1,03	1,2	1,1	2,16
C7								1,0	1,38	1,38	1,44	1,2	1,14	1,31	2,6
C8									1,38	1,38	1,44	1,2	1,14	1,31	2,6
C9										1,0	1,64	1,08	1,3	1,11	1,52
C10											1,64	1,08	1,3	1,11	1,52
C11												1,84	1,6	1,7	3,01
C12													1,05	1,09	1,41
C13														1,23	1,76
C14															1,41
C15	Incon: 0,00														

Fig. 4. Pairwise comparison of alternatives according to the local government budget criterion.

For the alternatives (Figure 6): these two figures represent the order of attractiveness of the alternatives which shows that the score of the alternative C2 is the most attractive with a score of 10.4% followed by the other alternatives C1, C3 respectively have important scores of 9.6 and 9.1. These scores can be explained by the fact that C1, C2 and C3 are important companies working in the field of real estate with very important performances at the level of the two families of economic and social criteria. Alternatives C15, C11 and C10 are the least attractive with scores respectively 4.5% 4.5% 4.6% due to the fact that these alternatives represent small companies with more reliable scores for the three families of criteria.

The comparison of the weights between the two alternatives C2 and C1 (Figure 7) shows that the weight of alternative C2 according to the three families of economic, social and environmental criteria is slightly higher than that of C1 due to the fact that these two alternatives are two important companies that operate in the real estate sector and record important results for the economic and social aspects and less important for the environmental aspect due to their location close to the houses

Discussion

From the recorded results we observe

For the families of criteria: There is a slight difference in weight between the family of economic criteria with a score of 38.8% and the family of environmental criteria with a score of 33.1%, and a slight difference for the family of social criteria with a score of 28.1%. This small difference reflects the concerns and importance of these elements in the eyes of decision-makers. Thus, for them, the economic component constitutes a vector of economic growth that contributes to the increase in productivity, which guarantees the availability of quantities of goods and services for citizens. This abundance of supply leads to lower prices and improves the well-

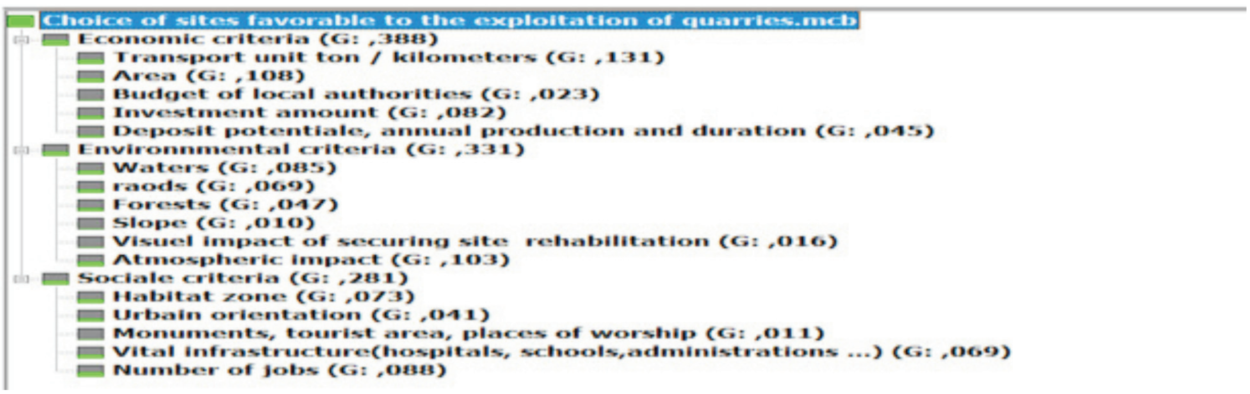


Fig. 5. Value tree.

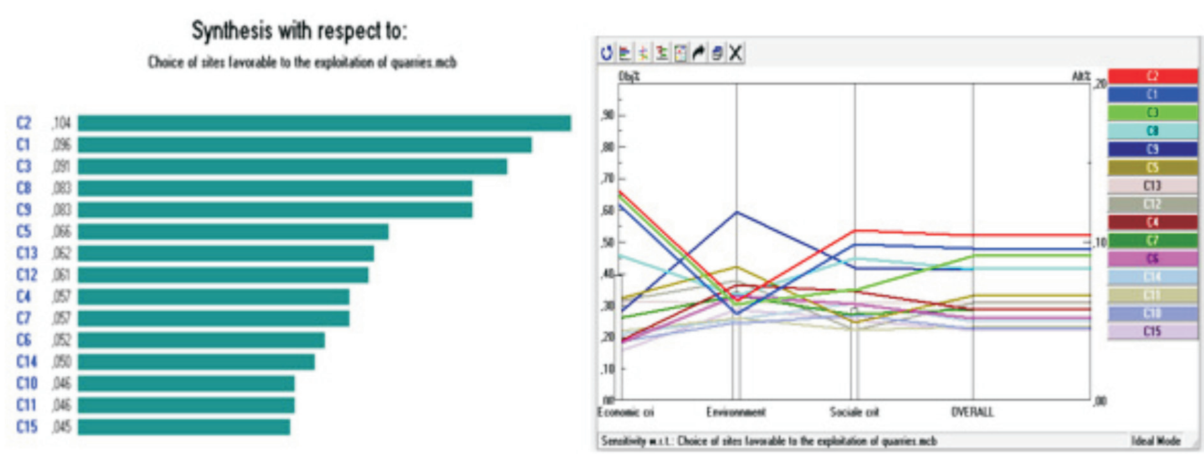


Fig. 6. Performance of alternatives.

being of the population. It also favors the creation of employment, thus reducing the unemployment rate and contributing to the increase of the purchasing power of the populations and reinforcing the capacities of the citizens to satisfy their aspirations. Regarding the environmental dimension and given the rise of awareness of environmental protection it has become essential for decision-makers to take as a priority the preservation of the receiving environment because the extent of environmental degradation and its negative effects are increasingly pronounced as well as the costs of these environmental damages which have become more burdensome on the economy. Concerning the social pillar, the consideration of this component by the decision-makers aims to improve the living conditions and welfare of citizens to enable them to live in dignity while ensuring access and satisfaction of basic and essential needs in education, health, also the fight against poverty, disparity, exclusion and precariousness for the ambition to achieve equity and social justice.

This conciliation between the three components can be explained by the emergence of the concept of sustainable development, which attaches great importance to the protection of the environment. This vision integrates the principles of responsibility, protection and precaution, in order to meet the expectations of development and human well-being, and to place social and environmental needs at the heart of decisions.

In this dynamic the Moroccan authority has deployed efforts these last decades at all levels to protect the natural environment against all degradations by adopting legal tools in order to achieve the consolidation of the preservation of the environment and to draw the main lines of roadmap for the territorial sustainable development.

In this spirit, and following this approach, the decision-makers have presented their preferences and concerns in favor of a development that respects the three dimensions of sustainable development and that integrates the principles of responsibility, protection and precaution in all decisions concerning the growth of the territory. The implementation of this approach based on the reconciliation of the three pillars of sustainable development - environmental protection, economic efficiency and social equity - will allow to meet the expectations of development and well-being, and will place social and environmental needs at the heart of the decisions. In other words, in all decision-making, responsibility must be engaged, both environmentally and socially and economically.

All this dynamics has been made possible by legislative reforms with the promulgation of several laws aimed at the realization of a sustainable development by these laws we can cite:

The Law 12-03 on Environmental Impact Assessment is considered one of the most important means that can assess beforehand the possible negative impacts of a project and provide measures to remove, mitigate or compensate them.

The law 27-13 on the exploitation of quarries which has just enriched the legal arsenal and to correct all the known balances in the sector and which gives a very important place to the protection of the environment.

It is thanks to the effort of the public power and to the application of its legal tools that this cohabitation between the extractive industry and its receiving environment is achieved. These instruments established by public policy are the vanguard to consolidate the prevention and protection of the environment, and which have essential objectives for prevention and protection of the natural environment against any possible pollution and allow this activity to be sustainable and perennial and to optimize it (Darkaoui, 2019).

For the criterion transport unit ton / Kilometers (13.10%): The cost of transport of extracted materials influences the cost of the finished product. It represents a decisive character of the logistics in the industrial positioning in a territory (2016 Amellal, I. et al), which explains their establishment near the basins of consumption or the creation of small sites of temporary and occasional quarries responding to a punctual demand, the more one moves away from the sites of extraction the more the cost of production is high;

The slope criterion (1%): the weight of this criterion is very low given the absence of steep slopes in the study area.

Monuments, tourist area and places of worship (1.1%): the weight of this criterion is very low given the distance of all the current quarry sites from tourist sites.

Alternative C2 (Figure 7): This is one of the companies that undertakes in the sector of cement production and one of the major real estate groups in Morocco, whose extraction and processing of materials is done at the site of the quarry adjacent to the cement production plant on a very large area about

146 hectares, producing a quantity of about 800,000 m^3 annually which gives it a very important weighting compared to other alternatives. In addition, it is also noted that this site has a number of negative effects that are manifested in its proximity to the inhabitants and the urban perimeter with a distance of less than 100 meters, hence their low weight. From the above, we can optimize the exploitation of quarries to amplify the positive impacts and remove or mitigate the negative impacts, through the creation of jobs for the local population and the contribution in local development.

Conclusion

The purpose of using decision support tools is to enable relevant decision making despite the large number of often contradictory criteria that must be considered. In this context, we have proposed an AHP decision-making approach based on economic, environmental and social dimensions, in order to evaluate the different existing quarries in the study area, to select the sites favorable to the establishment of this type of activity and to plan the optimization of future implementations.

The purpose of this work is to propose to decision makers a tool to facilitate decision making, in order to reduce the negative impacts and optimize the positive ones. According to the results recorded, there is a certain conciliation between these three dimensions, a kind of symbiosis between the activity and its receiving environment.

However, this approach does not give us a spatial representation and for more efficiency, we suggest a decision-making model based on the integration of a geographic information system (GIS) with the multi- criteria method AHP. This tool aims to allow the optimization and evaluation of development projects, improvement, and amplification of the positive effects of a project and this through the establishment of a tool outlining the roadmap for the realization of a sustainable territorial development aiming at an economic growth that respects nature and man.

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