Minimum Environmental Criteria in the architectural project. Trade-off between environmental, economic and social sustainability

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Abstract

In response to the European directives on procurement in 2004, strongly based on environmental issues, Italy makes it a legal obligation to apply the Minimum Environmental Criteria (MEC) through the Legislative Decree 50/2016, subsequently amended by the Legislative Decree 56/2017, governing the assignment of contracts of sale, public contracts and procurement procedures for entities operating. MEC are born with the aim of reducing environmental impacts, promoting more sustainable production systems and models and reducing consumption. The achievement of the sustainability in the field of construction sector thus is mandatory even if it remains a topic debated by theorists and designers especially in recent years. Sustainability, intended in a broader sense, considers not only environmental but also economic and social aspects and it becomes a challenge to combine and satisfy all the dimensions involved. In most of the cases it becomes necessary to find a trade-off since it is difficult to be able to optimize one aspect without compromising another one, especially when environmental and energy performance and the cost of the intervention are considered. The present work aims to clarify the procedures for the application of MEC for the selection of tenders, and to be a support in the drafting of a call for tenders for the evaluation of the Most Economically Advantageous Offer (MEAO), showing its criticality and strengths and trying to combine environmental, economic and social issues.

1. INTRODUCTION

Sustainability in the field of architecture, and especially in the building and construction industries, is one of the most debated and investigated issues, especially in recent years (Manzone et al, 2019) due to its direct implications on the natural environment and on the built environment (Capolongo *et al.*, 2014). In fact, given its strategic role in improving the quality of buildings (Manzone et al, 2019), it is recognized as an objective to be pursued in the design phase by both public and private actors (Finkbeiner *et al.*, 2010).

The concept of sustainable development has been first

introduced in the Brundtland report, a document published in 1987 by the World Commission on the Environment and Development. Here the definition of sustainability involves other dimensions besides the environmental one, in fact it is considered a development with direct consequences on the transformations of the economy and the society. Sustainability, however, cannot be pursued without policies aimed at limiting and regulating the use of resources available and at equitably distributing costs and benefits by responding to the needs of the current generations without compromising the needs of future ones. Indeed, sustainability, intended in a broader sense, considers not only environmental but also economic and social aspects and is based on their integration (Triple-Bottom-Line, TBL) (Elkington, 1998; Daneshpour and Takala, 2017; Martens and Carvalho, 2017). The achievement of the sustainability in the building sector thus, becomes a challenge given by the ever-increasing complexity of architectural projects, the number of actors involved in the different phases of the building process - from the feasibility study that is configured as a pre-design and a project financing stage, to the realization of the project, up to its demolition and disposal - and to the continuous evolution of the technical skills required (Schröpfer *et al.,* 2017). Given the difficulty in being able to satisfy and maximize all the instances involved, the role of architects and planners is crucial, becoming real Decision-Makers (DMs) with the task not only of producing quality results, but of managing the entire process of the project development, evaluating and estimating the effect produced by the choice of certain design solutions (Signorelli *et al.,* 2016). In this context, given the final objective, the attempt is to identify the solution capable of responding more efficiently to the issues involved, thus capable of reducing negative impacts and implementing the positive ones. Most of the time, however, it becomes necessary to find a trade-off between the dimensions involved, since it is difficult to be able to optimize one aspect without compromising another one, especially when environmental and energy performance and the cost of the intervention are considered.

Given these premises, the following contribution aims at providing a legislative framework on how Italy is responding to the needs of sustainability in the building sector, referring in particular to the Minimum Environmental Criteria (MEC) and how the construction sector increasingly applies established methodologies (Finkbeiner *et al.,* 2010) - such as the Life Cycle Assessment (LCA) method – or scoring tools – such as the LEED, BREEAM, Itaca Protocol - to evaluate the energy efficiency and the environmental impact of buildings. A literature review will allow to understand which, in the construction sector, are the topics most dealt with, considering sustainability as the final goal, and how environmental and economic issues have been combined and maximized. Finally, a case study will put into practice and apply the MEC for the choice of vertical closing system in a tender phase aimed at the work assignment according to the Most Economically Advantageous Offer (MEAO) and therefore considering the rewarding criteria, aimed at guaranteeing better performances than those guaranteed by the technical specifications. The application will show how MEC can actually be used and moreover, will assess which solution is the most suitable according to environmental, economic and social needs, and therefore the best offer according to the quality-price ratio.

The present work will highlight the limits, problems and innovations related to the application of MEC, underlining the importance of the initial phase of the project that has the potential to provide an adequate response to the decision problem and is able to respond to the different instances combining creative aspects and technical constraints. In this way the project is at the centre of a complex production process that does not only involve the use phase but starts from its evaluation in the preliminary phase.

2. HOW TO PURSUE SUSTAINABILITY IN THE BUILDING SECTOR

2.1 Legislative framework

The European Procurement Procedures of 2004 (Directive 2004/17/EC; Directive 2004/18/EC) promote the adoption of environmental considerations in the determination of technical specifications, award criteria and contract performance clauses. In addition, the new Community Directives on procurement and concessions (2014/23/EC; 2014/24/EC; 2014/25/EC) identify the public procurement sector as one of the cross-cutting tools for achieving the European strategic objectives (Europe 2020), encouraging extensive use of Green Public Procurement (GPP) for more efficient resource consumption and a low environmental impact economy.

In response to the European directives, Italy makes the application of MEC compulsory by law, through the Legislative Decree 50/2016[1] (subsequently amended by Legislative Decree 56/2017), which regulates the assignment of supply contracts, public contracts and procurement procedures of the entities operating for all types of contracts (works, supplies and services) and for all types of amounts, from negotiated procedures to European tenders. The MEC are part of a broader general plan defined as the National Plan on Green Public Procurement (PAN GPP)[2] (Manzone *et al.,* 2019), adopted by the Inter-Ministerial Decree in 2008 (G.U. no. 107, 8 May 2008), which

[1] The first building CAM is published with Ministerial Decree 24/12/2015, and subsequently adapted and amended with respect to the new procurement code Legislative Decree 50/2016

[2] In 2005, the European Union formulated the content of the National Action Plan for the implementation of GGP green policies in the Member States "Guidelines for the drafting of National Action Plans for GPP (2005)".

sets as its main objectives the optimization of the use of resources employed, the reduction of the use of hazardous substances and the production of waste. MEC were born with the aim of reducing environmental impacts, promoting more sustainable production systems and models and reducing consumption: the achievement of sustainability in the field of building thus becomes law. These criteria must be used within each procurement procedure of the Public Administration, obliging the contracting authorities to verify compliance in the various phases of the procurement procedure of works, goods and services (art. 34). In order to respond to economic requests, MEC are also involved in tenders aimed at assigning contracts in accordance with the MEAO with reference also to the rewarding criteria. While the minimum criteria constitute the minimum endowment of technical, technological or methodological specifications relevant to the environmental impact of the product or service to be acquired, the rewarding criteria attribute a higher score (following the decision of the individual administrations) depending on specific performances exceeding the defined base. The MEC verification phase concerns the public works process, from the project, to the evaluation phase of the technical offer with the mandatory identification of the rewarding criteria by the contracting authority on the costs of the entire life cycle of the building, up to the more complex phase of verifications of the elements/materials that make up the building body.

2.2 Evaluation methods and tools

In the construction sector, methodologies have been already established in the field of environmental impact assessment that allow to verify the satisfaction of the MEC in the design, contracting and execution phases of the construction work. The following section does not presume to be an in-depth examination of all existing methods, but to present the characteristics of the best known ones. The following methodologies do not overlap with the application of MEC but are integrated with it in order to promote a lower environmental impact throughout the life cycle of the building.

One of the most widely used procedures in the construction sector to assess the environmental performance of buildings is the LCA method (Hendrickson *et al.*; 1998; Ragheb, 2011), which allows to evaluate the entire life cycle of the product taking into account its environmental impacts. Given the ever-increasing complexity of architectural projects, different software has been developed able to support the designer by providing information on both the project and the choice of individual elements and materials part of the project. For the economic evaluation, to the LCA method the Life Cycle Cost (LCC) is flanked, which allows to evaluate the overall cost of the entire life cycle of the building, also considering its management and disposal (Gluch & Baumann, 2004). The integration of the two models proposed enables the consideration of both environmental and economic performance in order to meet the demand for sustainability required by the building sector (Norris, 2001). The limit in the use of these methodologies is based on the scarcity of "reward mechanisms" given by their application, although several evaluation tools are integrating their use in order to measure some indicators (Dalla Valle *et al.,* 2016).

Among the most well-known evaluation tools used in the national and international context there is the LEED (Leadership in Energy and Environmental Design), a scoring system developed to estimate the environmental sustainability of buildings. It consists of six macro categories, for all of which a specific number of credits is assigned; the total conformity to the requirements described in the protocol allows to obtain the maximum score. In fact, depending on the total score, different levels of certification can be achieved (Base, Silver, Gold, Platinum). Other recognised environmental certification systems are the BREEAM (Building Research Establishment Environmental Assessment Method), a British protocol divided into nine categories, and the DGNB (German Sustainable Building Council), a German assessment system that differs from other systems in its holistic approach, considering not only environmental performance but also maintenance costs or indoor comfort. In the national context there is the ITACA protocol aimed at assessing the environmental and energy sustainability of buildings through the use of a multi-criteria approach that is divided into five areas.

The tools here proposed, including the LCA and LCC methods, and the certification obtained through the conformity to the proposed criteria, have not yet been made mandatory in Italy, but are completely voluntary in contrast to MEC. Although MEC can be considered rigid in their structure, one of the criticisms detected from the scoring systems concerns the division of credits, i.e. the decision to assign a higher score to one category than to another one (Humbert *et al.*, 2007), even if the assignment has been decided by a pool of experts. Moreover, considering the sustainability as the integration of the environmental, economic and social dimensions, only the DGNB assesses costs and comfort, while the other systems only estimate the environmental performance.

2.3 Literature Review

By prioritising the achievement of the sustainability in the field of architecture, the following literature review aims at investigating how other authors have approached the topic, limiting the scope of action to the scale of the building and not to urban-scale projects. In fact, the analysis will allow to better understand the complexity of the issue and the key stages of the building process, underlining how sustainability is currently interpreted. In detail, a two-stage analysis has been carried out using the Scopus database:

i) the first phase consists of using keywords to

understand the context of application or investigation of the paper and whether sustainability is pursued in a specific phase or in the whole building process;

ii) the second phase consists in adding other keywords to those previously defined to understand how many of the papers previously detected use or describe the aforementioned methodologies (LCA, LCC, LEED, BREEAM, DGNB, ITACA Protocol).

The aim of structuring the literature review into two phases and highlighting the issue of sustainability is to define guidelines to support the different actors involved in the construction process. In fact, trying to underline trends or criticalities, it is possible to better understand how MEC can fit into the current debate and how they can be integrated with the most well-known methodologies.

For what concerns the first phase, the set of keywords has been defined starting from two key concepts and then adding other terms to better limit and detail the search. The final set considers "sustainability", "architecture", "building" and "construction industry" and 118 articles have been found. It is interesting to remark how the interest in topics related to the sustainability in the field of architecture, and in particular to the scale of the building, has grown in recent years, in fact, the first papers start to be recorded in 2003 with an increase from 2011 onwards (Fig. 1).

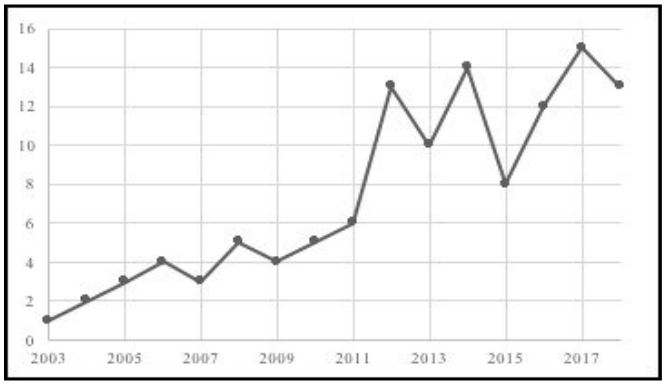

Figure 1 - *Relationship between number of papers and year of publication*

In addition to this first temporal analysis, as described above, one of the objectives of this phase is to investigate the area of application of the topic. In fact, by limiting the field of research to the building, some of the papers are very specific and are focused on achieving sustainability, considering the choice of materials with a lower environmental impact, such as Lozano-Miralles *et al.* (2018), which study the combination of clay bricks with organic waste, or Vân (2018), which emphasizes the use of bamboo as a material for interior design. Many authors also promote the use of Building Information Modeling (BIM), a model that optimizes the planning, design, construction and project management phase (Azhar, 2011). Musa *et al.* (2018) and Davies *et al.* (2018) apply it to the Malaysian context to respond to the complexity of the construction industry and the growing demand for efficiency, productivity and sustainability according to the notion of TBL. Vazquez *et al.* (2014), on the other hand, address the issue of choosing passive technological solutions for natural lighting and ventilation, demonstrating how the installation of these technologies can improve environmental impacts without great economic effort.

From these examples it is clear how issues that consider the different scales that constitute the complexity of the building have been dealt, from the choice of the material for the finishing, to the choice of the methodology for the management of the same.

By further limiting the search through the Scopus database, in the second phase new keywords have been added to verify which of the papers detected from the first search apply or describe the models and tools referred to in point 2.2.

Six different researches have been developed:

1. By adding the keyword "LCA" or "Life Cycle Assessment", four papers have been found. Two focus on the choice of the building material (Lozano-Miralles *et al.*, 2018; Maywald & Riesser, 2016), one on the integration with BIM models (Costa & Santos, 2017), and the last on the environmental benefits of using the LCA methodology (Simonen, 2014).
2. By adding the keyword "LCC" or "Life Cycle Cost", a paper has been found that deals with the topic of sustainable development starting from the choice of materials. In detail, Akadiri & Olomolaiye (2012) develop a multi-criteria analysis, where the cost of the life cycle is one of the six criteria analysed to achieve the sustainability.
3. By adding the keyword "LEED", fourteen papers have been found. Many authors present case studies of LEED-certified buildings where BIM methods have been applied for the project execution (Wu & Issa, 2015; 2014; Nguyen, & Toroghi, 2013) or in other cases LEED is one of the described scoring certification protocols to support DM in making sustainable decisions (Ismael & Shealy, 2018; Rivera, 2009).
4. By adding the keyword "BREEAM", a paper has been found discussing the differences between the two certification protocols, LEED and BREEAM (Rivera, 2009).
5. By adding the keyword "DNGB", a 2010 contribution have been found describing the introduction of this new certification system in Germany which allows to achieve the quality and to encourage sustainable construction.
6. By adding the keyword "ITACA" or "ITACA Protocol", a paper has been found that, through the description of a case study located in Italy, compares different evaluation systems to design "green buildings" (Mattoni *et al.*, 2017).

It is interesting to note that most of the contributions selected through this research address the issue of sustainability, especially from the point of view of environmental impacts, while few consider the holistic

concept that is also based on the integration of the economic and social dimension. From the analysis of the literature, it is also possible to highlight how, using the set of keywords previously defined, no papers dealing with MEC have been found. In fact, by searching through the same database and using the single keyword "Minimum Environmental Criteria", the only contribution identified, Manzoni *et al.*, 2019, explains how Italy is trying to respond to the sustainability topic.

3. HOW TO APPLY THE SUSTAINABILITY IN THE BUILDING SECTOR

Given the lack of literature on MEC applications in the construction sector, and the need to clarify how environmental issues can be integrated with economic issues, below a case study is proposed, concerning the purchase procedure for a building's element according to the MEAO. The example is oriented to catch the aspects related to MEC and rewarding criteria in the design and tendering phase: definition of specific requirements for participation and system of selection of bids. In detail, the procedure will be presented in order to proceed with the drafting of the requirements for the participation in the selection procedure according to the MEAO. The following procedure can support both the designer and the Public Administration in the implementation of the tender and both the contracting authority and the company to better meet the requirements indicated.

3.1 Case study

Given the complexity of proposing a case study on the construction of a new building, or its renovation, in this context it will be proposed the procedure for the purchase of windows for the energy upgrading of a historic building used by the Università del Piemonte Orientale. The project contributes to achieving the objective of energy saving according to national and regional regulations and aims to replace all the transparent vertical closures of the complex of buildings called San Giuseppe, located in Vercelli, Italy (Fig. 2; Fig. 3).

To proceed with the tender proposal, tools of environmental sustainability assessment and the concepts arising from the application of MEC building will be used. In order to define the limits with which to elaborate the project, it is necessary to consider that the building is included in the list of monumental and architectural assets of Piedmont with the constraint of Legislative Decree no. 42/2004, therefore the Superintendence of Architectural Heritage of Piedmont has authorized the replacement of windows with particular requirements such as morphological and material types, in order to protect and enhance the original historical and architectural features. In fact, the following project limits will be considered in the drafting of the call:

- the replacement of wooden frames with identical frames to the existing ones;
- the replacement of large iron windows with painted galvanized steel frames.

These prescriptions will not allow to obtain the maximum energy performance of the building, but they are a compromise to protect and enhance from an architectural point of view the monumental asset.

The procedure to be adopted relates to the assignment of contracts through a negotiated procedure, or through an open procedure or through a competitive dialogue, having as its object the supply of windows according to

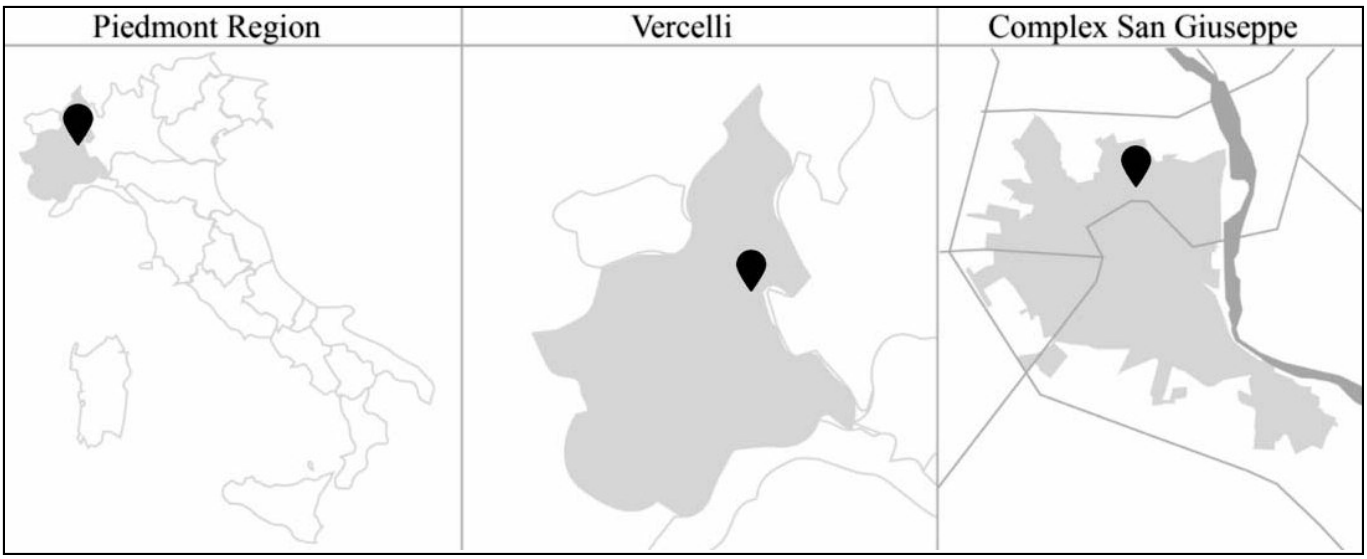

Figure 2 - *Location of the Complex San Giuseppe*

Figure 3 - *Complex San Giuseppe and detail of windows*

the environmental criteria provided for by Ministerial Decree 25/07/2011 and its annexes.

For the purposes of this contribution, the steps developed to draw up a call for tenders will be related only to the MEAO for wooden frames.

3.2 Application of the Minimum Environmental Criteria to a negotiated procedure

Figure 4 shows the steps developed to define the requirements for participation in the selection procedure according to the MEAO.

The methodological framework follows the configuration of the decision process proposed by Sharifi & Rodriguez (2002) and in fact is structured in three distinct phases: 1. Intelligence; 2. Design; 3. Decision. In the phase of 1. Intelligence, a part of understanding and description of the system plus an analysis of the current situation and the formulation of the objectives to be achieved are provided. The 2. Design phase involves the formulation of the model and the generation of the alternatives, while the last phase of 3. Decision considers the choice between the proposed alternatives also thanks to the evaluation of their impacts and the communication of the results. By analysing the application context, the phases proposed by Sharifi & Rodriguez (2002) have been maintained, considering the contents as a guide, while the specific

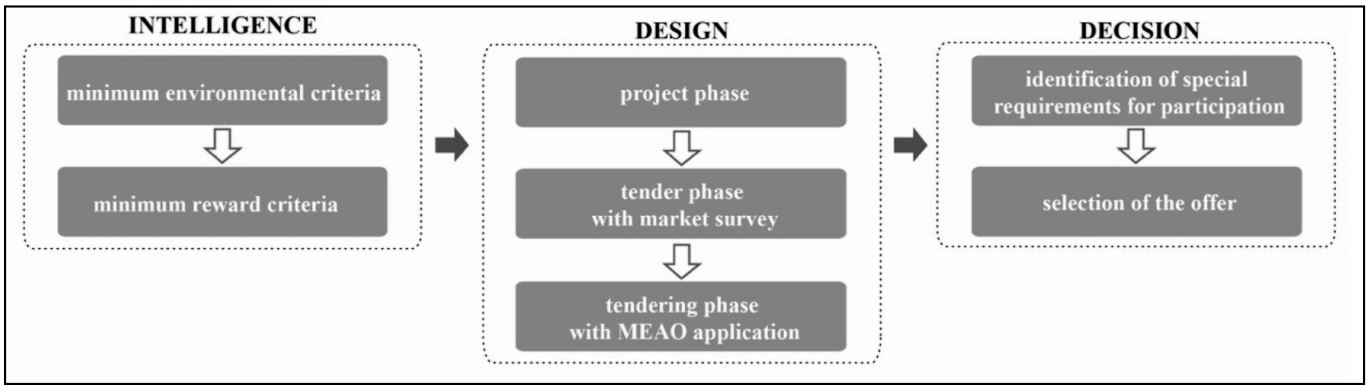

Figure 4 - *Phases developed*

steps have been modelled with reference to the final objective of drawing up a call for tenders for the assignment of works through a negotiated procedure, or open or competitive dialogue.

The first stage considers the clarification of the minimum environmental criteria, in fact, the basic technical specifications to be met for windows concern the value of i) thermal transmittance, depending on the climate zone and the value of ii) air permeability with their respective verification of congruence. For wood and glass, specific criteria such as the declaration of origin are also required.

Among the rewarding technical specifications:

i) again the thermal transmittance is considered, here a higher score is assigned if it is lower than the level established by law in relation to the climate zone;

(ii) non-renewable materials, where the score is assigned on the basis of the percentage of recycled content;

(iii) plastics, which allow additional scores to be made on the basis of compliance with certain characteristics, such as the absence of lead and halogenated paraffin;

(iv) virgin wood, i.e. from sustainably managed forests;

(v) recovery of replaced external windows and doors, if recovered and recycled;

(vi) formaldehyde, in order to promote materials that limit its emissions;

vii) Volatile Organic Compounds (VOCs,) in order to promote materials that limit their emissions.

Naturally, the specifications described here must be verified by means of declarations and/or certifications in order to assign additional scores.

In the second phase, the information about the system (in this case the window) is detailed in order to meet the sustainable requirements. For the project phase, in order to combine and benefit from the methodologies described above (see 2.2), and assess the environmental sustainability of the possible solutions proposed, it is recommended the application of the LCA method considering the minimum environmental criteria defined by the Ministerial Decree 25/07/2011 and its annexes. This methodological process allows to define the functional units of the element to be analysed, define the life cycle and the LCA indicators (e.g. CO2eq) and evaluate the impacts. This phase allows to determine the range of expected impacts and to understand in which phase of the life cycle there are the major impacts (Tarantini *et al.,* 2011).

The next phase involves the market surveys, the purpose of which is to understand which specific requirements of potential economic operators can reasonably be required during the tendering phase to comply with the competition principle, and which technical specifications of wooden windows on the market can constitute a further element of evaluation in the selection of bids according to the MEAO. The aim of the analysis is to be able to establish criteria for participation, a tender and prices that are consistent with the relevant market and which guarantee the principles of the procurement code, in particular the principles of competition and efficiency. The objective of the proposed market analysis is therefore to allow the drawing up of technical specifications, tender specifications and a contract outline that is consistent and attractive with the reference market, and in fact to prepare the offer for the tender. Table 1 shows an example of the survey and the analysis of the characteristics carried on, when the cells are empty, the information has not been found due to lack of data.

Given the proposed analysis, it is therefore possible to proceed with the drafting of a call for tenders for the MEAO, taking into account the MEC, the rewarding criteria, the application of the LCA method and the market survey.

3.3 Proposal for a selection of the most economically advantageous offer

Still in the 2. Design phase and after the analyses carried out, the content of a call for tenders is proposed below.

Given the final objective of replacing the windows of the San Giuseppe complex, located in Vercelli (Italy), a methodology capable of taking into account environmental, economic and social aspects is proposed. In fact, qualitative and quantitative criteria will be illustrated below, capable of assessing which of the proposals is the most suitable from the point of view of the sustainability.

Formulation of the call for tenders

To draw up the offer, the company, in order to respond to the indications of the contracting station, has to formulate the offer of the qualitative elements that constitute the technical proposal.

Among the criteria of qualitative nature there are:

a) *technical and safety features*, which assesses the impact resistance class and the load capacity of the locking devices for vasistas opening;

b) *installation characteristics and durability of the* window, a criterion that takes into account the aesthetic quality and in detail the certified installation and the guaranteed painting cycle;

c) *environmental characteristics related to MEC* and in fact considers the thermal transmittance, the recycled content of the window, the labelling and recovery of existing windows.

Considering the last point, the following specifications are proposed among the environmental rewarding criteria:

1) thermal transmittance: evaluation of a transmittance (U) of the finished window < 1,8 W/sqm K. Values below U= 1,4 W/sqm K will be assessed with the maximum score;

Table 1 - *Market survey*

	Company 1	Company 2	Company 3
Location	Taranto	Trento	Chiari (Brescia)
Detail Company	54 years 200 employs turnover: 18.000.000 € products: wood and aluminium	turnover: from 3 up to 5.000.000 €	30 years turnover: 14.000.000 € products: wood and aluminium
REQUIREMENTS			
ISO 9001	no	yes	yes
ISO 14001	no	yes	yes
SOA	/	yes	/
EMAS	no	no	no
ANALISI LCA	no	/	/
CE MARKING	yes	yes	yes
WINDOW CERTIFICATION	CASA CLIMA	LEED	/
CERTIFICATION OF INSTALLATION	CASA CLIMA	LEED	/
LABELS I-II-III	/	FSC TYPE I	FSC TYPE I
DECLARATION OF CONFORMITY	/	air permeability waterproof wind resistance	/
TRANSMITTANCE MOST INNOVATIVE PRODUCT	yes	no	no

2) wood origin labelling: the wood must have a certification of origin with type I labelling or type II EDP labelling (environmental labels);
3) recycled content of the window frame: it is evaluated the percentage in kg of raw material that constitutes the finished window;
4) recovery of existing windows: it will be evaluated the recycling of materials from existing windows and the possibility of recycling them in terms of weight (kg).

The above criteria and the request for the relative requirements are obviously illustrative and differentiated as much as possible. The verification tools consider the request for certification, the descriptive technical reports, up to sampling with purely discretionary aesthetic evaluation.

In the final phase of the 3. Decision, it is necessary to assign a score to the characteristics in order to assess which proposal is the most suitable.

Allocation of scores

The method of allocating the points for the qualitative criteria in the technical offer will be of discretionary type with the assignment of a variable coefficient between 0 and 1 by each tenderer, depending on the conformity with the requirements elicited (Table 2). For the evaluation and choice of the most suitable proposal, to each of the criteria has been assigned a weight. The aggregation through a weighted sum of the score obtained for the above category and the weight assigned will allow to have a final result on a scale from 0 to 100. Weights have been assigned with direct allocation; to qualitative criteria have been allocated a maximum influence of 70 while to quantitative criteria have been allocated a maximum of 30. The weighing of the criteria has been calibrated on the quality of the product that is considered most appropriate for the needs of the contracting authority (table 2).

For the quantitative criteria, on the other hand, the proposal of the economic offer is requested, evaluated at a lower percentage with respect to the amount placed on the basis of the tender, excluding the costs of site safety. The method of scoring the quantitative criteria - price - will be calculated using the non-linear interpolation formula.

Formulation of the ranking

The evaluation of the most suitable solution will therefore take place with reference to the requirements and weighing methods described in Table 2, according to the technical offer obtained through the evaluation of the qualitative criteria and according to the economic offer obtained through quantitative criteria.

Table 2 - *Summary scheme for the evaluation of the most economically advantageous offer*

QUALITATIVE CRITERIA			
CRITERIA	**INDICATORS**	**WEIGHTS**	**SCORE DEFINITION**
TECHNICAL, SAFETY AND SECURITY FEATURES	mechanical resistance to impact class	4	0 points: insufficient, characteristics not meet the requirements, 0.2 points: insufficient assessment, i.e. solution that does not fully meet the requirements, including the absence of sampling and clear and exhaustive documentation, 0.5 points: sufficient evaluation, 0.6 points: good rating, 1 points: excellent evaluation
	load capacity clamping devices for vasistas	10	
DURABILITY CHARACTERISTICS	certified installation	8	
	guaranteed painting cycle	8	
ENVIRONMENTAL CHARACTERISTICS	thermal transmittance	16	
	certificate of wood origin	6	
	recycled content	6	
	recovery of existing windows	12	
		70	
QUANTITATIVE CRITERIA			
CRITERIA	**INDICATORS**	**WEIGHTS**	**SCORE DEFINITION**
COST	cost of intervention	30	percentage reduction in relation to the amount placed on the basis of the tender

4. DISCUSSION OF THE RESULTS

The work proposed here aims to be a first attempt to clarify the application procedures of MEC for the selection of tenders and how different existing methodologies on the topic of sustainability in the field of construction can be integrated.

The final scheme presented in table 2 and the criteria described, aim to evaluate the building element, in this case the wooden window, from the point of view of environmental, economic and social sustainability. In fact, while MEC allows to evaluate the environmental impacts, the cost of the intervention defines its economic impact and the consideration of the historical value of the building and the analysis of aesthetic characteristics related to the proposals in the tender, also assess the social impact. In this way it becomes important to underline how the method aims to define a trade-off between the different dimensions involved in order to assess the most suitable, or at least, the one that best meets the requirements.

Since an aggregative compensatory method has been chosen, a negative performance obtained in one criterion will be compensated by a positive one obtained in another aspect. Considering this perspective, the DMs, in this case the contracting authority, have a fundamental role, in fact they have to govern the results obtained by reading the partial ones in order to understand which of the proposed solutions is able, in a more performing way, to respond to the defined instances. The alternative selected must be the one capable of maximising all the aspects involved or at least capable of finding a trade-off among them. The multi-criteria analysis of a technical element or of any building process (Sdino et al, 2018), therefore, allows its total understanding and evaluation and also allows to know a-priori risks and benefits obtained from its choice because, as described above, the partial results obtained in all the criteria are known.

The contribution also aims to highlight the importance of the design phase of the project, which has the potential to provide an adequate response to the decision-making problem and is able to respond to the different demands by combining both creative aspects and technical constraints (Nardi, 2010). The process of realization and construction of the work, according to the proposed indications, will also follow no longer a linear but a circular economic processes with the possibility to regenerate itself and be promoters of a sustainable development (Geissdoerfer *et al.,* 2017). It is therefore important to remember the strategic role of the designer, as well as the contracting authorities and the Public Administration, with the task to manage the complexity of an architectural process aimed at the realization of the work.

5. CONCLUSION

Italy makes the application of MEC mandatory by law through the Legislative Decree 50/2016 to respond to European directives on procurement, strongly based on environmental issues. Since the construction sector is responsible for the 50% of the natural resources obtained

from man and about 25-40% of the total energy used (Manzone *et al.*, 2019), the issue of sustainability in the field of construction becomes strategic and it is also urgent to provide specific guidelines. MEC are in Italy the first regulatory response to this necessity, despite the fact that voluntary environmental certification procedures and consolidated methodologies already exist. The objectives identified in the building MEC are very ambitious and define a framework of constraints such as to design buildings and infrastructure with minimal environmental impacts. However, in order to promote the cultural change towards the realization of sustainable works and infrastructures from an environmental and social point of view, the stimulus should start from the Public Administration through the training of internal personnel towards the tools and methodologies described above, in order to avoid a passive application of MEC. The effective application of the provisions of the MEC decree can only be pursued with cultural innovation and with new skills of the actors who interact with the building process (Ashford & Hall, 2011).

In this context, in addition to the environmental impacts, it is important to not overlook the challenge of being able to combine and satisfy all the dimensions involved to achieve the sustainability. MEC need to be flexible but also to respond to the social demands of the population and to promote the economic sustainability of the intervention without compromising the quality.

Notes

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