

The parameterization of physical quantities in the definition of parametric costs

The Legislative Decree n. 50/2016 on public works design

Orazio Campo*, Francesco Rocca**

key words: cost estimate, parameterization, standard cost

Abstract

The purpose of the contribution is to open a debate aiming to identify, considering the new Public Procurement Code (Article 23 Legislative Decree n. 50/2016) which introduces the technical and economic feasibility, the role of the designer, of the planner and of the evaluator.

An important innovation came with the introduction of art. 23 of the Legislative Decree n. 50/2016 (in this document Dlgs n. 50/2016). Thanks to this new regulation, the technical and economic feasibility project (replacing the preliminary draft and feasibility study) is further strengthened with regard to the technical and economic quality aspects. In order to prevent that the principles of the aforementioned regulation remain mere enunciations, it is necessary to define the construction of alternatives, the process of choices and the criteria for the evaluation of alternatives.

Yesterday, starting from the feasibility study even if in an indicative way, the only need was to know the realizing cost of the work to provide the necessary financial

coverage of the intervention. Today in addition, the costumer of the work needs to choose the best design solution based on the definition and selection of alternatives.

Nowadays, more than in the past, the shortage of historical data and the difficulty of adjusting cost to peculiar features, often neglecting the possibility to consider economies of scale of their context, have led to excessive simplification of estimation with adverse consequences that can easily be imagined. It is worth remembering that the need for parametric estimations, both for public and private, for network works and punctuation ones, is increasingly emphasized, and is also divided into a number of typologies that can be used for the same building and for all intended use. Although influential, the DEI bulletin of the College of Architects and Engineers of Milan, which reports about 60 records of new constructions to be used as reference prices, is poorly adapted to respond to the variety of estimation queries. This shows clearly the need for an up-to-date database with a broad set of benchmark

prices that it should be able to use for such diverse interventions.

The bulletin is not enough to cover the requirements for the ex-ante cost analysis during technical and economic feasibility. A remarkable positive contribution could have come from the publication of standard costs, considered as a measure of what the cost should be.

The Public Works Observatory (*Osservatorio dei lavori pubblici*) had been charged with drafting a proposal but nowadays in Italy any standardization has not been proposed yet. The contribution also contains the first contents of a research that is being carried out with regard to the determination of significant indicators for the economic and qualitative assessment of residential interventions.

1. AIM OF THE WORK

The aim of the contribution is to open a debate by asking about the role of the designer, of the planner and of the evaluator considering the new Public Procurement Code n. 50/2016 (in this document Dlgs 50/2016) which brings about substantial innovation in art. 23. The technical and economic feasibility project make a joint between the feasibility study and the preliminary project, integrating them with strongly innovative content. In this contribution, we do not think it is worth considering the critical evaluations of the new Public Procurement Code to better focus on the content that most urges the intervention of evaluation and estimation disciplines. The technical and economic feasibility project outlined in the new Dlgs 50/2016 implies that the project must be validated on the basis of an evaluation of "alternative solutions" for the choice of the best design solution. The issue is highlighted to initiate a debate not only within the area of evaluation discipline in order to understand which kind of professional contributions could be involved, but also to identify new contents and priorities to be introduced in the current didactics of the faculty of architecture and engineering. The main issue becomes the role and the involvement in the design process of the evaluation since the early stages of design drafting or planning activities, considering that the final value of a design or of a plan is formed throughout his whole editorial course.

The debate on the role of evaluators first poses the problem of defining the criteria to be used for project evaluation to measure the level of achievement of the objectives and the estimate of the total costs associated with the various alternatives considered. There is therefore a need to establish a dialectical comparison with the Public Administration during which it is possible to define sufficiently shared homogeneous criteria that motivate the choices in a transparent and indisputable manner.

In summary, the technical and economic feasibility project is further strengthened with regard to technical and economic quality aspects.

The identification of the best design solution, referring to the relationship between quality and cost among "multiple solutions", must find in the preliminary design document the criteria and guidelines for the formation of

the set of alternatives. These must be built on the basis of the guidelines contained in the preliminary design document. The evaluation of alternatives represents an important innovation developed in the experience over the past two decades, starting with the feasibility study phase, which starts from research topics with the aim of the construction of useful paradigms for design alternatives. For the first time, the regulatory framework introduces a fundamental innovation and focuses on the needs to be satisfied and the performance to be provided. Therefore focuses on the quality of the project and on the evaluation of the alternatives in order to find the best design solution, stimulates a main theme for public and private research centers and university education in this sector.

Therefore, the definition of new paradigms is based on specific evaluative research as a reference to the determination of parametric costs related to the quality of the works. In order to prevent that the principles of the aforementioned regulation remain mere enunciations, it is necessary to define the construction of alternatives, the process of choices and the criteria for the evaluation of alternatives.

As evident, the assessment aspects at this design stage are assuming a main role which is explicitly much more complex and articulated under the estimation profile and also strongly influenced by the development of the subsequent design phases (definitive and executive). The latter phases moreover will use unchanged the role played by the traditional bills of quantities with details of unit costs (*computo metrico estimativo*) as the only final moment linked to the bureaucratically acceptable cost estimate.

In this first contribution, we propose to focus on the implications of the Code's procedure for comparing and estimating the costs of the various alternatives.

As stated in comma 6, the aim of maintaining the expected costs within the spending limits of the project to be achieved can only be answered through the synthetic estimate of the intervention necessarily operated using parametric criteria of intervention costs. In the past, starting from the feasibility study even if in an indicative way, the only need was to know the realizing cost of the work to provide the necessary financial coverage of the intervention. Today in addition, the customer of the work

needs to choose among the alternative solutions the one that has the best cost and quality ratio. It is clear the importance of the evaluator's presence both in the role of supporting the single process manager and in the design team from the initial stage, so that the objectives of the new regulatory framework regarding technical and economic feasibility can be pursued concretely.

Obviously the provisions of the Decree concern the realization of public works, but the importance of a proper preventive assessment – also seen as the persistence of the economic and financial crisis and the difficulty of finding resources – has become increasingly important in private interventions and above all in those to be realized in public and private partnership where more control is required (Battisti F., Campo O., 2016).

2. SYNTHETIC COST ASSESSMENT

The logical and methodological process generally used till today, to calculate synthetically the realizing cost of a work is done through the preliminary finding of historical data on contemporary cost prices expressed through homogeneous unit parameters of similar construction works both qualitatively but also localized. The most frequently used reference is the "Price of Building Typologies" ("Prezzo delle Tipologie Edilizie") of the College of Architects and Engineers of Milan (Edizioni DEI), which has been published for more than 20 years and has been updated periodically. It has set the benchmark for all the people involved in the production process of settlements, by providing a summary information document on the costs of the works carried out, relating to a series of interventions of different types, for which the intervention costs of the works and the percentage incidence of the works categories are provided¹.

A remarkable positive contribution could have come from the publication of standard costs by the Public Works Observatory (Osservatorio dei Lavori Pubblici). Nowadays with the D.L. 90/2014 converted into Law 114/2014, the Authority for the Supervision of Public Works (Autorità per la Vigilanza sui Lavori Pubblici) was abolished and transferred to the National Anti-Corruption Authority (Autorità Nazionale Anticorruzione), but if more than thirteen years have passed (Article 4 L. 109 / 94) they have not defined shared, unified and standardized cost parameters yet. In the absence of standardized cost data references from the Observatory, the preliminary calculation of expenditure at the preliminary draft stage,

¹ For example, the regulation used to calculate the extraordinary contribution of Rome Capital (Campo, 2015), approved by Capitoline Assembly Resolution n.128/2014, establishes that the calculation of the technical cost of the building has to be calculated in a parametric manner using the values for square meter of the building obtained from the Dei bulletin (last edition available at the time of estimation).

now a technical and economic feasibility project, is carried out in accordance with the guidelines of the Implementing Regulation (Regolamento Attuativo²), applying to the characteristic quantities of the works a parametric cost drawn out from the economic value of the total construction cost of similar interventions already made.

So the estimate criterion is attributed to the sole responsibility of the evaluator. The criterion must be mediated by the calculated parametric costs by contextualizing the reference economic data. In particular: the variability of the scale conditions and also the market conditions. It is an important priority for the evaluator to determine the most probable standardized cost, firstly to contextualize the economic data, and secondly to characterize and analyze the typological and technological components to identify any differences between the model and the intervention subject of analysis (which, however, appear immediately and objectively measurable).

The need to carry out economic and quality assessments of a "future" object is a growing need in the construction sector at the preliminary stage, and requires the participation of all actors involved in the building process: buyers, designers, construction companies. Among the actors in the building process, the evaluator-designer figure is becoming more and more important in the overall direction of the building process and the construction sector in general. The qualitative design and the consequent economic evaluation of "future" objects both in the public and private sectors of buildings, increasingly need to take the form of "integrated design", becoming a reliable tool in decision making and spending processes. Just in relation to the need to evaluate the costs and benefits for the community, the legislation of the last decades tends to include in the building processes the activation of specific participation tools of the social subjects directly or indirectly involved in the process as well as the specific stakeholders.

There is a strong lack of historical data in the ordinary professional activity because of this the obvious difficulties in adjusting the cost to the peculiar features of the project under consideration. In addition, valuing and neglecting any economies of scale has led to excessive simplification of the estimate with the generalized consequence of determining estimated costs that generally do not match

² The article 22, comma 1 of the Regolamento n. 207/2010 (implementation of the Code) establish that "the calculation of the synthetic expenditure shall be made, in respect of activities or works, by applying to their characteristic quantities the corresponding parametric prices deducted from the standardized costs determined by the Observatory. In the absence of standardized costs, applying parameters derived from similar work realized, or by compiling a synthetic bills of quantities with details of unit costs (computo metrico estimativo di massima)".

the cost in the final balance of the work. It is important to remind that the need to use parametric estimates, both for public and private interventions, must be articulated with a number of typologies that can be used for the same building and for all permitted uses. Parametric studies demonstrate that the quantity of components, with the same useful result, strongly varies with the typological choices that characterize the project. The typological choice in the project for example in the residence field, varies based on the adoption of the fundamental typologies (row, line, tower, etc.) and within these with further design definitions mainly typological. About this issue, Figure 1 shows examples of parametric analysis of vertical closing elements³.

Based on these considerations, it is clear the need to implement an up-to-date database with an extended overview of data that takes into account typological variables and uses unit costs (price list that is determined on the basis of the probable average cost and not as it is currently on marginal cost). It is important to point out that the parametric quantities depend solely on the typology, while, starting from the same technology used and realized, the unit costs

depend on the specific intervention situations (intervention dimension, technologies used, forms of procurement, material supply conditions, business capacity, climatic conditions, etc.).

The methodology to be used to determine the parametric costs of a future object is the use of *standard parameters* and is implemented by the analysis of the unit cost per functional unit. Thus the methodology refers to the characteristics of fruition units.

Today the determination of the parametric cost related to each functional unit of "future" objects shows an oscillations within a national average cost reference range which is generally equal to the value of the standard work. Therefore, this approach requires the application of endogenous and exogenous⁴ correction factors and coefficients. The determination of these factors is based on local and environmental data from a local context. The endogenous corrective factors take into account the constructive variables determined by the designer's choices, the building typology and the constructive

³ extract from: La valutazione della qualità e dei costi nei progetti residenziali. Il brevetto SISCO. Seconda Parte, rivista SIEV (n. 8 - 2012) di Enrico Fattinanzi.

⁴ Exogenous variables are external and can not be controlled by the specific building process. (interest rate, economies of scale, specific conditions of the real estate market and material supply, labor costs, etc.) While endogenous variables are controllable by the actors involved directly in the process of realization (especially design ones: typological and technological morphological variables).

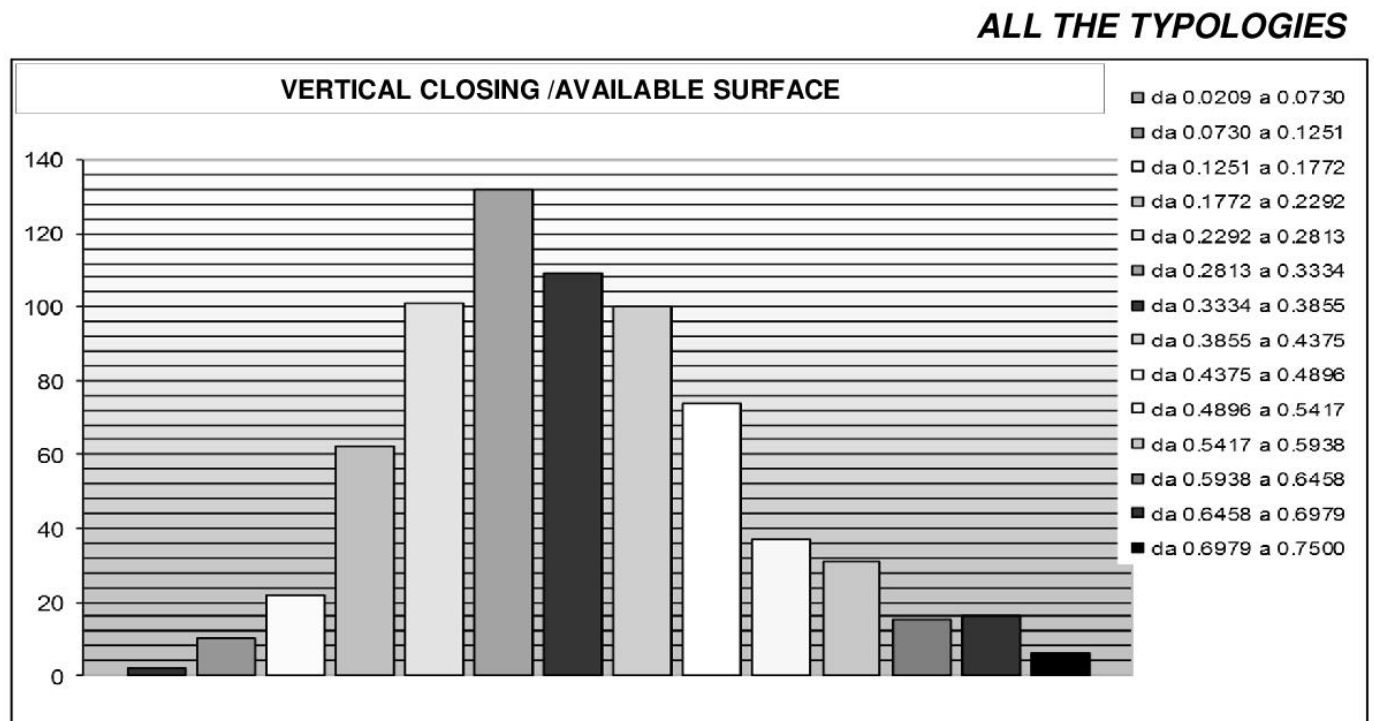


Figure 1 - Incidence of Vertical Closing Elements. The graphic refers to a sample of over seven hundred dwellings

technology. Exogenous factors refer to environmental data that do not depend on project choices but derive from the territorial context: geographic location, administrative location, cost differentiation, site accessibility, seismicity, geology and morphology. While endogenous factors are directly dependent on design choices and therefore typological. The following block representation shows the elements for determining the total cost of a work.

An important role in this contribution is played from a research activity⁵ that is being carried out for residential constructions. The research is addressed to the definition of significant indicators for assessing both new developments and existing building regeneration interventions. The work that is being carried out concerns the analysis and the typological decomposition from the Residential Settlement Module (Modulo Insediativo Residenziale) of the types of buildings: i) patio house, ii) row iii) line iv) tower house, referring to a significant universe of cases made in different periods in Italy and abroad. The work phases are about detection to investigate the variations in the physical quantities of the major components subordinate to the variety of typological characters found in this extended universe. The construction of a database will allow to obtain results suitable for interrogations for building classes and, within this, for the main subclasses. Among the main expected results of the research being carried out, there is the construction of Gaussian curves of the universe of the

analyzed cases for both individual building types and for reading the relative comparison. This kind of output will allow to have an important reference for qualitative assessment of ex-ante cost. Below some search results for the patio house types are shown. The graphs presented in the article refer to a sample of more than one hundred cases and concerns the relationship between the available surface (as defined below) and the surface of the vertical closing elements.

3. DEFINITION OF STANDARD COST

The standard cost is a cost configuration designed for control purposes: a standard cost "is a measure of what the cost should be, not what the cost was, [...] is therefore a hypothetical cost, an objective cost "(Anthony, 2001), determined on the basis of hypothetical efficiency levels, understood as the relation between the production volumes used and the production volumes obtained. A standard cost system is a system that, alternatively or in addition to actual costs, detects standard costs and associates a standard cost sheet for each product that represent a list of everything that the product is made of as well as the processing phases (processing cycle).

The standard cost, that fall into the category of parametric costs, is the product of predetermined (standard) unit quantities for an established price.

The standard cost is a meter by which it is possible to measure the efficiency levels of resource utilization. The validity of the standard depends on how this meter is built. Cost standard configurations include: i) standard costs based on ideal conditions; ii) standard costs based on achievable conditions (Aloi, 2012).

⁵ Current research is coordinated by Prof. Enrico Fattinnanzi with a working group of graduates from the Faculty of Architecture "La Sapienza" in Rome.

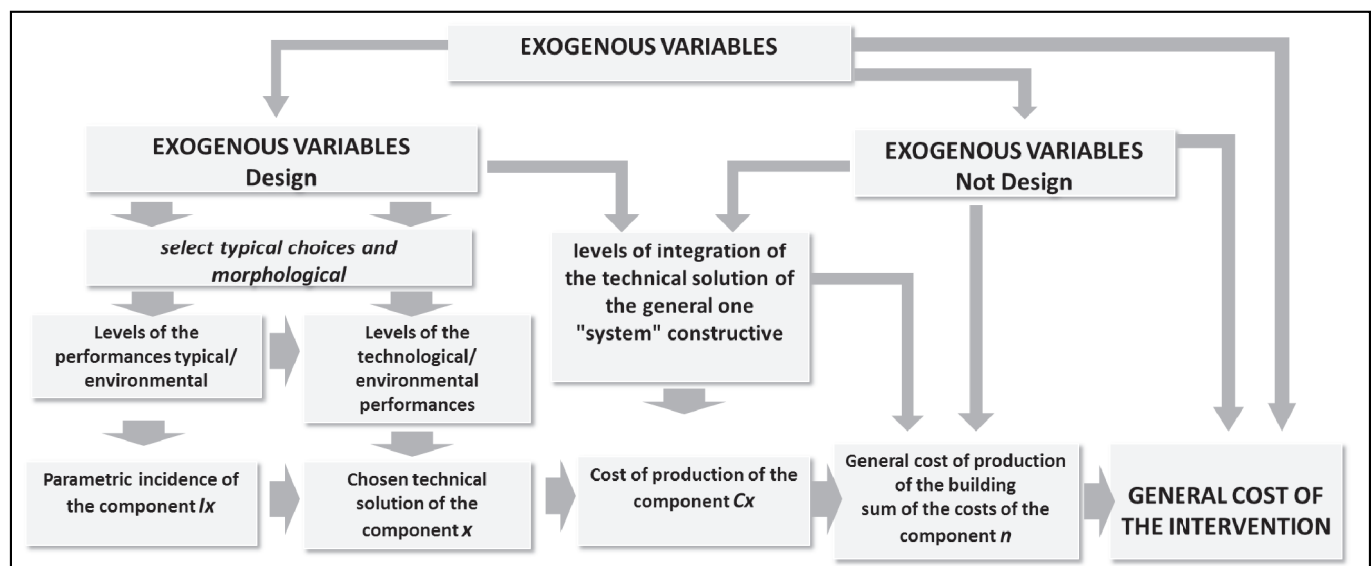


Figure 2 - Elements that determine the total cost of the intervention

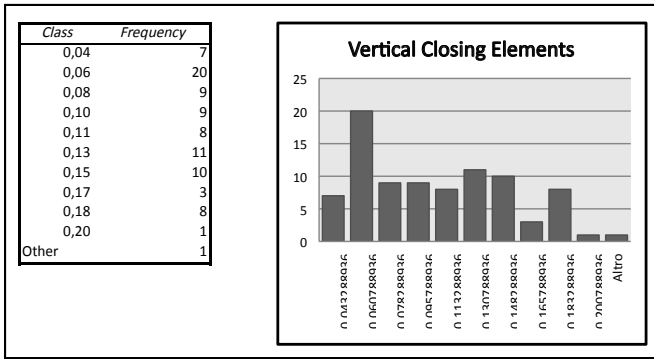


Figure 3 - Vertical closing elements graphic of all types of patio house

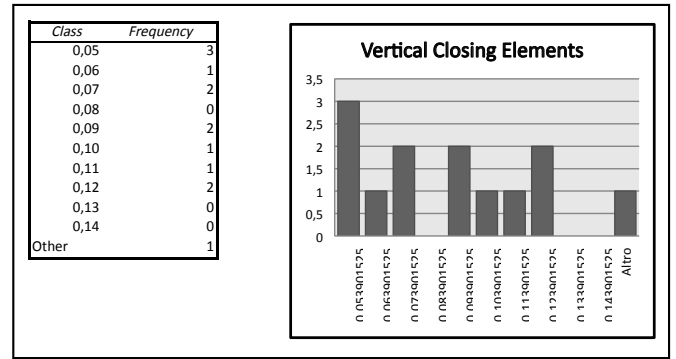


Figure 6 - Vertical closing elements graphic of "I" patio house type

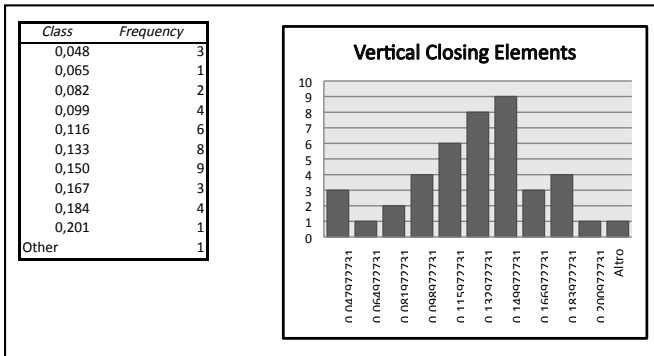


Figure 4 - Vertical closing elements graphic of "L" patio house type

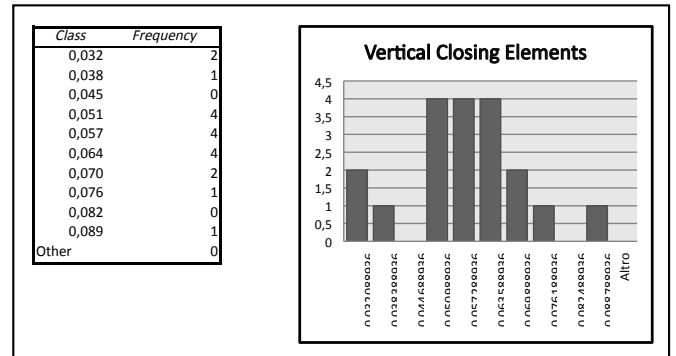


Figure 7 - Vertical closing elements graphic of "C" patio house type

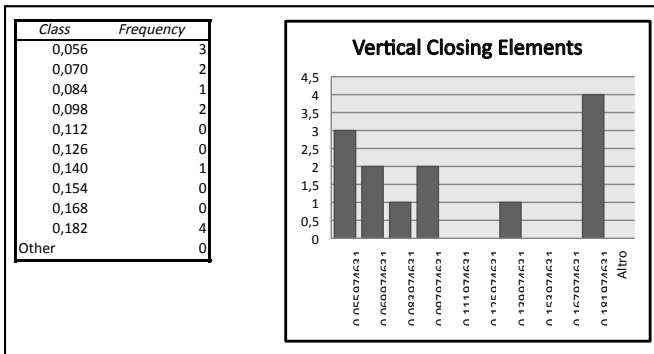


Figure 5 - Vertical closing elements graphic of "a z, h, t" patio house type and others

4. THE STANDARDIZED COST IN THE CONSTRUCTION INDUSTRY

In the construction industry there are many conditions that slow down the determination of standard costs. Among these, there are the variability of the environmental context, the uniqueness of the construction product, and the difficulty of standardizing different building activities.

On the other hand, for some sectors of construction

production, standardization of costs is facilitated specially when it deals with prefabricated buildings or when the building-site has characteristics of industrialization processes or when production can be reorganized.

For particular types of works, generally public, with particular destinations such as hospitals, offices, etc., or linear infrastructures (roads, cycle paths, technological works, etc.), the parametric cost is generally referred to "the helpful result"⁶.

⁶ For example:

- for schools: the number of students or classrooms;
- for hospitals: the number of beds;
- for roads: the development or the surface;
- for sewage networks: linear development;
- for lighting systems: light spots.

Istat calculates the cost indices of three indicators of the construction industry since 1977:

- the monthly index of the building cost for a residential building;
- the quarterly index of the building cost for an industrial warehouse;
- the quarterly index of the building cost for a road section.

Cost indices calculated by ISTAT⁷ are defined to enable all interested subjects to follow the variations of the direct building costs over time. In particular, the building cost index of a residential building measures the time-varying direct costs that need to be supported to build a predominantly residential building. The characteristics of the “standard” residential building ((project linked to the project linked to the 2010 reference base) include a building consisting of a single body made of concrete structures, four floors above ground, plus a basement and nine housing units. The floor at the road level is imagined to be partially used for commercial use (four stores). From this approach it is clear that the cost indices provided by ISTAT have an applicative limit. The determination of the parametric cost is affected by a series of variables, starting from the principle that *the building is not a simple sum of spaces, technical elements, materials and facilities, but it is a system in which each element interacts with each other in a complex manner to meet the needs of users*⁸.

It is necessary to operate the typological and technological decomposition of the building organism and the consequent identification of parameters, both quantitatively and qualitatively, for the determination of the physical quantities per components⁹ The physical quantities of the “product” and the identification of

parameters referring to indicators, in the case of residential construction, for example among the most significant indicators there is the ratio between the available surface¹⁰ and the surface of the vertical closing elements which assumes a remarkable importance for the purpose of standardized cost determination. In summary, following the typological breakdown of the building organism, the determination of the physical quantities to the identified parameters associated with a unit cost, determines the total cost of the work for significant and comparable indicators in order to apply the necessary endogenous and exogenous correction coefficients previously defined.

building organism and which can be physically defined by a congruent aggregation of technical elements.

¹⁰ As available surface: we means the including perimeter of the accommodation delimited from the vertical closings and the partitions type A (that means those which separate among them the accommodation from the horizontal and vertical distributors and from other accommodation or to other environments for any collective and public use). To this surface must be subtracts the surfaces hocked by vertical carrying structures and spaces for the fittings for any type of plant within the perimeter. In relation to the useful surface of the accommodation (as defined by the normative tide, in the decrees for the definition of the maximal ones of the norms in force for the different forms of the public residential housebuilding) are neglected the surfaces of the inside partitions to the accommodation that for a same building organism they vary strongly in general in operation of the cultural model that a determined historical moment and specific territory they vary strongly in dependence of the cultural model which presides to the use of the accommodation.

⁷ Istituto Nazionale di Statistica (ISTAT) http://dati.istat.it/Index.aspx?DataSetCode=DCSC_FABBRESID_1. Cost categories and categories are relate to hand-work, materials, transport and rental fees.

⁸ Terminology related to the user, performance, construction process and building quality regulation UNI 10838/1999.

⁹ In the economy of this contribution we define the component as a defined spatial object that performs a certain function in the

* **Orazio Campo**, Department of Architecture and Design (DIAP) Sapienza University of Rome.

e-mail: oraziocampo@gmail.com

** **Francesco Rocca**, Architect freelance.

e-mail: arch.francesorocca@gmail.com

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