



Analysis of the Reconstruction Process of the Historical Centres hit by the 2009 Abruzzi Earthquake: Intervention Costs and Analysis of the Grant Increases for Historic Traditional Buildings

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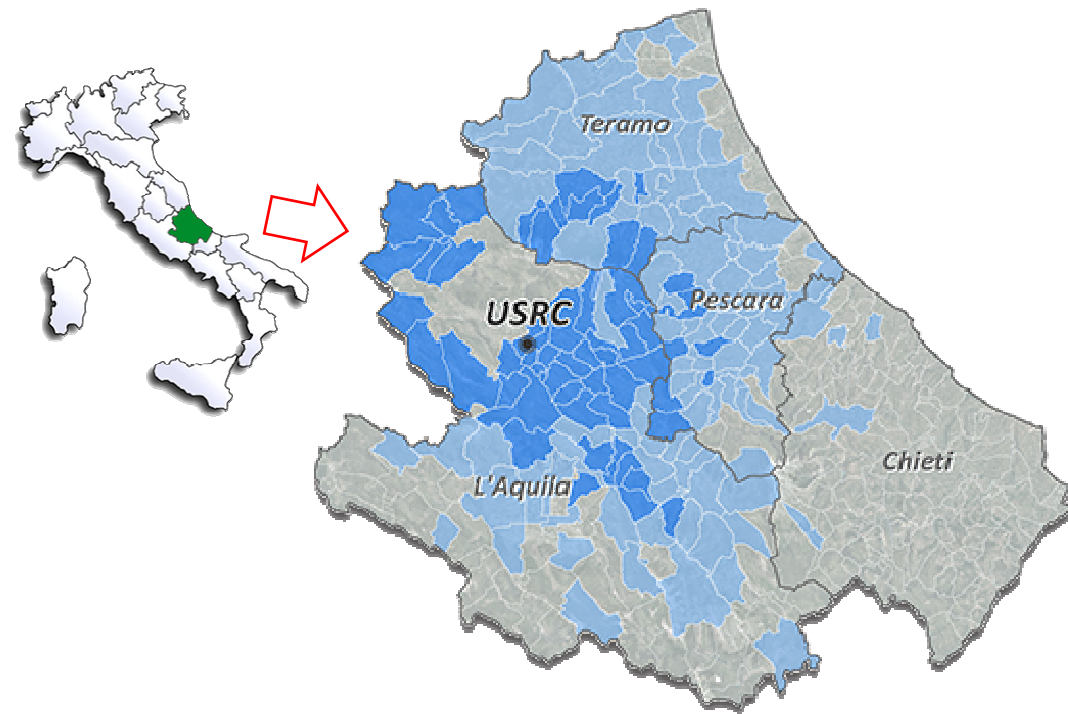
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On **April 6th 2009** an earthquake struck the Abruzzo Region, Central Italy. It was of Richter magnitude (MI) 5.8 and moment magnitude (Mw) 6.3

The most affected centre was **L'Aquila**, a historical city and capital of the region, but several small towns, hamlets and villages were strongly involved and damaged by the event.



Dark blue: Crater Area (56 Municipalities heavily damaged)
Light blue: Others areas with lighter damage

139.584 people involved in the quake (*residents in the crater area*)



RECONSTRUCTION MODEL **OUTSIDE** HISTORICAL CENTERS *a brief review...*

The reconstruction process of residential buildings damaged by L'Aquila 2009 earthquake began few months later the main event of April 6th 2009 and initially involved buildings **outside** historical centres. Reconstruction policy was regulated by Law 77/2009 and several Ordinances of the President of the Council of Ministers (OPCM)



STRATEGY:

Fully coverage of the repair work costs to restore the usability of damaged buildings with different thresholds for strengthening interventions as a function of the usability rating of each building (obtained from a post-earthquake field inspections carried out by team of surveyors and adopting **AeDES survey form** as a tool for the seismic damage and usability assessment).

PROCEDURE:

DESIGN



SURVEY



CONSTRUCTION

For each building the repair and strengthening works and relevant costs were determined by **practitioners** (engaged by owners) who carry out the construction executive project

A proper team, called "**Filiera**" was set up to oversee projects from the administrative, technical and economic angle and to deal with the numerous applications for funding

Once the project is approved, the approval form is transmitted to the public offices of the municipality concerned for transferring the financial contribution and to start the construction site.

20.400 requests for repair works in residential buildings with a total amount that can be estimated of the order of **9.1 billion euros**



RECONSTRUCTION MODEL OF RESIDENTIAL BUILDINGS IN THE HISTORICAL CENTERS (from August 2012)

The second phase of the reconstruction process involved **historical centers** of L'Aquila and other 56 municipalities; the reconstruction policy was regulated by Law 134/2012 which introduces a **parametric model** to determine the maximum public grant eligible to restore the usability of damaged buildings.

A new reconstruction model defined on the basis of new procedures was necessary in order to deal with the reconstruction of old masonry **building aggregates** (i.e. **groups of masonry buildings to form complex building agglomerates**) with a cultural and architectural heritage value. Historical masonry buildings incorporate structural elements, such as arches, domes, vaults and irregular shaped-columns, with earthquake-response, which is difficult to simulate and predict in numerical analyses.



Historical center of Castelvechio Calvisio (AQ)



Given the complex spatial and morphological structure of the territory, special rules for reconstruction have been issued for historical centres. The management of such stage of the reconstruction process was assigned to two special offices:



The Special Reconstruction Office of L'Aquila USRA for the reconstruction process of buildings in historical centres of L'Aquila

The Special Reconstruction Office of the Crater Municipalities - USRC for the reconstruction process of buildings in historical centres of other municipalities (56 municipalities in the area hit by the earthquake, the so called "crater", divided in **8 homogeneous areas** (with different colours in the map at left) with 8 relevant reconstruction offices, **UTR**, depending on USRC

<http://www.usrc.it/>

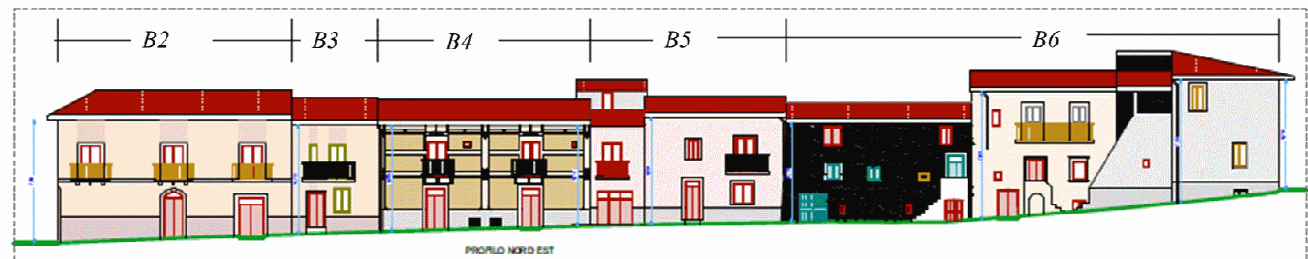
**The parametric model adopted by the USRC
Integrated Model for the municipalities of the Crater (IMC)**

Step 1: DEFINITION OF ALLOWABLE GRANT:

by means of a suitable form specifically set up to quickly define the building vulnerability class and damage grade, the so called **IMC form**

Step 2: **DEFINITION OF THE EXECUTIVE PROJECT:** including quantities and materials costs for repair, strengthening intervention, energy efficiency upgrade

The application for funding can be filled with reference to a **Building Aggregate** (namely **BA**); or a portion of the BA with homogeneous characteristics, **Aggregate Minimum Unit** (namely **AMU**). The application related to BA or AMU contains data related to one or more **buildings** (**B**) which consist of one or more dwellings.



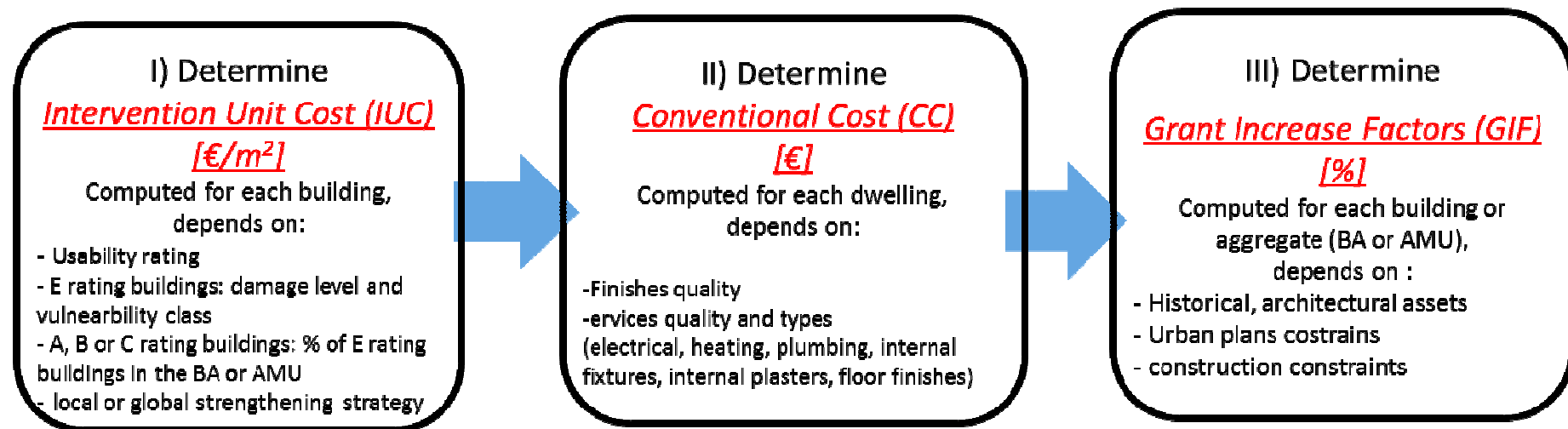


The parametric model adopted by the USRC Integrated Model for the municipalities of the Crater (IMC)

Step 1: **DEFINITION OF ALLOWABLE GRANT:**

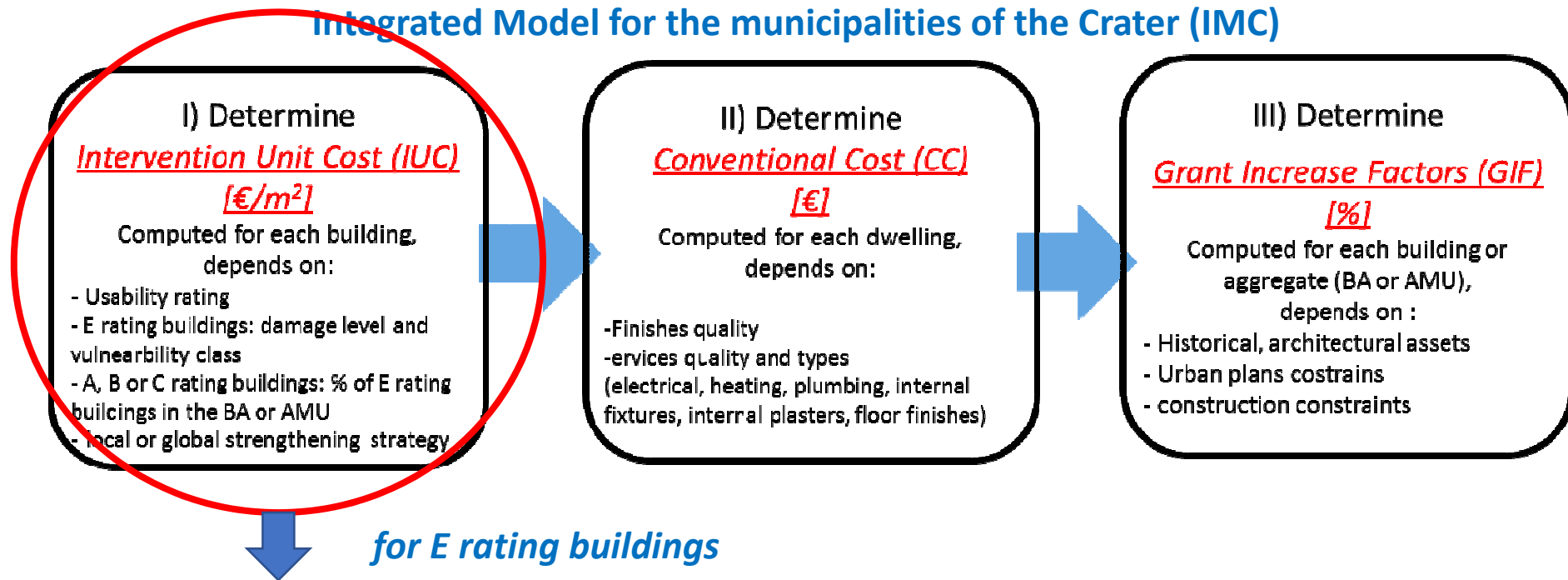
by means of a suitable form specifically set up to quickly define the building vulnerability class and damage grade, the so called **IMC form**

The *Allowable Grant*, AG, related to BA or AMU is determined according to the following procedure:





The parametric model adopted by the USRC Integrated Model for the municipalities of the Crater (IMC)



Damage level		Vulnerability class		
		V1	V2	V3
none	D0	L0	L0	L1
light	D1	L0	L1	L1
moderate	D2	L1	L1	L2
medium	D3	L1	L2	L3
heavy	D4	L2	L3	L3
very heavy	D5	L3	L3	L3

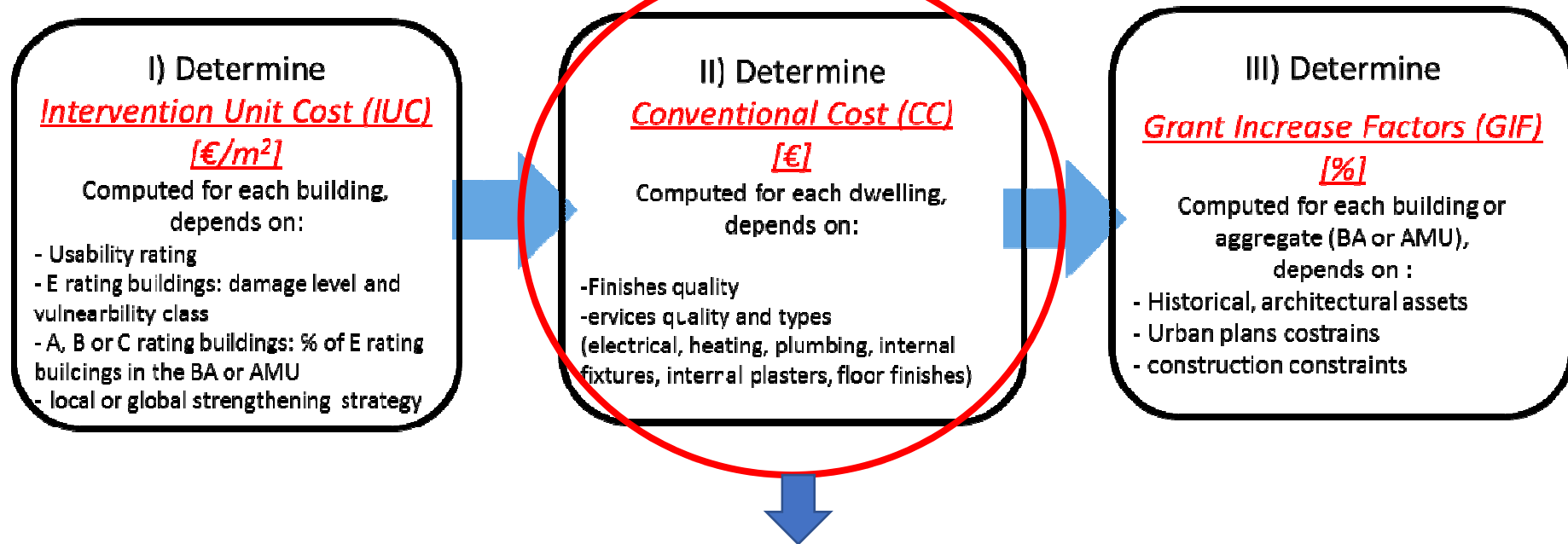


Damage-Vulnerability	IUC [€/m²]
L0	700
L1	1000
L2	1100
L3	1270



The parametric model adopted by the USRC

Integrated Model for the municipalities of the Crater (IMC)



The Conventional Cost (CC) is defined considering the presence of services, their quality, and the quality of finishes of each building dwelling according to the intended use. A preliminary analysis of the AeDES survey forms confirmed the presence of old unused buildings with level of finishing and quality of services much different by current building standards.

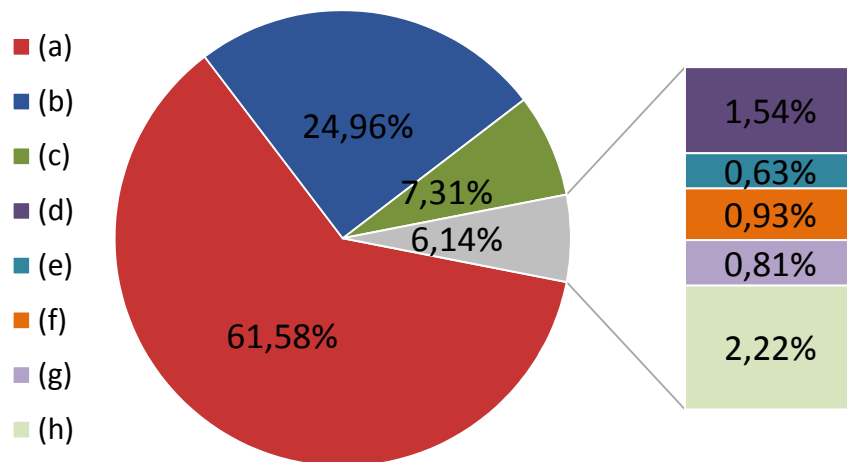
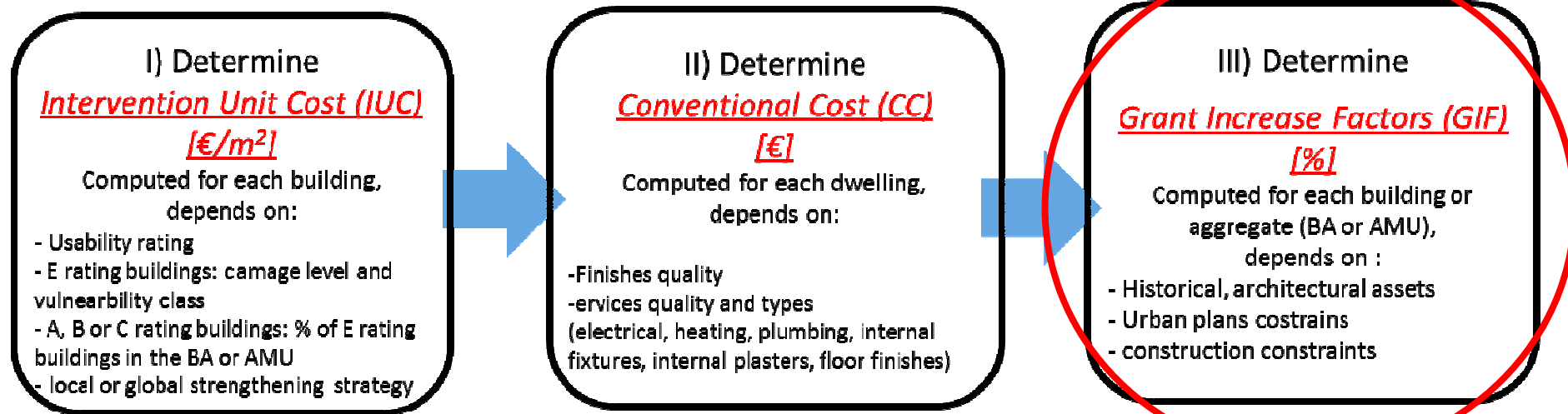
Percentage reduction coefficients, r_k , in case of finishing and services lacking.

Electrical	Heating	Plumbing	Internal fixtures	Internal plasters	Floor finishes
-5%	-4%	-2,5%	-4%	-4%	-7%



The parametric model adopted by the USRC

Integrated Model for the municipalities of the Crater (IMC)



Increases percentage related to total cost of approved interventions

account for:

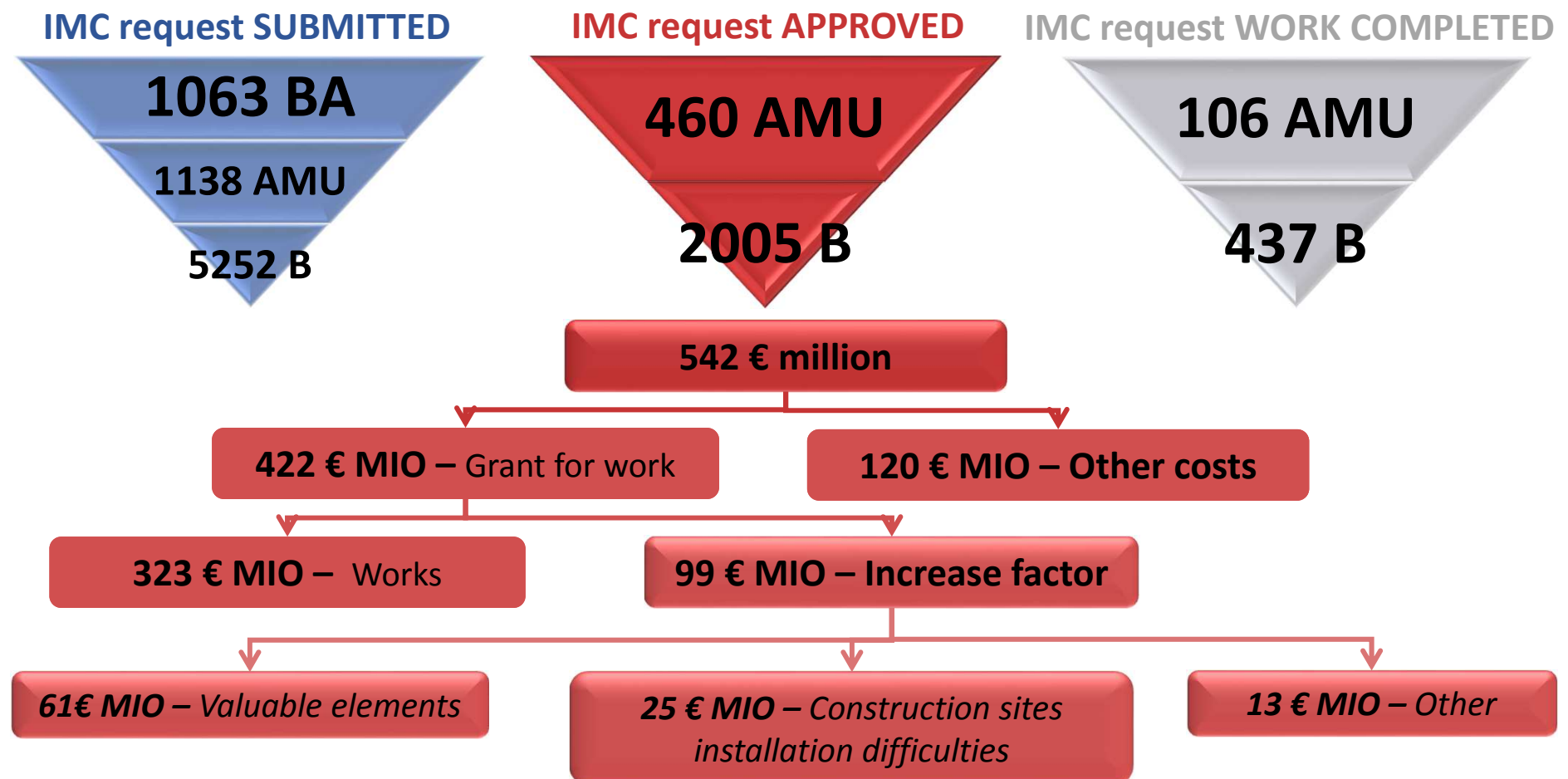
- Architectural, environmental, material and constructive values (a)
- Construcion sites installation difficulties (b)
- Local Amplification (c)
- Shores removal (d)
- Ruins safety (e)
- Presence of caves below the building (f)
- Ancillary urban Items (h)
- Minor elements (g)



Integrated Model for the municipalities of the Crater (IMC)

Grant approved and analysis of interventions

The parametric model started to be effective since 2014. At the end of September 2017, 1138 parametric IMC requests have been submitted, 460 of which have been already approved for a total grant amount of around 542 million of euros

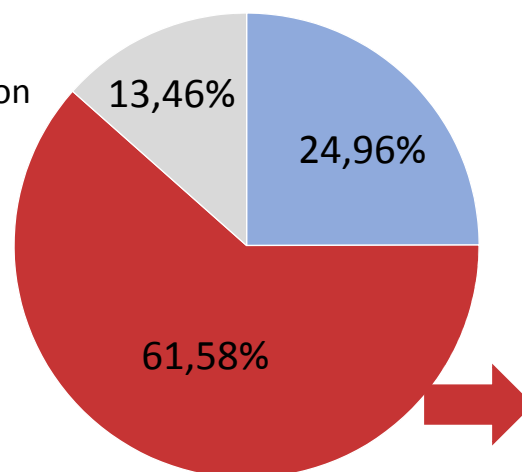




■ Construction
sites installation
difficulties

■ Valuable
elements

■ Other



Increase factors percentage related to total cost of
approved interventions

99 € MIO – Increase factor

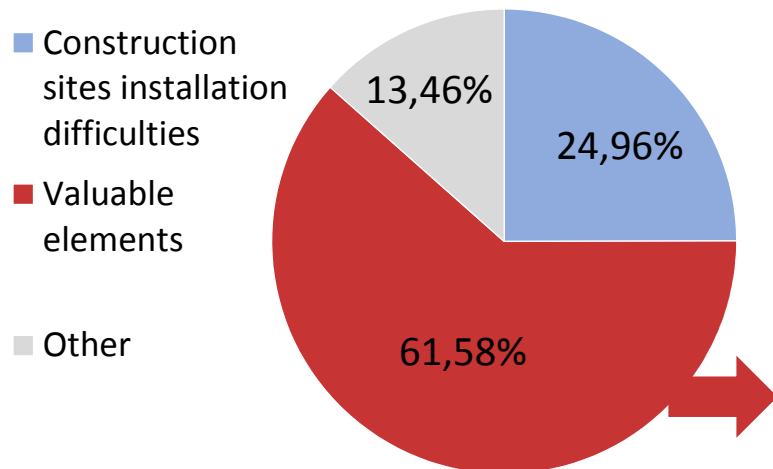
**61€ MIO –
Valuable
elements**

**25 € MIO –
Construction
sites
installation
difficulties**

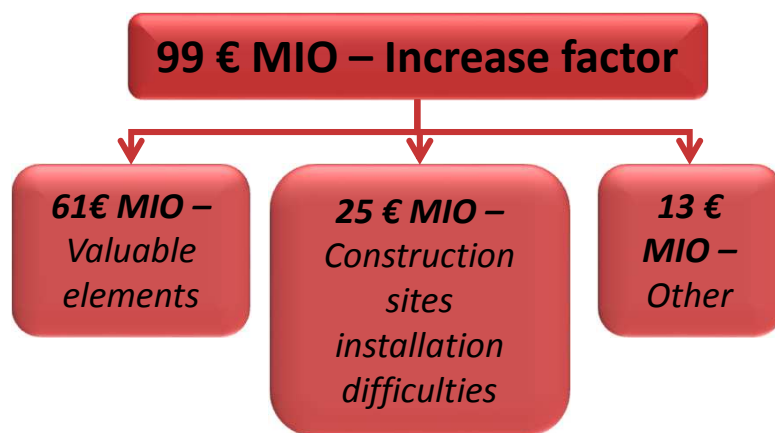
**13 €
MIO –
Other**

GRANT INCREASE FACTORS OF THE VALUABLE ELEMENTS

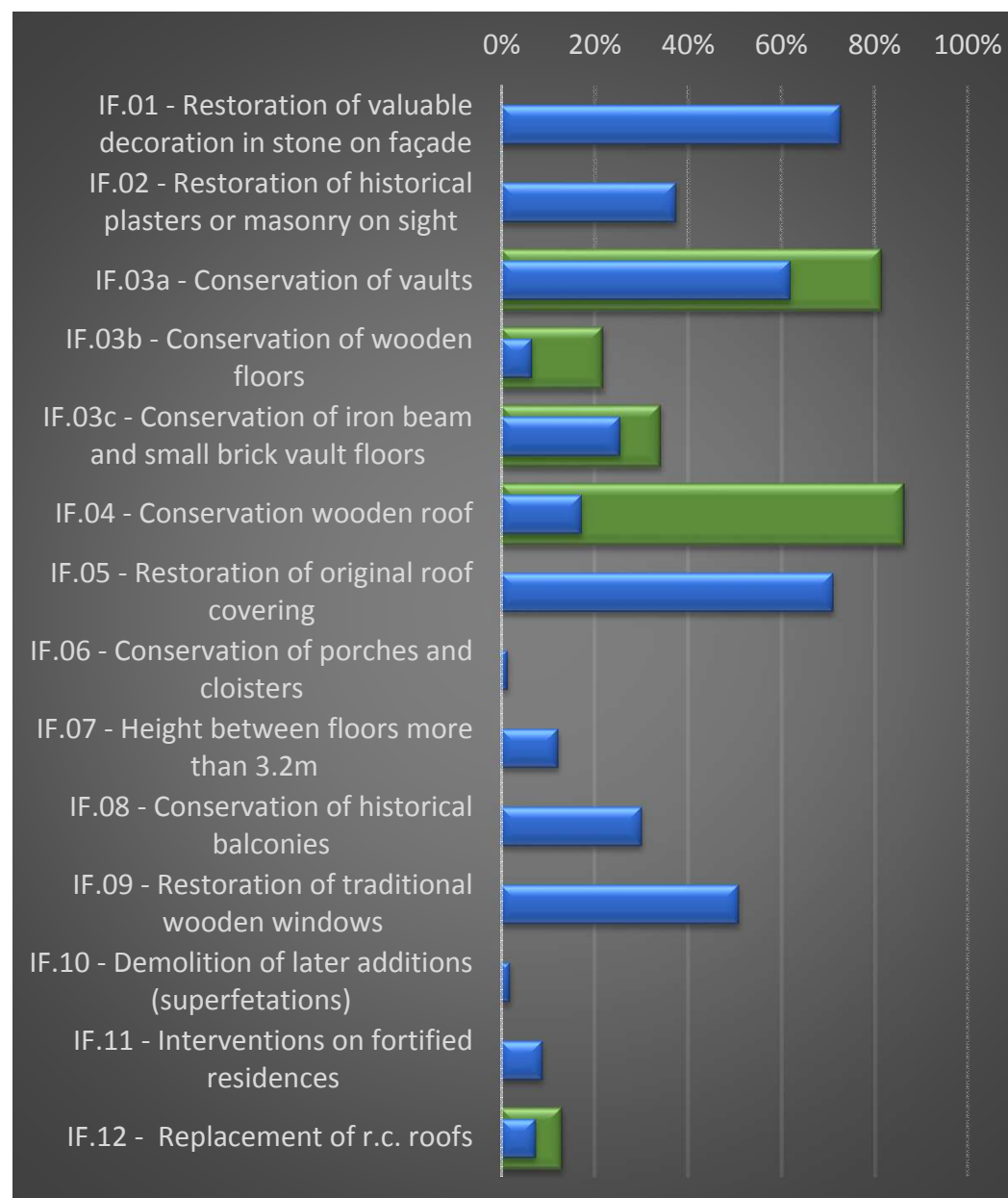
IF.01	Restoration of valuable decoration in stone on façade Like stone portal, mouldings, cornices (in stone, brick, plaster or wood)		IF.06	Conservation of porches and cloisters Conservation and restoration of common spaces such as porches, entrance halls and cloisters	
IF.02	Restoration of historical plasters or masonry on sight		IF.07	Height between floors more than 3.2 m 	
IF.03a	Conservation of vaults		IF.08	Conservation of historical balconies with stone corbels and/or stone or iron balustrades	
IF.03b	Conservation of wooden floors		IF.09	Restoration of traditional wooden windows or substitution of incongruous ones	
IF.03c	Conservation of iron beams and small brick vault floors		IF.10	Demolition of later additions (superfetations)	
IF.04	Conservation of wooden roof		IF.11	Interventions on fortified residences (fortress-houses, tower-houses, etc.)	
IF.05	Restoration of the original roof covering Reintegration of roof covering with handmade tiles		IF.12	Replacement of r.c. roofs Replacement of reinforced concrete with wooden roofs, in accordance with local tradition	



Increase factors percentage related to total cost of approved interventions



On the right graphic, % of buildings that received a specific grant increase with respect the total number of buildings (Blue); distribution of floor and roof types (Green).





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