

Valutazioni multidimensionali per una sostenibilità integrale

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OBIETTIVO DEL LAVORO DI RICERCA

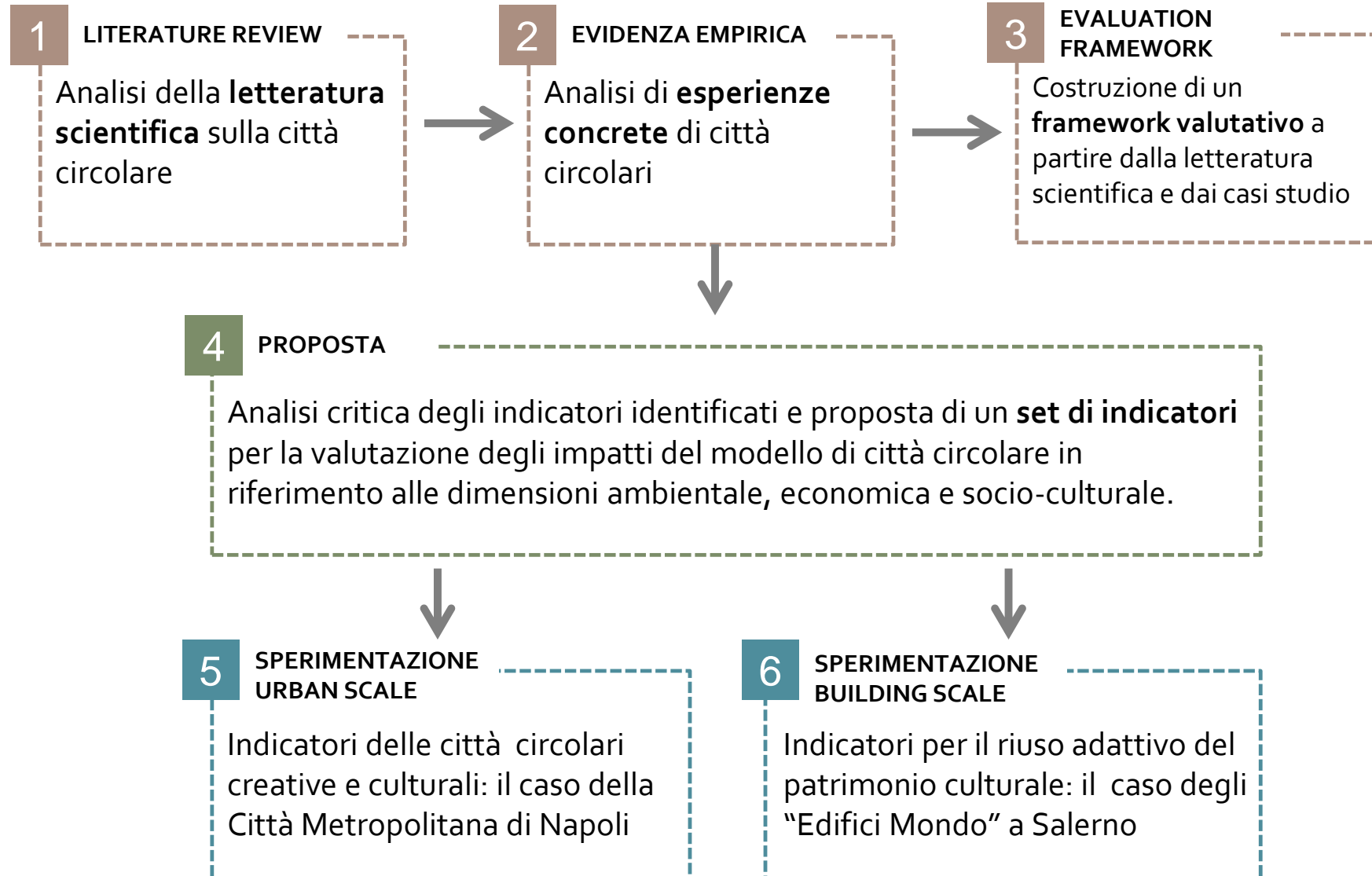
Obiettivo del presente lavoro di ricerca è quello di proporre un **quadro valutativo degli impatti multidimensionali del modello di città circolare**, con particolare attenzione al capitale culturale e creativo, alla salute e al benessere.



STRUTTURA DELLA PRESENTAZIONE

1. Introduzione
2. Metodologia
3. Il modello di città circolare: analisi della letteratura e delle esperienze concrete
4. Gli strumenti per l'attuazione del modello di città circolare: indicatori multidimensionali
5. Città circolari, culturali e creative: il caso della Città Metropolitana di Napoli
6. Città circolare e patrimonio culturale: il caso degli "Edifici Mondo" a Salerno

METODOLOGIA



IL MODELLO DI CITTA' CIRCOLARE



IN LETTERATURA

WILLIAMS, 2021

A circular city is a **socio-ecological system**, consisting of a bio-geo-physical unit and its associated social actors and institutions. It is a **complex, regenerative and adaptive system**, delimited by spatial and functional boundaries, surrounding an ecosystem. There are three actions fundamental to both a circular city and circular development: Looping actions; Ecologically regenerative actions; Adaptive actions.

KOENDERS AND DE VRIES, 2015

The circular city is a **metaphor for a new way of looking at the city and of organizing it**. The idea is that linear processes in the circular city, from extraction to waste can be (partly) replaced by circular processes and that lasting connections can be made between flows. A circular society is **less dependent on the import of scarce and precious resources** and at the same time the negative effects of production and consumption will be limited

ELLEN MACARTHUR FOUNDATION, 2015

A circular city **embeds the principles of a circular economy** across all its functions, establishing an urban system that is regenerative, accessible and abundant by design. These cities aim to **eliminate the concept of waste, keep assets at their highest value at all times, and are enabled by digital technology**. A circular city seeks to generate prosperity, increase liveability, and improve resilience for the city and its citizens, while aiming to decouple the creation of value from the consumption of finite resources.

NELLE "ESPERIENZE CONCRETE"



CIRCULAR CITY
MODEL
(some reports of
concrete experiences)

IL MODELLO DI CITTA' CIRCOLARE – ESPERIENZE CONCRETE

	City—Country	Project Name
1	London (United Kingdom)	Circular London
2	Glasgow (United Kingdom)	Circular Glasgow
3	Rotterdam (The Netherlands)	Circular Rotterdam
4	Amsterdam (The Netherlands)	Circular Amsterdam
5	Paris (France)	Circular Paris
6	Antwerp (Belgium)	Antwerp Circular South
7	Brussels (Belgium)	Be Circular Be.Brussels
8	Maribor (Slovenia)	Roadmap towards the circular economy in Slovenia
9	Luibljana (Slovenia)	Roadmap towards the circular economy in Slovenia
10	Praga (Czech Republic)	Circular Prague
11	Kawasaki (Japan)	Eco-town project
15	Kalundborg (Denmark)	Kalundborg Industrial Park
12	Marseille (France)	*
13	Göteborg (Sweden)	*
14	Malmö (Sweden)	*

“PUNTI DI INGRESSO” PER L’ATTUAZIONE DEL MODELLO DI CITTA’ CIRCOLARE

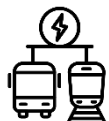
I principali “punti di ingresso” per l’attuazione del modello di città circolare (emersi dai casi studio analizzati) sono:



Ambiente costruito (Es. Amsterdam, Londra)



Sistema energetico (Es. Rotterdam)



Mobilità (Es. Parigi, Rotterdam)



Rifiuti (Es. Glasgow)



Settore agro-alimentare (Es. Londra)

QUALI STRUMENTI PER L'ATTUAZIONE DEL MODELLO DI CITTA' CIRCOLARE?

QUALI STRUMENTI DI VALUTAZIONE? QUALI INDICATORI?.

CATEGORIE DI INDICATORI IN TERMINI DI SCALA TERRITORIALE DI RIFERIMENTO

- > **Micro-level (Mi)** - livello aziendale, livello edificio, livello comunità
- > **Meso-level (Me)** - livello di rete aziendale, parco eco-industriale, livello quartiere, livello città;
- > **Macro-level (Ma)** - livello regionale, livello nazionale, livello internazionale.

CATEGORIE DI INDICATORI IN TERMINI DI RISULTATO

> **Indicatori di circolarizzazione:**

Indicatori relativi all'intensità dei processi circolari

Es. rapporto tra materiali recuperati e il totale dei materiali consumati; numero di scambi simbiotici tra imprese

> **Indicatori di impatto:**

Indicatori relativi agli impatti che i processi circolari hanno sulla città

Es. n. di nuovi posti di lavoro generati; quantità di emissioni di inquinanti (PM₁₀, CO₂,)

INDICATORI DEDOTTI DALLA LETTERATURA SCIENTIFICA

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLA LETTERATURA SCIENTIFICA

Indicator	Unit of Measure	Scale
Environmental Dimension		
Annual amount of greenhouse gas emissions; Annual amount of CO ₂ emissions; Percentage of reduction of greenhouse gas emissions	%/year or tons/year	Mi-Me-Ma
Recycling rate of municipal waste	%/year	Me
Recycling rate of packaging waste	%/year	Me-Ma
Amount of landfilled waste Percentage of material solid waste landfilled Percentage of household waste ended in landfills	%/year or tons/year	Mi-Me-Ma
Percentage of material solid waste incinerated	%/year	Me-Ma
Percentage of material solid waste composted	%/year	Me-Ma
Using of recycled goods in municipal administration	%/year	Me
Using of recycled goods in industrial production	%/year	Me-Ma
Saving energy due to the use of recycled goods in industrial production	%/year or kWh/year	Mi-Me-Ma
Saving water due to the use of recycled goods in industrial production	%/year mc/year	Me-Ma
Amount of recycled goods sold	N./month (or year)	Me-Ma
Percentage of household waste reused or recycled	%/year	Me-Ma
Unsold products recovered every day for redistribution at the market itself or through nearby community facilities	Kg/day	Me-Ma

**DIMENSIONE
ECONOMICA**

**DIMENSIONE
AMBIENTALE**

**DIMENSIONE
SOCIO-CULTURALE**

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLA LETTERATURA SCIENTIFICA

Input (energy, materials) in production processes from renewable sources	**	Mi-Me-Ma
Input in production processes from reused materials	**	Mi-Me-Ma
Input in production processes from recycled materials	**	Mi-Me-Ma
Output from production processes from renewable sources	**	Mi-Me-Ma
Output from production processes from reused materials	**	Mi-Me-Ma
Output from production processes from recycled materials	**	Mi-Me-Ma
Amount of resources saved	**	Mi-Me-Ma
Percentage of water consumption for habitat (reduction for example thanks to harvesting rainwater on the roofs)	%/year	Mi-Me-Ma
Volume (amount) of resource flow	**	Me-Ma
Amount of recycled resources	**	Mi-Me-Ma
Amount of reused resources	**	Mi-Me-Ma
Percentage of green roofs	%/ total city surface	Mi-Me-Ma
Amount of food waste treated Food waste treated in Small and Medium-size Enterprises (SMEs)	%/total food waste	Mi-Me-Ma

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**DIMENSIONE
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INDICATORI CITTA' CIRCOLARI DEDOTTI DALLA LETTERATURA SCIENTIFICA

Percentage of retrofitting interventions on buildings	%/total building	Mi–Me– Ma
Percentage of degraded buildings	%/ total building	Me–Ma
Public transport usage	% of inhabitants using public transport	Me–Ma
Electrical energy consumed in the transport sector	% of transport sector using electrical energy	Me–Ma
Synergies among industries	N.	Me–Ma
Safe water accessibility (water issues regarding its treatment and distribution)	**	Me–Ma
Water efficiency (water issues regarding its treatment and distribution)	**	Me–Ma
Separated waste (recovery and treatment of waste generated in city)	Kg/year	Me–Ma
Percentage of non-renewable energy use	%/year	Mi- Me– Ma
Percentage of renewable energy use	%	Mi–Me– Ma
Percentage of local nutrient recovery	%	Me–Ma
Buildings designed for complete disassembly	N.	Me–Ma
Reuse of building components at the end of life	%	Me–Ma
Design for flexibility by using modular systems	%	Me–Ma
Recycling rate of recyclable materials and constructions	%	Me–Ma
Low-impact and non-toxic materials used in production processes	%	Me–Ma
Sustainable materials sourced from certified or eco-verified sources	%	Me–Ma
Amount of waste heat from industry used for heating the city and horticulture	kWh/year	Mi–Ma– Ma

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLA LETTERATURA SCIENTIFICA

Amount of groundwater warmed in the earth and used to heat homes and offices	Mc/year	Mi–Ma– Ma
Number of homes getting their energy (heat and electricity) from biogas (i.e., fermenting the manure of cows)	N./total	Me–Ma
Amount of recovered phosphate from the sewage water	Kg/day	Mi–Me– Ma
Percentage of reuse or recycling of recyclable demolition materials	%	Mi–Me– Ma
Economic and Financial Dimensions		
Spending on waste management	€/year	Me–Ma
Disposable income of households (reduction through the reduced costs of products and services)	€/year	Me–Ma
Revenue from recycled goods sold	€/month €/year	Mi–Me– Ma
Potential value of the material after recovery/re-use	€	Mi
Circular economy innovation budget (in relation to the number platforms and businesses that lead to innovation in circular economy subjects)	%/year	Mi–Me– Ma
Annual cost saving from recover phosphate from the sewage water (precious and scarce fertilizer)	€/year	Mi–Me– Ma
Social and Cultural Dimensions		
Liveability (e.g., increase through reduction of time lost from congestion, reduction of air pollution, improved waste and wastewater treatment)	**	Me–Ma
Employment opportunities Job creation	N. of jobs	Me–Ma
Number of events and dissemination activities about circular economy	N. of events/year	Me–Ma
Participants in events about circular economy (including public bodies, companies, universities, research centres, professional		

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLA LETTERATURA SCIENTIFICA

Economic and Financial Dimensions

Spending on waste management	€/year	Me–Ma
Disposable income of households (reduction through the reduced costs of products and services)	€/year	Me–Ma
Revenue from recycled goods sold	€/month €/year	Mi–Me– Ma
Potential value of the material after recovery/re-use	€	Mi
Circular economy innovation budget (in relation to the number platforms and businesses that lead to innovation in circular economy subjects)	%/year	Mi–Me– Ma
Annual cost saving from recover phosphate from the sewage water (precious and scarce fertilizer)	€/year	Mi–Me– Ma

Social and Cultural Dimensions

Liveability (e.g., increase through reduction of time lost from congestion, reduction of air pollution, improved waste and wastewater treatment)	**	Me–Ma
Employment opportunities Job creation	N. of jobs	Me–Ma
Number of events and dissemination activities about circular economy	N. of events/year	Me–Ma
Participants in events about circular economy (including public bodies, companies, universities, research centres, professional associations, etc.)	N. of participants/year	Me–Ma
Active population in circular economy initiatives	%	Me–Ma
People involved in the informal waste recycling sector	%/tot. inhabitants	Me–Ma

Note: ** The indicators whose unit of measure does not emerge or is not clear in the source are reported with a double asterisk.

INDICATORI DEDOTTI DALLE ESPERIENZE CONCRETE

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Indicator	Unit of Misure	Scale	City Reference
Environmental Dimension			
Amount or percentage of recycled material	Tons/year or %/year	Mi-Me-Ma	Circular London Circular Rotterdam Maribor, Slovenia Ljubljana, Slovenia
Amount or percentage of products reused	Tons/year or %/year	Mi-Me-Ma	Circular London Circular Rotterdam Maribor, Slovenia
Amount or percentage of products recovered	Tons/year or %/year	Mi-Me-Ma	Circular Prague Maribor, Slovenia Ljubljana, Slovenia
Amount of raw materials used in the manufacturing processes	Tons/year	Mi-Me-Ma	Circular London
Average amount of materials retained in the cycle per citizen per year	Kg/year	Mi-Me-Ma	Antwerp Circular South
Percentage of incoming/outgoing flows	%/year	Me	Circular Paris
Amount of CO ₂ emissions Amount of greenhouses gases emissions	Kg of CO ₂ /year	Mi-Me-Ma	Circular London Circular Amsterdam Circular Prague Malmö, Sweden

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INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Average amount of materials retained in the cycle per citizen per year	Kg/year	Mi-Me-Ma	Antwerp Circular South
Percentage of incoming/outgoing flows	%/year	Me	Circular Paris
Amount of CO ₂ emissions Amount of greenhouses gases emissions	Kg of CO ₂ /year	Mi-Me-Ma	Circular London Circular Amsterdam Circular Prague Malmö, Sweden
CO ₂ (or CO ₂ equivalent) emissions saved (also through industrial and urban symbiosis) GHG emissions saved (for example by an increase in circularity)	Tons/year or T Co ₂ equivalent /year or %/year	Mi-Me-Ma	Circular London Circular Glasgow Marseille Kalundborg Industrial Symbiosis Circular Prague Malmö, Sweden Gothenburg, Sweden Kawasaki, Japan
Amount of emissions of NO _x	Tons/year	Me-Ma	Circular Prague
Amount of emissions of fine dust emissions Annual average air quality particulate matter	Tons/year or PM _{2.5} µg/m ³	Me-Ma	Circular Prague Circular Rotterdam
Reduction in embodied carbon (building environment chain)	kilograms of CO ₂ e per kilogram of product	Mi-Me-Ma	Circular London
CO ₂ intensity	tons/capita	Mi-Me-Ma	Circular Rotterdam
Embedded CO ₂ emissions ("Further research is needed to calculate this indicator" [37])	tons/capita	Mi-Me-Ma	Circular Rotterdam
Percentage of reduction of emissions due to a smart and clean building logistics (construction sector)	%	Mi-Me-Ma	Circular Rotterdam
Air pollution and greenhouse gas emissions associated to transport	Tons/year	Me-Ma	Circular London

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Average amount of products going to landfill or incineration	Tons/year	Me–Ma	Circular London Circular Prague
Waste reduction in production of goods–raw material efficiency	kilograms of waste per €1000 output	Me–Ma	Circular Amsterdam Circular Prague
Amount or percentage of waste separation	%/year or tons/year	Me–Ma	Circular Rotterdam Circular Prague
Increase in the clean plastics and drink packaging streams from residual waste	%/year	Me–Ma	Circular Rotterdam
Percentage of recycling of the solid waste generated in the city Percentage of recycle of packaging waste Percentage of recycle of municipal waste	%/year	Me–Ma	Circular Rotterdam Maribor, Slovenia Ljubljana, Slovenia
Amount of construction waste by implementing of interventions related to circular economy	tons/year	Me–Ma	Circular Rotterdam
Difference between tonnes of waste and tonnes of products consumed	Tons of waste/tons of products consumed	Me–Ma	Circular Rotterdam
Tonnage of waste diverted via repair, reuse, recovery and upcycling activities (recycling centres, artisans, second-hand goods stores, fab labs, etc.)	tons/year	Me -Ma	Circular Paris
Traceability of hazardous waste	**	Me–Ma	Maribor, Slovenia
Amount of waste produced in the city Amount of waste generated per capita	Tons/year or tons/per capita/year	Me–Ma	Gothenburg, Sweden Circular London Circular Rotterdam
Amount of waste produced in the city and treated within the city itself	tons/year or %/year	Me	Circular Prague
Amount of solid waste reused	Tons/year or %/year	Me–Ma	Maribor, Slovenia Ljubljana, Slovenia Circular Glasgow Circular Prague

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Amount or percentage of waste avoided Amount of household waste reduced preventing waste and encouraging reuse	Tons/year or %/year	Mi-Me-Ma	Circular London Circular Glasgow Circular Prague Circular Rotterdam Antwerp Circular South Circular Paris Maribor, Slovenia Malmö, Sweden Gothenburg, Sweden
Amount of biowastes processed in biogas facilities	% or tons/year	Me-Ma	Circular Prague
Percentage of reduction of noise of waste collection fleet by a perceived percentage	%	Me-Ma	Circular Prague
Use of renewable resources	%/year	Mi-Me-Ma	Circular Amsterdam Antwerp Circular South Circular Rotterdam Malmö, Sweden
Energy savings per year	%/year	Mi-Me-Ma	Circular Glasgow Circular Paris
Tap water use	%/year	Me-Ma	Antwerp Circular South
Absolute (kWh) and relative (%) reduction of yearly electricity consumption	kWh/year or %/year	Mi-Me-Ma	Antwerp Circular South
Less use of peak power	%/year	Mi-Me-Ma	Antwerp Circular South

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INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Primary resources used	% /year or Tons/year	Mi–Me– Ma	Circular Rotterdam
Virgin resources used			Malmö, Sweden
Amount of primary resource use avoided			Circular London Circular Prague Circular Glasgow
Primary raw material demand per capita	ton/capita	Me–Ma	Circular Rotterdam
Energy requirement per capita	GJ/person/year	Me–Ma	Circular Rotterdam
GDP per energy requirement	€/GJ	Me–Ma	Circular Rotterdam
Supply of renewable energy	%	Mi–Me– Ma	Circular Rotterdam
Embedded energy use ("Further research is needed to calculate this indicator" [37])	ton/capita	Mi	Circular Rotterdam
Amount of material saving due to the implementation of circular strategies	tons	Mi–Me– Ma	Circular Amsterdam
More efficient resource use	**	Mi–Me– Ma	Circular London
Percentage of renewable or recycled energy use	%/year	Mi–Me– Ma	Malmö, Sweden
Renewable energy production on total energy production	MWh/year/total	Mi–Me– Ma	Malmö, Sweden
Fossil-fuel-free transport sector	%	Me–Ma	Malmö, Sweden
Percentage of renewable electricity supply for all municipal operations	%	Me	Malmö, Sweden
Number of families powered by energy produced by wind turbines	N./total	Me–Ma	Malmö, Sweden

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Electricity consumption per capita	MWh per Capita/year	Me–Ma	Malmö, Sweden
Public transit ridership for work and school commutes	%	Me–Ma	Malmö, Sweden
Eco-car strategy–Municipal fleet powered by biogas, hydrogen or electricity (including plug-in hybrids)	%/ year	Me–Ma	Malmö, Sweden
Construction materials come from secondary sources	%	Mi–Me– Ma	Circular Prague
Tonnes of residual materials not utilised (construction sector)	Tons/total	Mi–Me– Ma	Circular Prague
Percentage of building heating mainly by natural gas	%	Me–Ma	Circular Prague
Percentage of building heating mainly by energy from incineration	%	Me–Ma	Circular Prague
Percentage of water heating by natural gas	%	Mi–Me– Ma	Circular Prague
Raw material consumption	%/year	Mi–Me– Ma	Circular Prague
Sq metres that includes facilities and services to develop their circular sustainable projects	Sqm/total surface	Me–Ma	Be circular Be.Brussels
Liters of households daily water-consumption	Liters/day	Me–Ma	Antwerp Circular South
Raw materials with high risk for impact on biodiversity (“Further research is needed to calculate this indicator” [37])	%	Me–Ma	Circular Rotterdam
Percentage of sustainable food	%	Me–Ma	Circular Paris
Maritime traffic (amount of maritime throughput)	Tons/year	Me–Ma	Marseille
Land covered by a circular platform in the industrial port area	Sqm	Me–Ma	Marseille
Percentage of the land area used for circular economy projects implementation	%	Me–Ma	Marseille
Number of plants involved in circular economy projects	N./year	Me–Ma	Marseille
Percentage of biodiversity	%	Me–Ma	Malmö, Sweden
Percentage of annual rainfall absorbed by green roofs	%/year	Me–Ma	Malmö, Sweden

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Percentage of the land area used for circular economy projects implementation	%	Me-Ma	Marseille
Number of plants involved in circular economy projects	N./year	Me-Ma	Marseille
Percentage of biodiversity	%	Me-Ma	Malmö, Sweden
Percentage of annual rainfall absorbed by green roofs	%/year	Me-Ma	Malmö, Sweden
Temperature of external facades (decrease for example thanks to green facades)	°C	Mi	Malmö, Sweden
Indoor temperatures (decrease for example thanks to green facades)	°C	Mi	Malmö, Sweden
Amounts of ground-level ozone recorded near the green facades	**	Mi	Malmö, Sweden
Creation of protected green areas	N./year	Me-Ma	Malmö, Sweden
Green areas used as stormwater storage	Sqm/total surface	Me-Ma	Malmö, Sweden
Energy consumption referred to transport sector	KWh/year	Me-Ma	Maribor, Slovenia
Proportion of green and recreational areas per capita	%	Me-Ma	Maribor, Slovenia
Percentage of improvement of fuel utilisation compared to a separate production of heat and power	%	Me-Ma	Kalundborg Industrial Symbiosis
Reduction of the total water consumption by recycling water and by letting it circulate between the individual symbiosis partners	%	Me-Ma	Kalundborg Industrial Symbiosis
Amount of ground water substituted by lake water that is processed up to drinking water quality by municipality. Amount of surface water saved	Cubic meters/year	Me-Ma	Kalundborg Industrial Symbiosis
Amount of reduced oil consumption through symbioses	Tons/year	Me-Ma	Kalundborg Industrial Symbiosis
Amount of newspaper/cardboard sold to cardboard and paper consuming industries producing new paper, egg boxes, etc.	Tons/year	Me-Ma	Kalundborg industrial symbiosis
Amount of rubble and concrete used for different surfaces after crushing and sorting	Tons/year	Me-Ma	Kalundborg
Amount of garden/park refuse delivered as soil amelioration in the area	Tons/year	Me-Ma	Kalundborg industrial symbiosis
Amount of bio waste from households and company canteens used in the compost and biogas production	Tons/year	Me-Ma	Kalundborg industrial symbiosis

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Amount of iron and metal resold after cleaning for recycling	Tons/year	Me–Ma	Kalundborg industrial symbiosis
Amount of glass and bottles that are sold to producers of new glass	Tons/year	Me–Ma	Kalundborg industrial symbiosis
Amount of resources saved through the industrial symbiosis initiatives	Tons/year	Me–Ma	Kalundborg industrial symbiosis
Number of different resource streams exchanged	N. /year	Me–Ma	Kalundborg Industrial Symbiosis
Climate change adaptation	**	Me–Ma	Circular Prague
Number of symbioses/synergies connecting businesses (resources exchanged)	N./year	Me–Ma	Kawasaki, Japan Malmö, Sweden
Reduction in the physical value of material use due to industrial and urban symbiosis	%	Me–Ma	Kawasaki, Japan
Economic And Financial Dimensions			
Money saved (in a year) for average household due to reducing the amount of products thrown away	€/year	Me–Ma	Circular London
Financial savings to both consumers and businesses adopting more efficient circular business models	€/year	Mi–Me– Ma	Circular London
Financial savings to public sector bodies through improved procurement practices/waste management	€/year	Me–Ma	Circular London
Financial savings for consumers from decreased consumption of “new products”	€/year	Me–Ma	Circular London
Waste management costs	€/year	Me–Ma	Circular Glasgow Circular Prague
Budget allocated to stimulate pilot projects that employ circular economy at the local level	€/year	Me	Be circular Be.Brussels
Environmental costs (costs of exhaustion, water pollution, CO ₂ -emissions, toxicity and land use in € per kilogram)	€/kg	Me–Ma	Circular Amsterdam
Gross value added	€/year	Mi	Circular Prague
Return on investment	€	Mi	Circular Prague
Total revenue from sale/leasing of reused products	€/year	Mi	Circular Prague
Economic savings in purchasing reused products for citizens	€/year	Mi	Circular Prague

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Economic savings in purchasing reused products for citizens	€/year	Mi	Circular Prague
Resource usage: total raw material productivity	GDP/tons of primary material input	Mi–Me–Ma	Circular Rotterdam
Euros allocated from the municipality to various district heating and district energy projects	€/year	Me	Malmö, Sweden
Sustainability of investments from the municipality	**	Me	Malmö, Sweden
Average value of products	€	Mi	Circular London
Value of re-usable or recyclable used goods sent to landfill	€	Mi	Circular London
Money granted to businesses or research projects linked to the circular economy	€/year	Me–Ma	Be circular Be.Brussels
Increase in productivity for municipality by organizing the production chains in a circular way	%/year or €/year	Me	Circular Amsterdam
Net added value due to the implementation of circular strategies	€/year	Mi–Me–Ma	Circular Amsterdam
Value creation thanks to the growth of circular economy models	€/year	Mi–Me–Ma	Circular Paris
Volume of sales thanks to the growth of circular economy models	Amount/year or €/year	Mi–Me–Ma	Circular Glasgow
Sales of locally produced goods	Amount/year or €/year	Me–Ma	Circular Glasgow
Revenues through sales thanks to the growth of circular economy models	€/year	Mi–Me–Ma	Circular Glasgow
Change in GDP through circular activities	%	Ma	Circular Rotterdam
Turnover of organizations working in the circular economy (including all sectors and types)	€/year	Mi	Circular Paris
Global sales related to circular economy	%/year	Me–Ma	Marseille
Annual fees related to circular economy	%/year	Me–Ma	Marseille
Tenancy turnover	%/year	Me–Ma	Malmö, Sweden
Costs related to flood risk	€/year	Me–Ma	Malmö, Sweden

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Costs related to flood risk	€/year	Me–Ma	Malmö, Sweden
Resources productivity	**	Me–Ma	Maribor, Slovenia
Creating added value and economic growth	€/year	Me–Ma	Maribor, Slovenia Ljubljana, Slovenia
Attractiveness in terms of tourist visits	N. of visitors/year	Me–Ma	Maribor, Slovenia Ljubljana, Slovenia
Public funding in circular economy projects	€/year	Me–Ma	Gothenburg
Economic advantage from industrial symbiosis activities	€/year	Me–Ma	Kawasaki, Japan
Economic opportunity generating from waste diverted from incinerator and landfill thanks to material exchanges	€/year	Me–Ma	Kawasaki, Japan
Social and Cultural Dimensions			
Number of new jobs			Circular London Marseille
Share of circular jobs (full- or part-time jobs that are related to one of the seven basic principles of circular employment)			Circular Amsterdam Circular Rotterdam Circular Paris
Percentage of new jobs related to the circular economy	N./year or %/year	Mi–Me– Ma	Circular Glasgow Kalundborg industrial symbiosis
Number of new jobs from recycling of packaging			Maribor, Slovenia
Number of new jobs from industrial ecology			Circular Prague Ljubljana, Slovenia
Number of new green jobs			Kawasaki, Japan

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SOCIO-CULTURALE

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

New business opportunities New businesses that have integrated circularity into their development process	N./year or %/year	Me–Ma	Circular London Marseille Circular Amsterdam Circular Rotterdam Circular Paris Circular Glasgow Kalundborg industrial symbiosis Maribor, Slovenia Circular Prague Ljubljana, Slovenia Be circular Be.Brussels
Number of training opportunities related to circular economy	N./year	Me–Ma	Circular London Circular Prague
Unemployment rate	%/year	Me–Ma	Circular Rotterdam Maribor, Slovenia Ljubljana, Slovenia Malmö, Sweden
Change in circular jobs	%	Me–Ma	Circular Rotterdam
Number of employees	N./year	Me–Ma	Kalundborg industrial symbiosis
Number of companies supported in the implementation of circular economy approaches	N./year	Me–Ma	Be circular Be.Brussels
Number of individuals trained through the education measures	N./year	Me–Ma	Be circular Be.Brussels
New collaborations between public agencies and enterprises	N./year	Me–Ma	Be circular Be.Brussels
Number of participants in circular economy processes	N./year	Me–Ma	Be circular Be.Brussels
Public tenders incorporating circular economy and resource efficiency criteria	%	Me–Ma	Be circular Be.Brussels

DIMENSIONE
ECONOMICA

DIMENSIONE
AMBIENTALE

DIMENSIONE
SOCIO-CULTURALE

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Number of people using a personal dashboard that display real-time data-flows from smart energy, water and waste bin meters, helping to increase awareness about consumption	N./year	Me–Ma	Antwerp Circular South
Training for employees to think in a circular way	N./year	Me–Ma	Be circular Be.Brussels
Percentage of population that shows an increase in circular behaviour	%	Me–Ma	Circular Rotterdam
Annual number of visitors (with active engagement) to the reuse hubs	N./year	Mi	Circular Prague
Social Cohesion (participate objectively)	**	Me–Ma	Circular Rotterdam
Percentage of population that describes their own health as good or very good	%/year	Me–Ma	Circular Rotterdam
Population with middle or high education	%/year	Me–Ma	Circular Rotterdam
Percentage of population dying from diseases of the respiratory system (diseases of the respiratory system can be an air quality indicator, but also of habits such as smoking)	%/year	Me–Ma	Circular Rotterdam
Average household income	€/year	Me–Ma	Circular Rotterdam
Population below poverty line	%/year	Me–Ma	Circular Rotterdam
Health benefits (how to evaluate this indicator is not specified in the report)	**	Me–Ma	Circular London
Alleviating food poverty (how to evaluate this indicator is not specified in the report)	**	Me–Ma	Circular London
Positive community activity (how to evaluate this indicator is not specified in the report)	**	Me–Ma	Circular London
Physical and mental health benefits (how to evaluate this indicator is not specified in the report)	**	Me–Ma	Circular London
Number of new circular initiatives	N./year	Me–Ma	Circular Rotterdam
Percentage of residents participated in dialogue and/or design related to circular economy	%/year	Me–Ma	Malmö, Sweden
Number of local "green" companies	N./year	Me–Ma	Malmö, Sweden
City attractiveness in terms of creation of recreational and cultural spaces	**	Me–Ma	Malmö, Sweden
Development of cooperative economy	**	Me–Ma	Maribor, Slovenia

INDICATORI CITTA' CIRCOLARI DEDOTTI DALLE ESPERIENZE CONCRETE

Health benefits (how to evaluate this indicator is not specified in the report)	**	Me–Ma	Circular London
Alleviating food poverty (how to evaluate this indicator is not specified in the report)	**	Me–Ma	Circular London
Positive community activity (how to evaluate this indicator is not specified in the report)	**	Me–Ma	Circular London
Physical and mental health benefits (how to evaluate this indicator is not specified in the report)	**	Me–Ma	Circular London
Number of new circular initiatives	N./year	Me–Ma	Circular Rotterdam
Percentage of residents participated in dialogue and/or design related to circular economy	%/year	Me–Ma	Malmö, Sweden
Number of local “green” companies	N./year	Me–Ma	Malmö, Sweden
City attractiveness in terms of creation of recreational and cultural spaces	**	Me–Ma	Malmö, Sweden
Development of cooperative economy	**	Me–Ma	Maribor, Slovenia
Number of new forms of enterprises (SMEs, start-ups, incubators, etc.)	N./year	Me–Ma	Maribor, Slovenia Ljubljana, Slovenia
Level of satisfaction of citizens with the administration services	qualitative	Me–Ma	Maribor, Slovenia
Transformation of neighborhoods and local community	**	Me–Ma	Maribor, Slovenia
Competitiveness of the economy	**	Me–Ma	Maribor, Slovenia
Competitiveness of the university	**	Me–Ma	Maribor, Slovenia
Professional and managerial transformation of the city administration	**	Me–Ma	Maribor, Slovenia
Interaction between residents	**	Me	Maribor, Slovenia
Number of private partners involved in industrial symbiosis	N./year	Me–Ma	Kalundborg Industrial Symbiosis
Number of public partners involved in industrial symbiosis	N./year	Me–Ma	Kalundborg Industrial Symbiosis

DIMENSIONE
ECONOMICA

DIMENSIONE
AMBIENTALE

DIMENSIONE
SOCIO-CULTURALE

QUALI STRUMENTI DI VALUTAZIONE PER LA CITTA' CIRCOLARE?

MATRICE DI INDICATORI MULTIDIMENSIONALI		
	INDICATORI DALLA LETTERATURA SCIENTIFICA	INDICATORI DA ESPERIENZE CONCRETE DI CITTA' CIRCOLARI
Dimensione ambientale	49 indicatori	90 indicatori
Dimensione economica	6 indicatori	35 indicatori
Dimensione Socio-culturale	7 indicatori	40 indicatori
	62 indicatori	165 indicatori
		227 indicatori

ALCUNE CRITICITA':

- > Alcuni indicatori, seppur significativi, non sono facilmente valutabili a causa della **carenza di dati disponibili**.
- > I framework di valutazione analizzati risultano carenti negli **indicatori soggettivi/qualitativi/percettivi**.
- > Molti Report delle città che stanno concretamente attuando il modello di città circolare non indicano in maniera chiara l'unità di misura di alcuni indicatori che quindi, seppur menzionati, risultano non popolati nei Report.
- > La componente dell'ambiente costruito che ha valori storici, artistici e culturali "sfugge" alla letteratura e alle esperienze concrete analizzate, nonostante il **patrimonio culturale/paesaggistico** possa svolgere un ruolo significativo nell'attuazione della città circolare.
- > Carenza di indicatori relativi al **benessere** e alla **salute** delle persone (**dimensione umana**)
- > Non vi è distinzione tra gli indicatori legati al **processo di transizione** verso la città circolare e quelli legati al **raggiungimento** di tale modello. Tale distinzione sarebbe necessaria considerando il (lungo) tempo che il processo di transizione può richiedere.
- > Il quadro di valutazione della città circolare è riferito prevalentemente alla fase **ex-ante**, trascurando le fasi di **monitoraggio ed ex-post**.
- >

IL RUOLO CHIAVE DELLA VALUTAZIONE EX-POST

Il processo di valutazione ex-post svolge un ruolo chiave nella pianificazione:

- > **VALUTAZIONE DELL'EFFETTIVO SUCCESSO (O INSUCCESSO) DELLE POLITICHE, DELLE STRATEGIE E DEI PROGETTI**
E' stato raggiunto l'obiettivo posto all'inizio del processo decisionale? Sono stati raggiunti i risultati previsti?
- > **IDENTIFICAZIONE DELLE LEZIONI APPRESE**
Cosa abbiamo imparato? Cosa ha funzionato e cosa no? Quali conoscenze possono essere utilizzate per informare sforzi futuri?
Come evitare di ripetere eventuali errori? Quali elementi di successo possono essere replicati?
- > **SUPPORTO PER UNA PIANIFICAZIONE BASATA SULL'EVIDENZA EMPIRICA**
Esaminando gli effettivi risultati e impatti di interventi passati, la valutazione ex-post fornisce dati e informazioni base sull'evidenza empirica preziose per i decisori. Aiuta a prendere decisioni informate riguardo a futuri progetti, politiche e allo stanziamento di risorse, basandosi sulle lezioni apprese e una comprensione più approfondita di ciò che funziona e cosa no in specifici contesti urbani.
- > **POTENZIAMENTO DI RESPONSABILITÀ E TRASPARENZA**
La valutazione ex-post promuove la responsabilità valutando le performance delle iniziative di pianificazione urbana rispetto agli obiettivi stabiliti. Permette agli stakeholder di valutare l'efficienza e l'efficacia dell'utilizzo delle risorse e garantisce trasparenza nel processo decisionale.
- > **SUPPORTO ALLA PIANIFICAZIONE ADATTATIVA ED ITERATIVA**
La pianificazione urbana è un processo iterativo che richiede apprendimento continuo e adattamento. La valutazione ex-post fornisce un feedback che può informare la gestione adattiva dei piani e dei progetti, consentendo regolazioni, miglioramenti e affinamenti basati su risultati reali.

QUALI STRUMENTI PER LA CITTA' CIRCOLARE?



- > QUALI ULTERIORI PUNTI DI INGRESSO PER L'ATTUAZIONE DEL MODELLO DI CITTA' CIRCOLARE?
- > QUALI STRUMENTI DI ATTUAZIONE?
- > QUALE GOVERNANCE?
- > QUALI STRUMENTI URBANISTICI?
- > QUALI STRUMENTI FINANZIARI?
- > QUALI INDICATORI MULTIDIMENSIONALI?

INDICATORI PROPOSTI – PATRIMONIO CULTURALE NELLA CITTA' CIRCOLARE

Indicator	Unite of Measure	Scale
Sense of place in sites/area	qualitative (scale 1–5)	Me
Realization of low energy consumption systems in projects related to cultural heritage	N.	Mi
Implementation of renewable energy sources in projects related to cultural heritage	N.	Mi
Use of local traditional materials, bio-materials and/or reuse/materials in projects related to cultural heritage	tons/projects	Mi
Amount of construction waste to landfill (reduction due to avoiding new construction thanks, for example, to adaptive reuse projects)	tons/year	Mi
Job creation (linked for example to cultural heritage adaptive reuse)	N./year	Mi–Me– Ma
Attraction capacity of innovative startups and companies (following the implementation of projects related to cultural heritage)	N./year	Mi–Me– Ma
Attraction capacity of cultural and creative industries (following the implementation of projects related to cultural heritage)	N./year	Mi–Me– Ma
Attraction capacity of new commercial activities (following the implementation of projects related to cultural heritage)	N./year	Mi–Me– Ma
Attraction capacity of cultural visitors (following the implementation of projects related to cultural heritage)	N./year	Mi–Me– Ma
Quality of public spaces in terms of attractiveness (enhancement of the quality following the implementation of projects related to cultural heritage)	Qualitative (scale 1–5)	Me–Ma
Real estate values in the area (increase of values following the implementation of projects related to cultural heritage avoiding gentrification in the area)	€/year	Mi–Me– Ma

INDICATORI PROPOSTI – PATRIMONIO CULTURALE NELLA CITTA' CIRCOLARE

Attraction capacity of cultural visitors (following the implementation of projects related to cultural heritage)	N./year	Mi–Me– Ma
Quality of public spaces in terms of attractiveness (enhancement of the quality following the implementation of projects related to cultural heritage)	Qualitative (scale 1–5)	Me–Ma
Real estate values in the area (increase of values following the implementation of projects related to cultural heritage avoiding gentrification in the area)	€/year	Mi–Me– Ma
Place attachment and local identity (following the implementation of projects related to cultural heritage)	Qualitative (scale 1–5)	Me–Ma
Social cohesion (following the implementation of projects related to cultural heritage)	Qualitative (scale 1–5)	Me–Ma
Inclusion of marginalized groups (following the implementation of projects related to cultural heritage)	Qualitative (scale 1–5)	Me–Ma
Landscape visual quality of the area (following the implementation of projects related to cultural heritage)	Qualitative (perception, scale 1–5)	Me–Ma
Cultural activities and events (following the implementation of projects related to cultural heritage)	N. events/year	Me–Ma
Citizens' participation in cultural activities and events (following the implementation of projects related to cultural heritage)	N. participants/events	
People wellbeing (following the implementation of projects related to cultural heritage)	Further research is needed for this indicator	Me–Ma
Number of third sector units (non-governmental organizations (NGOs), associations, etc.) involved in partnership/cooperation (following the implementation of projects related to cultural heritage)	N./year	Me–Ma
Number of startups, enterprises (following the implementation of projects related to cultural heritage)	N./year	Me–Ma
Number of volunteers (following the implementation of projects related to cultural heritage)	N./year	Mi–Me– Ma
Annual revenues from new uses/functions (following adaptive reuse projects)	€/year	Mi–Me– Ma
Safety in the area (following the implementation of projects related to cultural heritage)	Qualitative (safety perception). N. of murders/year	Me–Ma

INDICATORI PROPOSTI – LA “NUOVA” PIANIFICAZIONE URBANISTICA

Indicator	Unit of Misure
Number of building reused for a new function	N.
Number of spaces reused with a new function	Sqm/total city surface
Number of projects including nature-based solutions	N./total projects
Amount of financial support to implement nature-based solutions	€/year
Recovering of abandoned areas	Sqm recovered/sqm abandoned
Reduce production of waste due to the use of sustainable materials	tons/year
Adoption of green and blue infrastructure which can help to regulate CO ₂ emissions, flooding and the heat island effect	N.
Virgin material use	%/year
Percentage of reuse of materials of buildings for repurposing	%
Number of retrofitting projects	N./year
Number of projects/solutions that maximise energy efficiency and minimise waste reduction	N./year
Percentage of space for (peri-) urban farming in spatial planning	%
Changes in property value	€/year
Avoided damage costs	€/year
Carbon storage and sequestration in vegetation and soil	CO ₂ /year
Monetary values: value of carbon sequestration by trees	€/year
Carbon savings from reduced building energy consumption	KJ/year

INDICATORI PROPOSTI – LA “NUOVA” PIANIFICAZIONE URBANISTICA

Adoption of green and blue infrastructure which can help to regulate CO ₂ emissions, flooding and the heat island effect	N.
Virgin material use	%/year
Percentage of reuse of materials of buildings for repurposing	%
Number of retrofitting projects	N./year
Number of projects/solutions that maximise energy efficiency and minimise waste reduction	N./year
Percentage of space for (peri-) urban farming in spatial planning	%
Changes in property value	€/year
Avoided damage costs	€/year
Carbon storage and sequestration in vegetation and soil	CO ₂ /year
Monetary values: value of carbon sequestration by trees	€/year
Carbon savings from reduced building energy consumption	KJ/year
Energy savings from reduced building energy consumption	CO ₂ /year
Temperature in urban areas (reductions thanks for example to the implementation of nature-based solutions (NBS) projects)	°C
Distribution of public green space – total surface or per capita	sqm/ total surface
Annual amount of pollutants captured by vegetation	CO ₂ /year
Encourage re-use of building materials in new constructions	N. of incentives/year
Encourage efficient use of resources, materials, and construction techniques that maximise the effective life-cycle of the building	N. of incentives/year
Public transport links: walking distance to nearest facilities	Km
Land dedicated to pedestrians: percentage of road network	%

INDICATORI PROPOSTI – BENESSERE E SALUTE NELLA CITTA' CIRCOLARE

Rapporto sul Benessere Equo e Sostenibile: i 12 domini del benessere

Indicator	Unit of Misure	Scale
Health care spending on diseases caused by air pollution amounted on the total health expenditure	%/year	Mi–Me–Ma
Lost productivity arising from ill health due to pollution (market cost)	€/year	Mi–Me–Ma
Attraction of investments in environmental projects (willingness to pay of the public body to avoid health problems)	€/year	Me–Ma
Impacts on health (including occupational health and safety issues, mental health and respiratory) due to use of nontoxic materials in remanufacturing, refurbishment, and reuse of products and components in “Circular buildings”	***	Me–Ma
Impacts on health (including occupational health and safety issues, mental health and respiratory) due to improved indoor air quality	***	Me–Ma
Impacts on health (including reduced cancer, negative birth outcomes, and respiratory risks) due to the reduced waste generation (thanks also to product life extension)	***	Me–Ma
Impacts on health (including reduced cancer, negative birth outcomes, and respiratory risks) due to the reduced production emissions (thanks also to product life extension)	***	Me–Ma
Reduced impacts on health (respiratory and cardiovascular conditions) due to lower emissions related to air quality from sharing models (as car sharing)	***	Me–Ma
Reduced impacts on health (cancer, negative birth outcomes, and respiratory diseases) due to the reduction of air, water and soil pollution thanks to recycling	***	Me–Ma
Reduced impacts on health (cancer, negative birth outcomes, and respiratory diseases) due to the reduction of air, water and soil pollution thanks efficient use of resources	***	Me–Ma
Reduced impacts on health (cancer, negative birth outcomes, and respiratory diseases) due to the reduction of air, water and soil pollution thanks to reduced use of landfill, and incineration	***	Me–Ma
Impacts on health (including road safety, road accident deaths and injuries) due to sharing models, shift in consumption in mobility sector	***	Me–Ma
Reduced impacts on health (cardiovascular and respiratory effects) due to lower air pollutants and GHG related to use of renewable energy sources, general move to renewable energy and energy efficiency in the circular economy across many sectors	***	Me–Ma
Reduced impacts on health (cancers, respiratory and negative birth outcomes) due to use of renewable energy sources, reduced generation of pollutants during energy recovery process	***	Me–Ma

INDICATORI PROPOSTI – BENESSERE E SALUTE NELLA CITTA' CIRCOLARE

Rapporto sul Benessere Equo e Sostenibile: i 12 domini del benessere

Reduced impacts on health (respiratory and cardiovascular conditions) due to lower emissions related to air quality from sharing models (as car sharing)	***	Me–Ma
Reduced impacts on health (cancer, negative birth outcomes, and respiratory diseases) due to the reduction of air, water and soil pollution thanks to recycling	***	Me–Ma
Reduced impacts on health (cancer, negative birth outcomes, and respiratory diseases) due to the reduction of air, water and soil pollution thanks efficient use of resources	***	Me–Ma
Reduced impacts on health (cancer, negative birth outcomes, and respiratory diseases) due to the reduction of air, water and soil pollution thanks to reduced use of landfill, and incineration	***	Me–Ma
Impacts on health (including road safety, road accident deaths and injuries) due to sharing models, shift in consumption in mobility sector	***	Me–Ma
Reduced impacts on health (cardiovascular and respiratory effects) due to lower air pollutants and GHG related to use of renewable energy sources, general move to renewable energy and energy efficiency in the circular economy across many sectors	***	Me–Ma
Reduced impacts on health (cancers, respiratory and negative birth outcomes) due to use of renewable energy sources, reduced generation of pollutants during energy recovery process	***	Me–Ma
Reduced costs in health sector that allow improving health services due to waste reduction and recycling in health sector	***	Me–Ma
Reduced impacts on health (cardiovascular and respiratory problems) due to indirect impact via reduced manufacturing air/water emissions thanks use of recycled materials in manufacturing processes	***	Me–Ma
Average income available on which wellbeing perception depends	€/year/person	Me–Ma
Inequality index of disposable income. (Ratio between total equivalent income received by 20% of the population with the highest income and that received by 20% of the population with the lowest income).	%/year	Me–Ma
Healthy life expectancy at birth. (Average number of years that a child born in the reference year can expect to live in good health, assuming that the risks of illness and death at different ages observed in that same year remain constant over time).	N.	Me–Ma
Rate of non-participation in the work	%	Me–Ma
Predatory crime index. Number of victims of home burglaries, pick-pocketing and robberies per 1,000 inhabitants	N./1000 inhabitants	Me–Ma

Note: *** Further research is needed for this indicator involving other disciplines.

SPERIMENTAZIONE URBAN SCALE

Indicatori delle città circolari creative e culturali:
il caso della Città Metropolitana di Napoli

PARTNER



MEDIA PARTNER



CON LA COLLABORAZIONE DI



PARTNER ISTITUZIONALI



Indici composti per la valutazione delle città circolari, culturali e creative

Poli, G., Muccio, E., & Cerreta, M. (2022). **Circular, Cultural and Creative City Index: a Comparison of Indicators-based Methods with a Machine-Learning Approach.** *Aestimum*, 81.

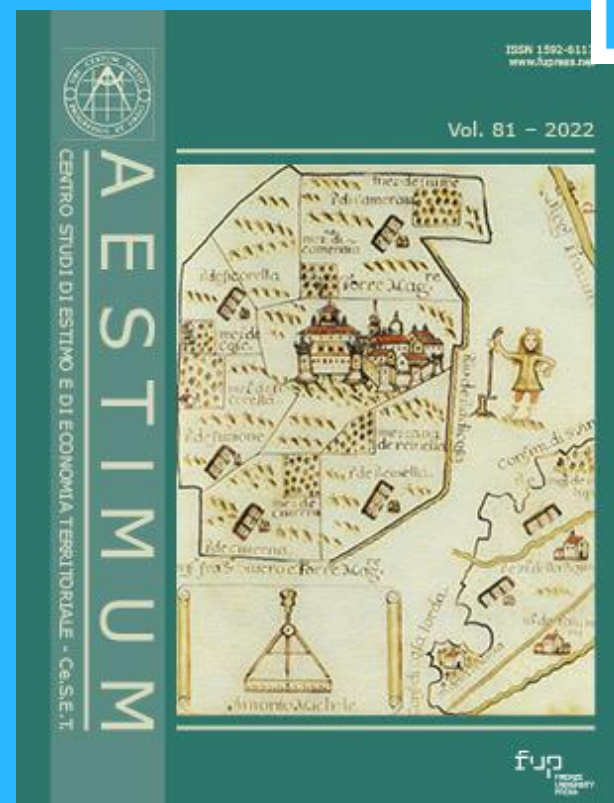
Obiettivo: Testare una metodologia data-driven per **valutare le performance circolari, culturali e creative** delle città mettendo a confronto metodi oggettivi e soggettivi per la determinazione dei pesi degli indicatori selezionati.

Caso studio: 92 Municipalità della Città Metropolitana di Napoli

Strumenti di valutazione: Indicatori di performance e benchmarking

Strumenti operativi: Machine Learning, GIS

Metodi confrontati: Expert-driven (Weighted Linear Combination) e PCA-driven (Principal Component Analysis)



Domande di ricerca per il caso studio

Quali possibilità offre il benchmarking per la valutazione dei caratteri materiali ed immateriali legati ai processi circolari, culturali e creativi delle città contemporanee?

Può il Machine Learning espandere le metodologie di valutazione degli indicatori compositi per valutare le performance delle città in termini circolari, culturali e creativi?

Come produrre in modo efficace indicatori e indici di performance implementando metodi di valutazione soggettivi e oggettivi con il ML per informare meglio un processo decisionale?

Città circolari, culturali e creative



Le **città creative** sono i luoghi in cui la cultura, le arti, le industrie culturali e creative (ICC), le diverse espressioni e l'immaginazione fioriscono e contribuiscono allo sviluppo urbano sostenibile e alla crescita inclusiva (UNESCO & the World Bank, 2021).

"Il **capitale culturale** delle città, in combinazione con altri fattori produttivi, contribuisce alla produzione di altri beni e servizi culturali, alla creazione di posti di lavoro e al benessere complessivo delle comunità locali" (UNESCO & the World Bank, 2021).

Quali sono i fattori trainanti dei processi di transizione alla base delle città circolari, culturali e creative?



indicatori di
performance

cambiamento
istituzionale



Indicatori e indici di performance per la valutazione delle città culturali e creative



indicatori di performance

“Indicators arise from values (we measure what we care about), and they create values (we care about what we measure)” [Meadows, 1998]

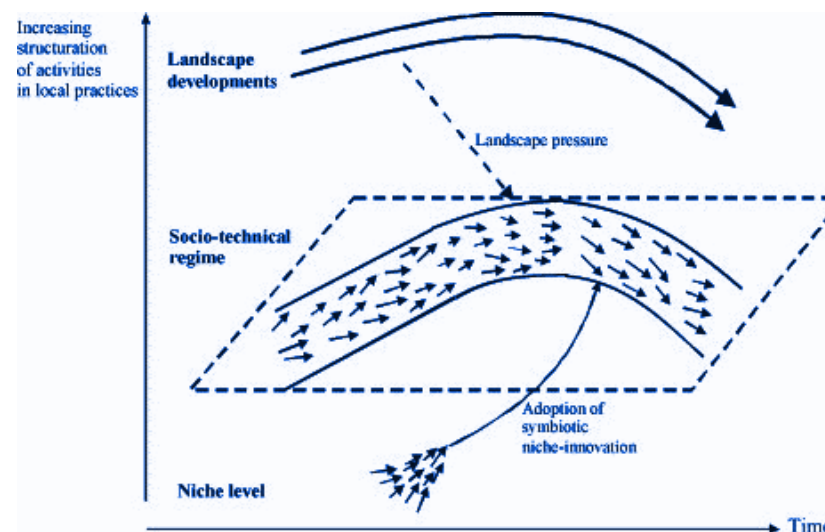
“Visualizzando i fenomeni ed evidenziando le tendenze, gli indicatori **semplificano**, **quantificano**, **analizzano** e **comunicano** informazioni altrimenti complesse e difficili da comunicare” [Waas et al., 2014]

I framework di valutazione basati sugli indicatori sono determinanti per misurare i progressi delle città verso le transizioni (ecologiche, culturali, economiche, etc...) garantendone il livello operativo [da Ehnert et al., 2018]

I Sistemi Socio-tecnici

In un sistema socio-tecnico [Geels & Schot, 2007] le **innovazioni di nicchia** hanno un **rapporto competitivo** con il regime esistente, quando mirano a sostituirlo. Le innovazioni di nicchia hanno un **rapporto simbiotico** se possono essere adottate come complemento di competenza nel regime esistente per risolvere i problemi e migliorare le prestazioni.

Gli indicatori diventano strumenti fondamentali per misurare gli impatti che le nicchie di innovazione operano sul regime, consentendo l'analisi dei trend di sviluppo dei paesaggi, intesi come sistemi complessi.



Paesaggio scientifico: temi più ricorrenti nelle pubblicazioni scientifiche (2002-2023)

Parametri di ricerca

("Machine learning" OR "Artificial Intelligence") AND
("cultural" OR "culture") AND
("indicators" OR "indices" OR "benchmarking")

Banca dati: SCOPUS

Range temporale: 2002 - 2023

Campi disciplinari: Computer Science; Engineering;
Environmental Science; Social Science; Agriculture;
Decision Science; Arts and Humanities; Economics;
Multidisciplinary.

Numero di pubblicazioni: 204

Numero di cluster: 5

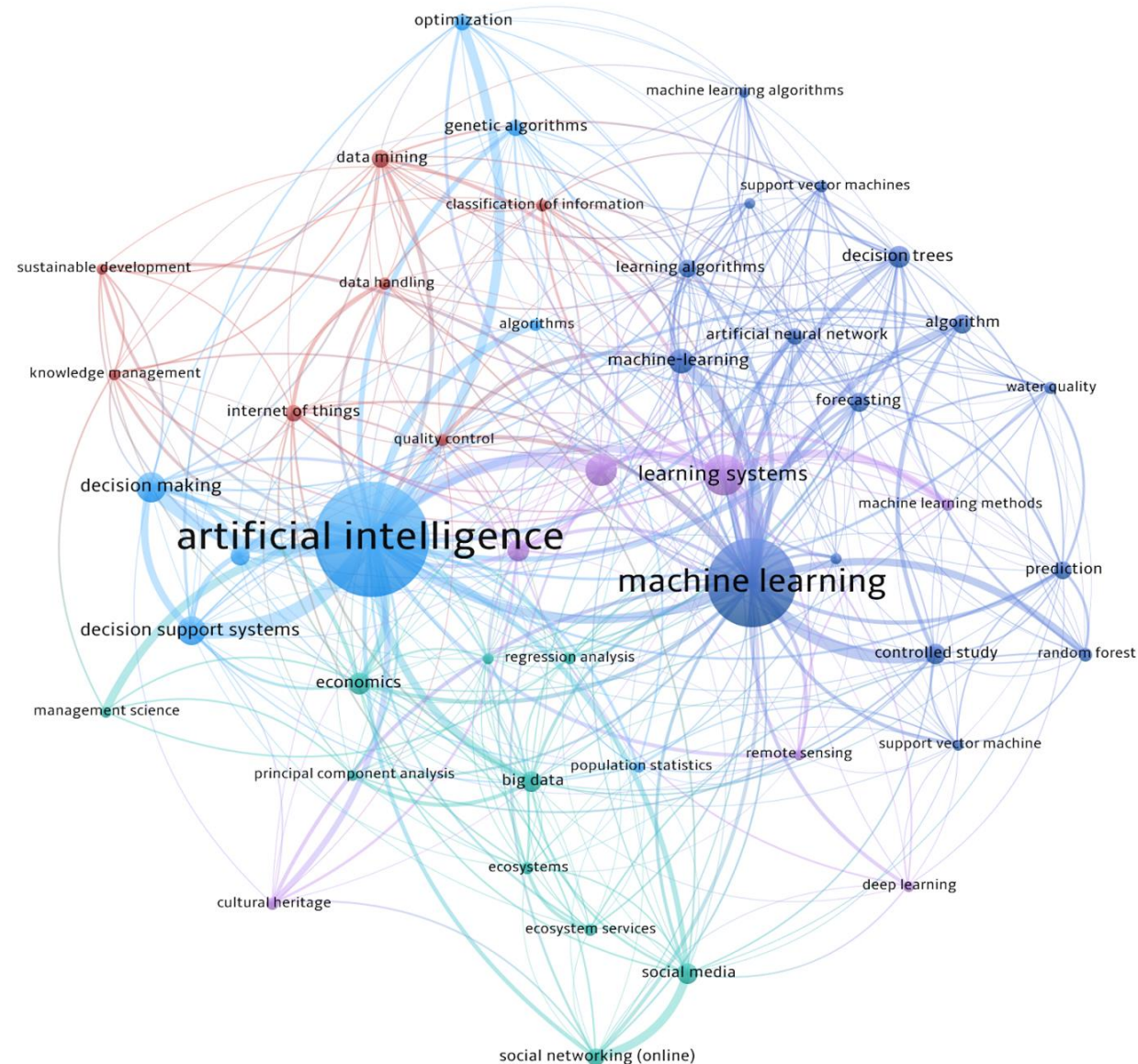
Cluster 1 (16 items) - Algoritmi di ML applicati in
ambiti interdisciplinari

Cluster 2 (10 items) - Metodi statistici supportati da
AI nel campo dell'economia ecologica

Cluster 3 (8 items) - AI per l'implementazione dei
Sistemi di Supporto alla Decisione

Cluster 4 (7 items) - ML per il Management
(Sostenibilità)

Cluster 5 (7 items) - ML per il patrimonio culturale



Strumenti di Machine Learning

WEAK MACHINE LEARNING

Non viene impiegato per modelli previsionali ma per implementare algoritmi statistici che rilevano patterns e riducono la multidimensionalità dei dati al fine di operare scelte procedurali e strumentali.

IMPLEMENTAZIONE IN PYTHON

Python 3 è stato utilizzato come linguaggio per dare alla macchina istruzioni sui dati di input. In particolare il modulo **scikit-learn** ha consentito di implementare algoritmi di ML.

APPROCCIO NON-SUPERVISIONATO

Riduzione della multidimensionalità: Analisi di correlazione per ridurre un dataset di **72** variabili a **26** significative.

Armonizzazione dei dati

Test statistici

Analisi delle Componenti Principali (PCA)



Modello di conoscenza: Cultural and Creative City Monitor (JRC, 2017)

3

domini

7

dimensioni

26

indicatori

C1. Cultural Vibrancy: cultura espressa in termini di luoghi e partecipazione;
C2. Creative Economy: occupazione nel settore economico culturale e creativo;
C3. Enabling Environment: le risorse che rendono le città un terreno fertile per innescare processi culturali.

D1. Cultural Venues & Facilities: la presenza di luoghi e infrastrutture legati alla cultura;
D2. Cultural Participation & Attractiveness: la capacità delle città di attrarre persone nella loro vita culturale;
D3. Creative Jobs & Activity: imprese e organizzazioni non profit del settore culturale e creativo;
D4. Human Capital & Education: il numero di giovani laureati e, di contro, l'abbandono scolastico;
D5. Openness, Tolerance & Trust: la presenza di culture diverse e la partecipazione sociale;
D6. Local Connections: il sistema di mobilità pubblico e privato;
D7. Quality of Governance: gli investimenti dei comuni in cultura.

Domains	Dimensions	Indicators (i)	ID	Source	
Cultural Vibrancy	Museums, monuments and archaeological areas	Museums, monuments and archaeological areas	01	ISTAT	
		Architectural heritage	02	ISTAT	
		Archaeological heritage	03	ISTAT	
		Cultural Venues & Facilities	Libraries	04	Campania Region
			Theaters	05	teatri.it
			Cinema screens	06	SIAE
			Entertainment and cinema organizations	07	Campania Region
		Parishes	08	italia.indettaglio.it	
	Cultural Participation & Attractiveness	Visitors to museums, monuments and archaeological areas	Visitors to museums, monuments and archaeological areas	09	ISTAT
			Entrances to cinemas	10	SIAE
		Cultural events	Cultural events	11	Authors' processing of MiBACT and Campania Region data
			Hotel accommodation rate	12	Authors' processing of ISTAT data
			Non-hotel accommodation rate	13	Authors' processing of ISTAT data
Creative Economy	Creative Jobs & Activities	Incidence of cultural and creative enterprises	14	ISTAT	
		Incidence of employees of cultural and creative enterprises	15	ISTAT	
		Incidence of cultural and creative non-profit organizations	16	ISTAT	
Enabling Environment	Human Capital & Education	Incidence of young people with university education	17	ISTAT	
		Early exit from the education and training system	18	ISTAT	
	Openness, Tolerance & Trust	Social participation index	19	ISTAT	
		Incidence of foreign residents	20	ISTAT	
Local Connections	Railway stations density index	Railway stations density index	21	Authors' processing of OpenStreetMap data	
		Bus stop density index	22	OpenStreetMap	
		Vehicle fleet density index	23	comuni-italiani.it	
Quality of Governance	Per capita expenditure for the enhancement of cultural heritage and activities	Per capita expenditure for the enhancement of cultural heritage and activities	24	openpolis	
		Per capita expenditure on tourism	25	openpolis	
		Per capita expenditure on sports and leisure activities	26	openpolis	

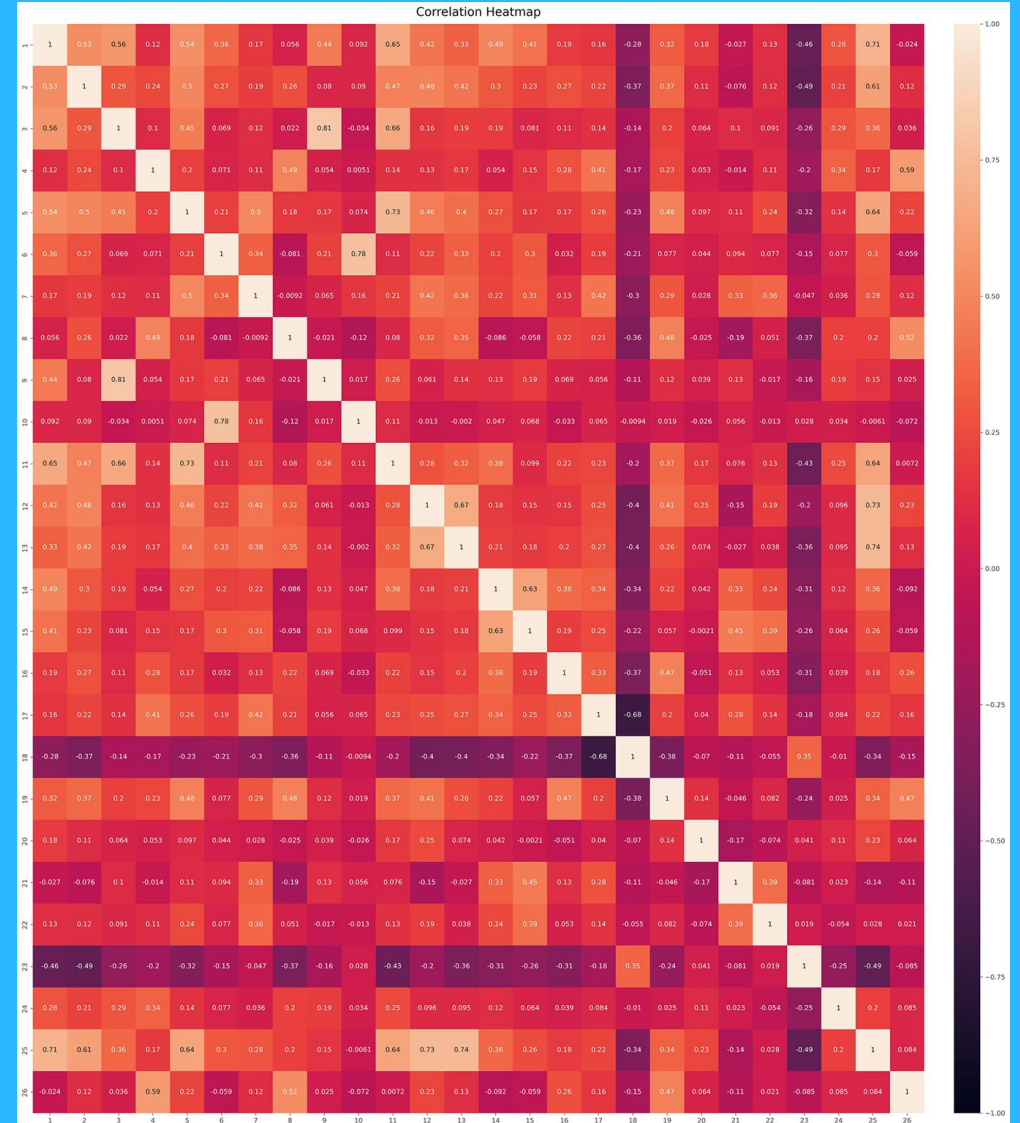
Riduzione della complessità e armonizzazione dei dati

Il **Data Cleaning** è un'operazione essenziale per ridurre gli errori statistici nei calcoli e rendere i dati confrontabili prima di lanciare un algoritmo di ML.

L'**analisi di correlazione** di variabili è una tecnica statistica che viene utilizzata per studiare la relazione tra due o più variabili, misurando l'**intensità** e la **direzione**, negativa o positiva, di questa relazione.

L'**uso combinato dei moduli di python Numpy** (per il test statistico) e **Seaborn** (per implementare la visualizzazione dei risultati attraverso la *correlation heatmap*) **ha orientato il processo di selezione degli indicatori iniziali**, consentendo di **eliminare le ridondanze e verificare la coerenza del dataset di base**.

CORRELATION HEATMAP

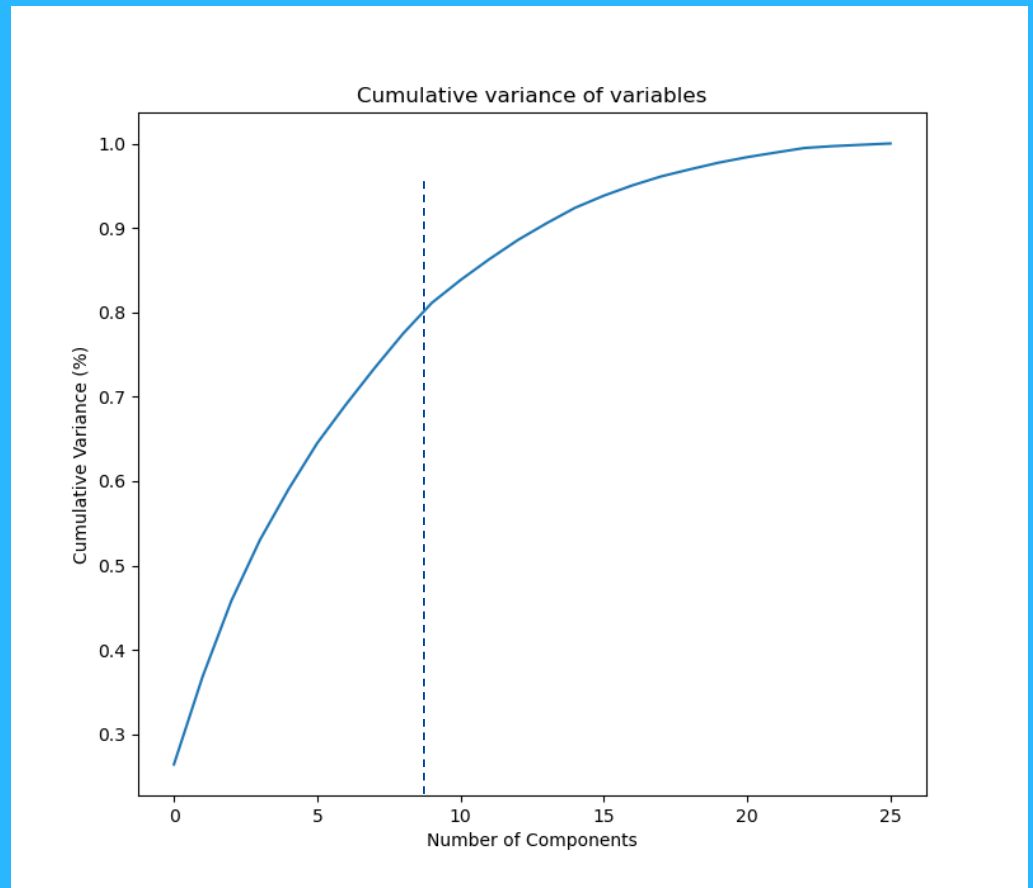


Analisi delle componenti principali in Python

Lo scopo della **Principal Component Analysis (PCA)** è quello di identificare all'interno di un dataset un **numero ridotto di variabili**, definite componenti principali, che catturano la maggior parte della variazione nei dati originali.

La rappresentazione a dimensioni ridotte del dataset è stata utilizzata come sistema di ponderazione del PCA-driven Index, in cui il peso degli indicatori viene determinato con le prime 9 componenti principali che rappresentano le componenti che spiegano maggiore varianza nell'intero dataset.

VARIANZA CUMULATIVA DELLE VARIABILI



Rappresentazione GIS del PCA-DRIVEN INDEX



$$\text{PCA-driven index} = \sum_{i=1}^n (\mu^2 * PC_{ki})$$

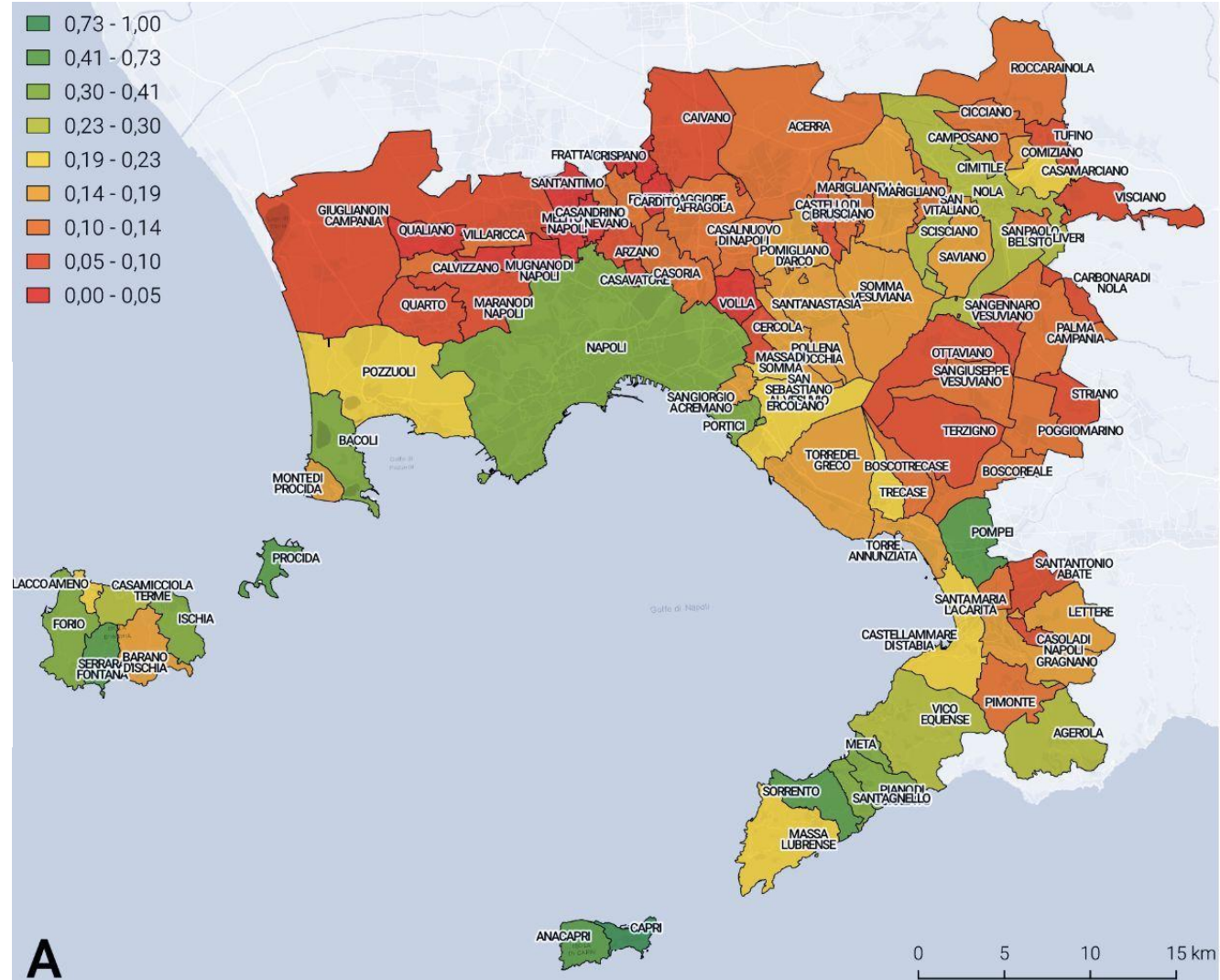
μ^2 = varianza percentuale spiegata

PC = componente principale

k = autovalore

i = variabile (indicatore)

Rappresentato sulla prima componente principale (k=1)



Rappresentazione GIS dell'EXPERT-DRIVEN INDEX

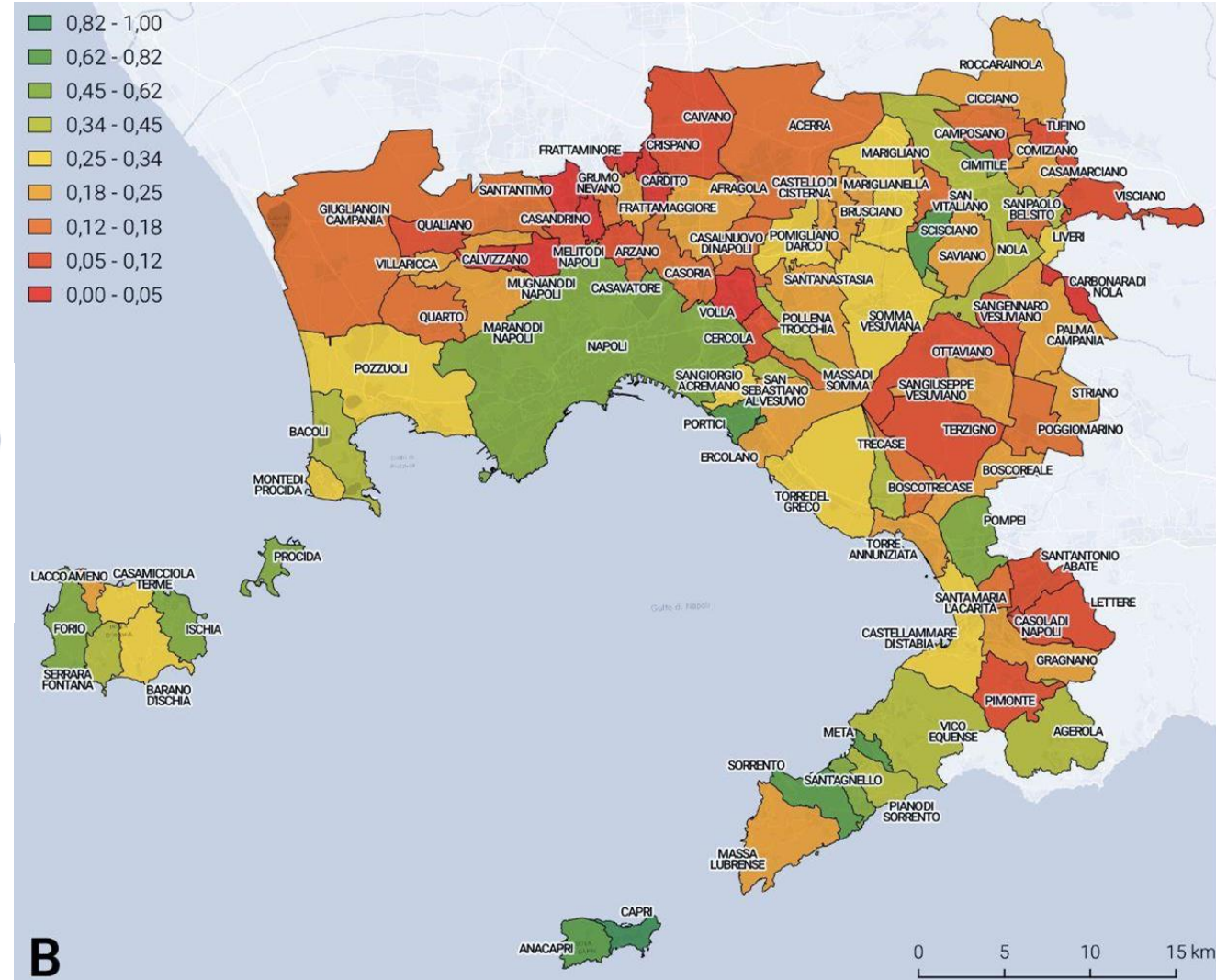


$$\text{Experts-driven index} = \sum_{j=1}^n w_j * V(x_{kj})$$

w_j = peso attribuito da esperti

$V(x_{kj})$ = valore dell'indicatore

Ottenuto con la WLC (Combinazione Lineare Pesata) moltiplicando i valori delle variabili per il peso attribuito da esperti e desunto dal CCCM

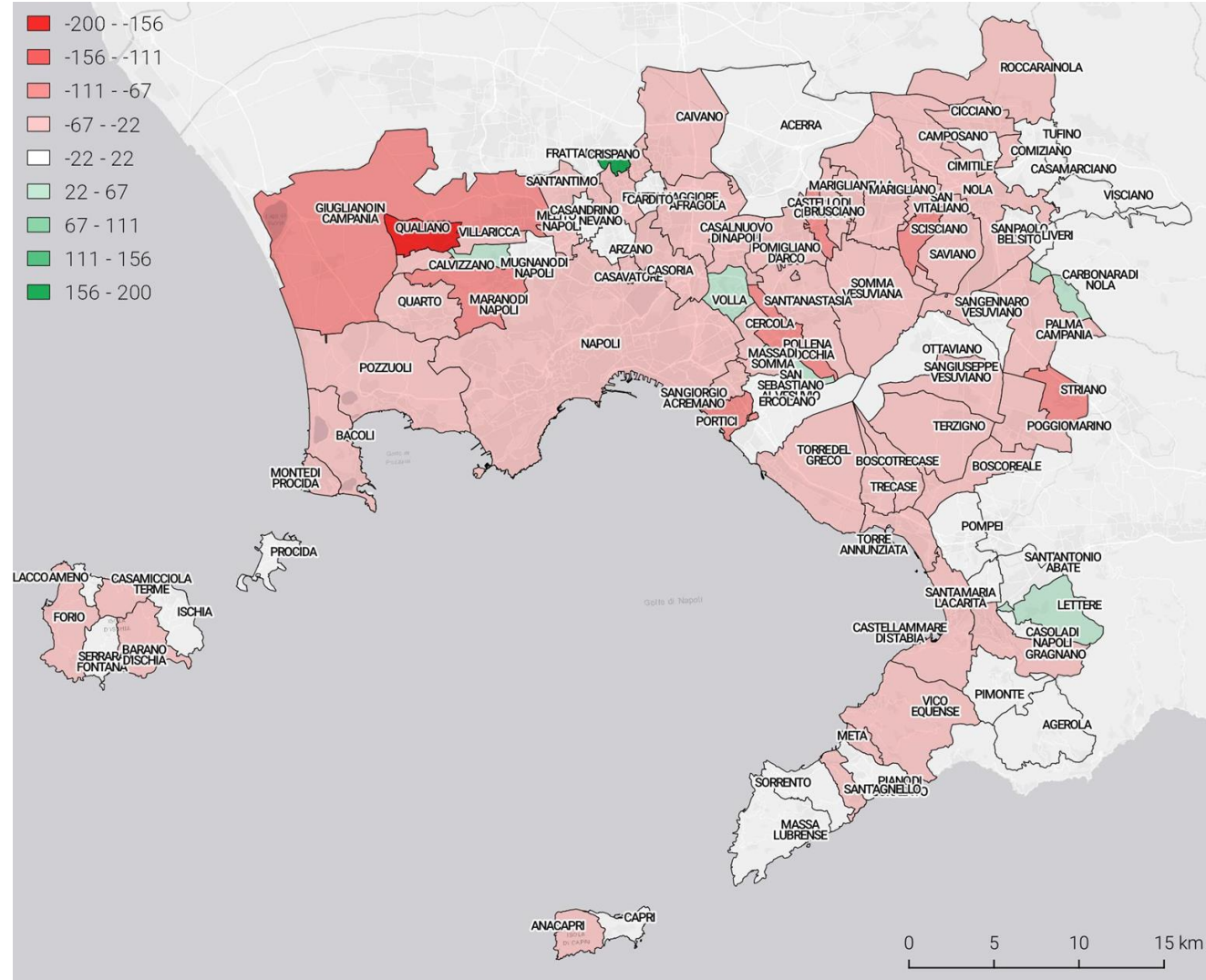


Rappresentazione GIS dell'Indice di confronto



$$\text{Indice di confronto} = \frac{(\text{PCA Index} - \text{Experts Index}) * 100}{(\text{PCA Index} - \text{Experts Index}) / 2}$$

Il colore rosso indica un posizionamento migliore della Municipalità rispetto all' Expert-driven Index, mentre il colore verde indica il contrario: miglior posizionamento nel ranking della Municipalità rispetto al PCA-driven index.



SPERIMENTAZIONE BUILDING SCALE

Indicatori per il riuso adattivo del patrimonio culturale: il caso degli "Edifici Mondo" a Salerno

PARTNER



MEDIA PARTNER

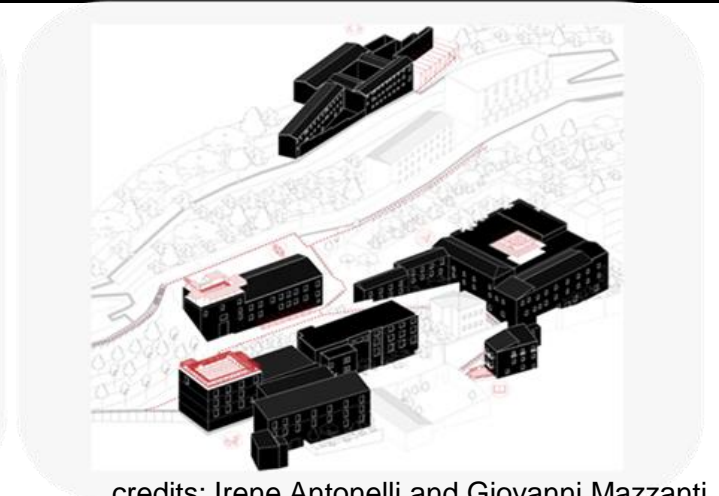
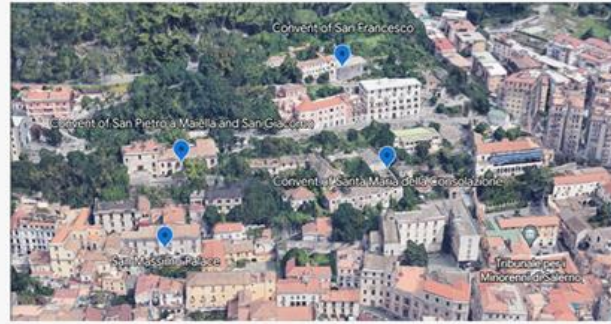
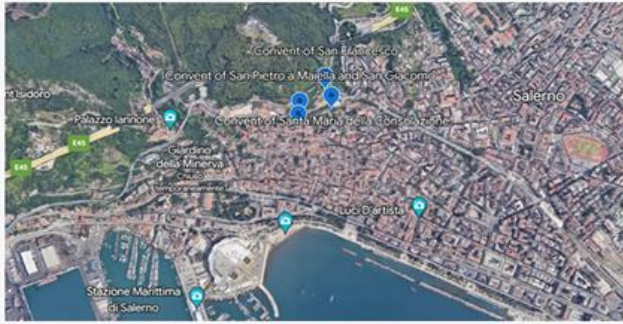


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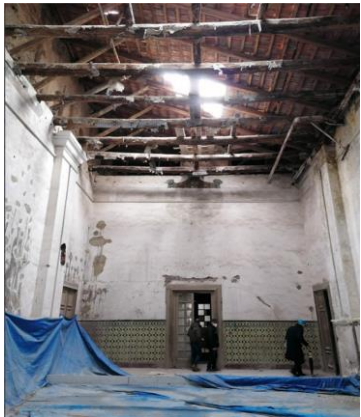
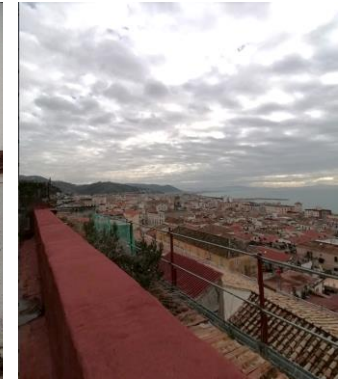
LE VALUTAZIONI PER LA SOSTENIBILITÀ. APPROCCI, ESPERIENZE E STRUMENTI



Google Earth
Image © 2022

Google Earth
Image © 2022

credits: Irene Antonelli and Giovanni Mazzanti



2

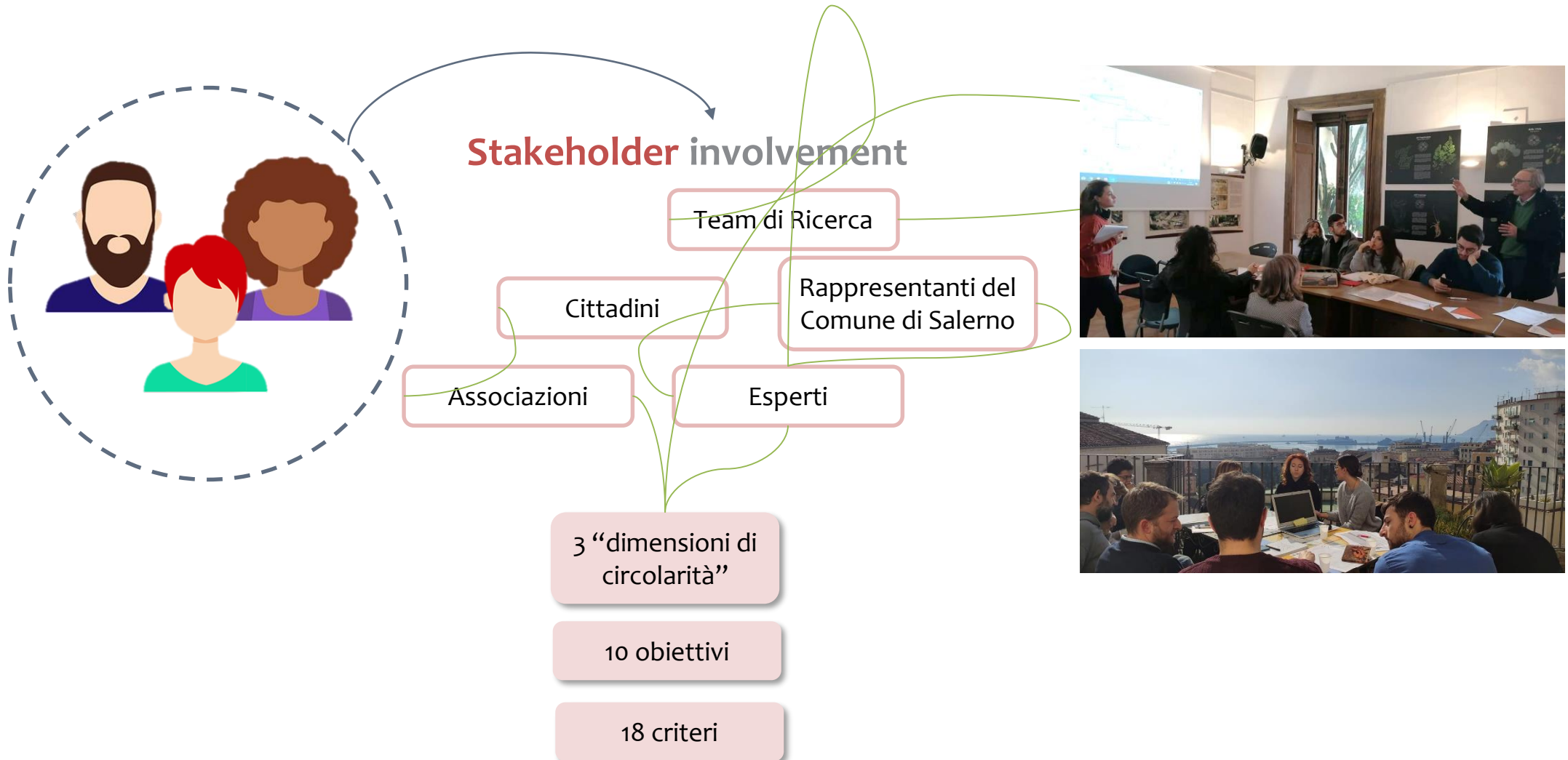
Definizione degli
obiettivi e dei criteri
di valutazione

“Impatti del riuso adattivo del patrimonio culturale”:
3 “dimensioni di circolarità”, 10 obiettivi e 18 criteri

Stakeholders

Comune di Salerno

Team di ricerca



3

Elaborazione delle
alternative progettuali

Circular Business Model Workshop (CBMW)
(14 proposte selezionate)

Stakeholders

Comune di Salerno

Team di ricerca

Consultazione Pubblica: 14 proposte

Edifici Mondo e San Massimo Salerno, 14 idee per il recupero

L'URBANISTICA

Giovanna Di Giorgio

Sono 14 le possibili idee di riuso adattivo di palazzo San Massimo e degli Edifici Mondo, nel centro storico alto della città, arrivate al Comune di Salerno e valutate (in videoconferenza, causa emergenza Covid19) in modo da poter stilare una graduatoria. Perché, sebbene non siano vincolanti, le proposte idonee potranno partecipare al workshop di formazione del Progetto Horizon 2020 Clic per la sperimentazione di modelli di fattibilità per il riuso circolare del patrimonio culturale dell'ente. Al primo posto si è piazzata l'idea progetto del gruppo di architetti guidati da Francesca Ciampa, una proposta dal nome che è tutto un programma: la casa della musica. La chiamata di palazzo di città, partita poco prima del lockdown, è una consultazione pubblica intesa come sperimentazione operativa nell'ambito del progetto europeo di ricerca e innovazione Horizon 2020 Clic. Le proposte pervenute non sono vincolanti per il Comune di Salerno, né i partecipanti

**LA CASA DELLA MUSICA
DEGLI ARCHITETTI
GUIDATI DA CIAMPA
PRIMA IN GRADUATORIA
PER IL PROGETTO
HORIZON 2020 CLIC**

maturano alcuna posizione di vantaggio, di prelazione o di altro tipo di diritto in relazione alle future scelte. Tuttavia, l'attribuzione di un punteggio è stata necessaria per selezionare le proposte più idonee da presentare nell'ambito dei lavori del workshop.

I MODELLI

Al centro, i possibili modelli di riuso adattivo e gestione di palazzo San Massimo e dell'intero gruppo degli Edifici Mondo: il convento di San Pietro a Maiella e San Giacomo, il convento di Santa Maria della Consolazione e il convento di San Francesco. Tutti edifici oggi inutilizzati. Al secondo posto, dopo La casa della musica, si è piazzata l'idea del gruppo di architetti guidati da Francesco Montella, Hippocratica Hills Health Heri-

tage Hub. Terzo posto per l'idea progetto di Nib, la scuola di architettura New Italian Blood ideata da Luigi Centola, con Salerno (re)starts - hotel diffuso città storica: un'idea di rigenerazione del centro storico. A seguire, Percorsi d'acqua di Arcan Salerno Cantieri& Architettura; l'identità tra tradizione e innovazione: solidarietà, arte, scienza e conoscenza per la rinascita del centro antico di Salerno di Carlo Guadagno; l'idea del complesso alberghiero recettivo «Plajuium montis» di Carmine e Francesca Spirito; interventi discreti per la riattivazione degli Edifici Mondo di Irene Antonelli e Giovanni Mazzanti; condominio solidale Hippocratica Civitas - solidarietà e resilienza urbana, di Giuseppe Iagulli; la Reggia di Salerno di Francesco Formisano; riutilizzo creativo in chiave artistica di edifici abbandonati di Simona Fasano. Sono queste le dieci proposte che verranno presentate al workshop, al quale potranno però prendere parte anche gli autori delle restanti quattro: Upselling Tourism, Tripmeteo, la Pro loco Salerno città visibile e l'associazione I colori del Mediterraneo.

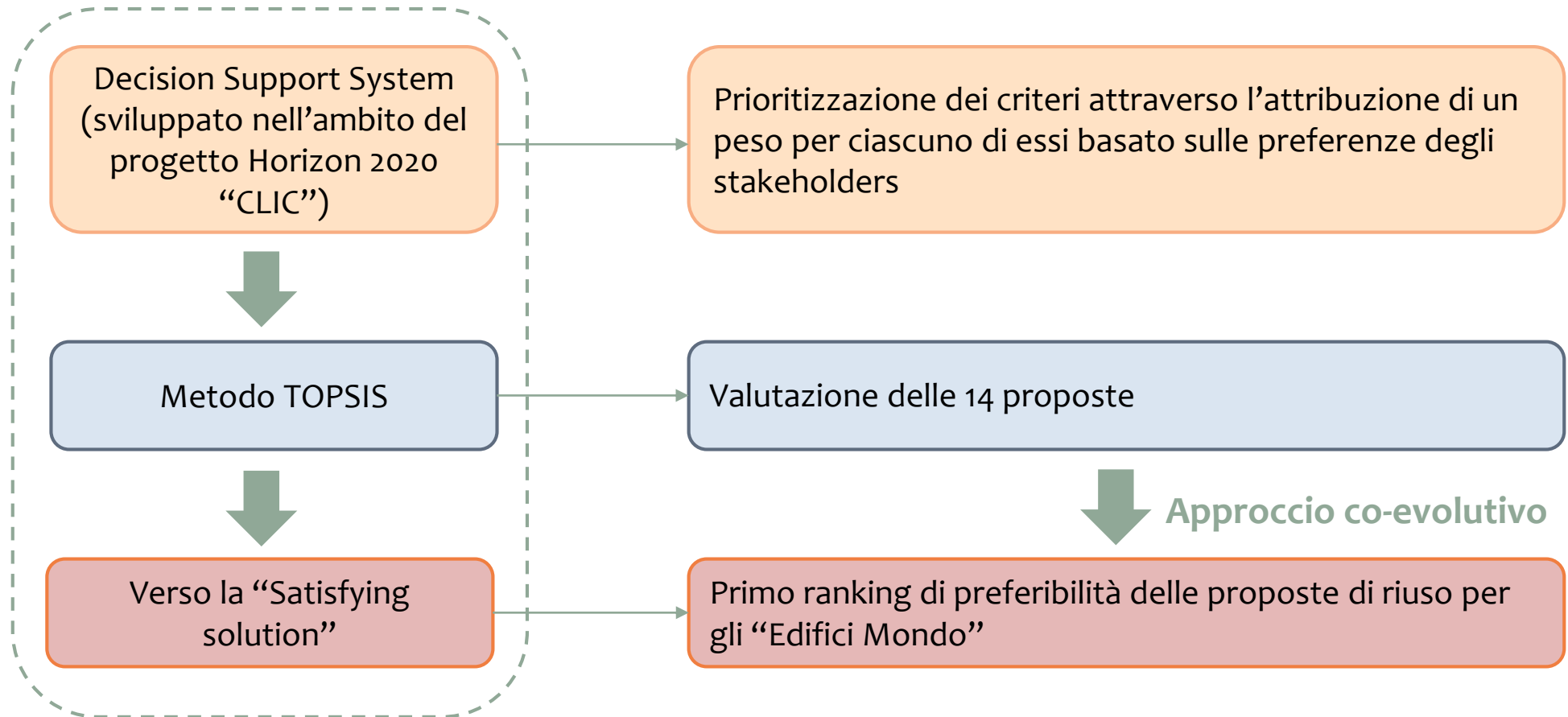
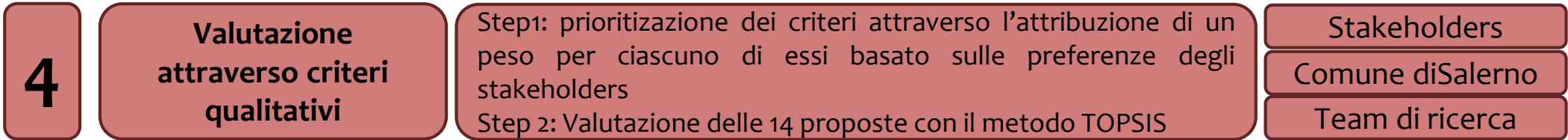
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Circular Business Model Workshop



- 4 proposte selezionate
- Studio di pre-fattibilità
- >20 partecipanti



4

Valutazione attraverso criteri qualitativi

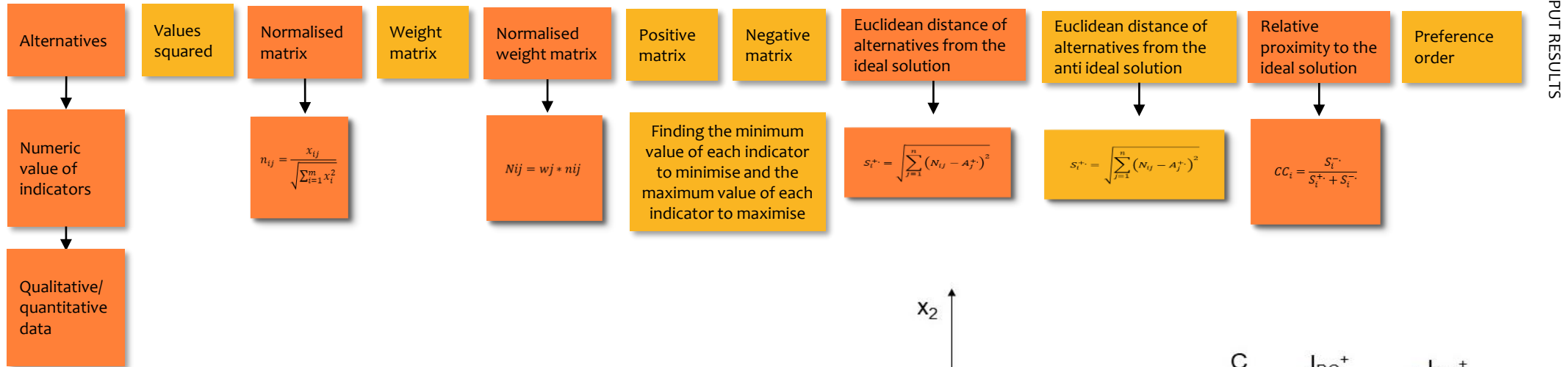
Step1: prioritizzazione dei criteri attraverso l'attribuzione di un peso per ciascuno di essi basato sulle preferenze degli stakeholders

Step 2: Valutazione delle 14 proposte con il metodo TOPSIS

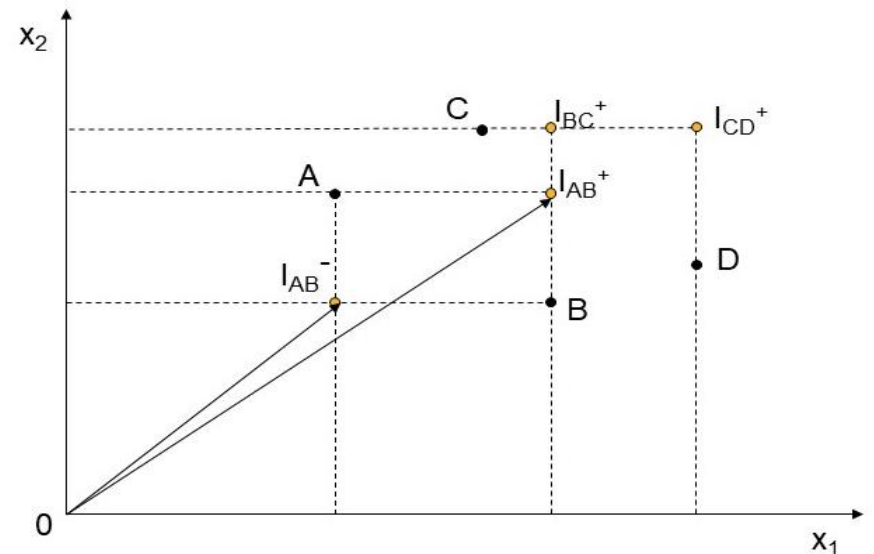
Stakeholders

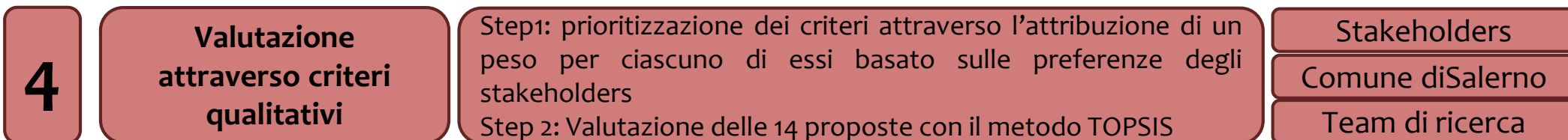
Comune di Salerno

Team di ricerca



Il metodo TOPSIS si basa sul concetto che l'alternativa scelta deve avere la distanza euclidea più breve dalla soluzione ideale positiva e la distanza euclidea più lunga dalla soluzione ideale negativa (Assari, 2012).





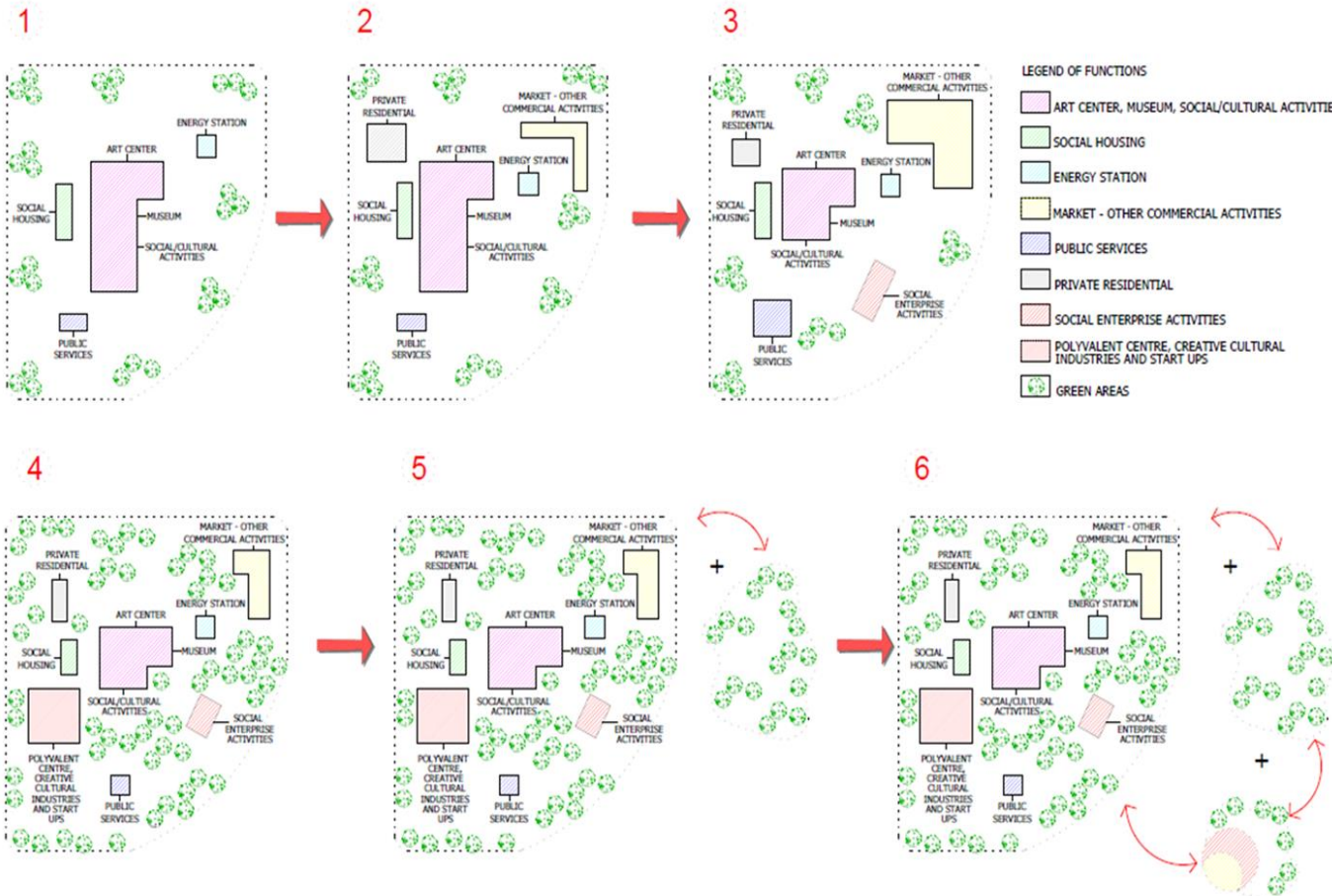
Alternative progettuali	Posizione
Hotel Complex 'Plajum Montis'	11
SALERNO (re)STARTS	14
Reggia di Salerno	10
The identity between tradition and innovation	3
Solidarity condominium	5
Hippocratica Hills Health Heritage Hub	2
Academy ASSE3 T - Academy for the Environment and the Empathetic-Ethical-Ecological-Economic Sustainable Development of the Territory	9
Tourism Learning Based	8
School hotel	13
Discreet interventions for the reactivation of 'Edifici Mondo'	6
The Awakening of the Senses	12
The house of music	4
Water paths	1
Creative reuse of abandoned buildings under an artistic key	7

5

Discussione e
iterazione circolare

Secondo ranking di preferibilità delle 4 proposte
selezionate

Team di ricerca



14 proposte

Primo ranking di preferibilità delle
proposte di riuso per gli "Edifici
Mondo"

4 proposte selezionate

Secondo ranking di preferibilità
delle proposte di riuso per gli
"Edifici Mondo"

6

Valutazione
attraverso indicatori
quanti-qualitativi

Secondo ranking di preferibilità delle 4 proposte
selezionate

Team di ricerca

Objectives	Criteria	Indicators	Evaluation scales		
1 Conservation, transmission and regeneration of cultural values	1.1 Adaptive reuse of cultural heritage	1.1.1 Degree of compatibility of the new uses with attributes and values of cultural heritage	Ordinal (five points scale)		
	1.2 Financial self-sustainability	1.2.1 Net Present Value	Cardinal (Euros)		
		1.2.2 Internal Rate of Return	Cardinal (percentage)		
2 Enhancement of community awareness and knowledge of cultural heritage values	2.1 Engagement of local community	2.1.1 Propensity to engage residents and visitors in awareness raising activities	Ordinal (five points scale)		
		3 Valorisation of intangible cultural heritage	3.1 Recovery and re-interpretation of local intangible cultural heritage	3.1.1 Capacity of implementing activities linked to the Salerno Medical School tradition	Ordinal (five points scale)
		4 Enhancement of local entrepreneurial ecosystem	4.1 Job creation	4.1.1 Number of jobs directly generated by the new uses	Cardinal (no. of jobs)
4.2 Activation of local co-investments	4.2.1 Level of local co-investment leveraged		Ordinal (five points scale)		

6

Valutazione
attraverso indicatori
quanti-qualitativi

Secondo ranking di preferibilità delle 4 proposte
selezionate

Team di ricerca

Objectives	Criteria	Indicators	Evaluation scales
5 Strengthening of social capital	5.1 Social inclusion	5.1.1 Degree of diversity of community groups involved as users	Cardinal (percentage)
	5.2 Neighbourhood vibrancy	5.2.1 Level of integration of neighbourhood activities and proximity shops in the area	Ordinal (five points scale)
	5.3 Stakeholder engagement	5.3.1 Degree of diversity of stakeholders involved as co-producers of services	Cardinal (percentage)
6 Enhancement of cultural, creative and innovation ecosystem	6.1 Cultural vibrancy and innovation ecosystem	6.1.1 Capacity of generating in the area new cultural, creative and innovative activities due to the adaptive reuse	Ordinal (five points scale)
	6.2 Traditional skills	6.2.1 Propensity to involve artisans and craftsmen with traditional skills in the adaptive reuse works	Ordinal (five points scale)
7 Accessibility improvement	7.1 Accessibility of the urban area	7.1.1 Level of provision of public spaces recovered and made accessible	Ordinal (five points scale)
8 Increasing of energy self-sufficiency	8.1 Energy self-sufficiency	8.1.1 Degree of energy self-sufficiency through the use of renewable sources	Ordinal (five points scale)

6

Valutazione
attraverso indicatori
quanti-qualitativi

Secondo ranking di preferibilità delle 4 proposte
selezionate

Team di ricerca

Objectives		Criteria		Indicators		Evaluation scales
9	Reduction of natural resources consumption	9.1	Freshwater efficiency	9.1.1	Propensity to the reduction of freshwater consumption through water recovery and reuse	Ordinal (five points scale)
		9.2	Nature-based solutions	9.2.1	Surfaces covered with nature-based solutions (e.g. green roofs, green façade, gardens, etc.)	Cardinal (square metres)
		9.3	Construction and demolition wastes	9.3.1	Level of construction and demolition wastes avoided through the reuse of materials on site	Ordinal (five points scale)
		9.4	Greenhouse gas emissions	9.4.1	Level of greenhouse gas emissions in the operation phase compared to the average emissions of the buildings in the same area	Ordinal (five points scale)
10	Natural capital regeneration	10.1	Urban biodiversity	10.1.1	Surface of new and recovered green urban areas	Cardinal (square metres)

7

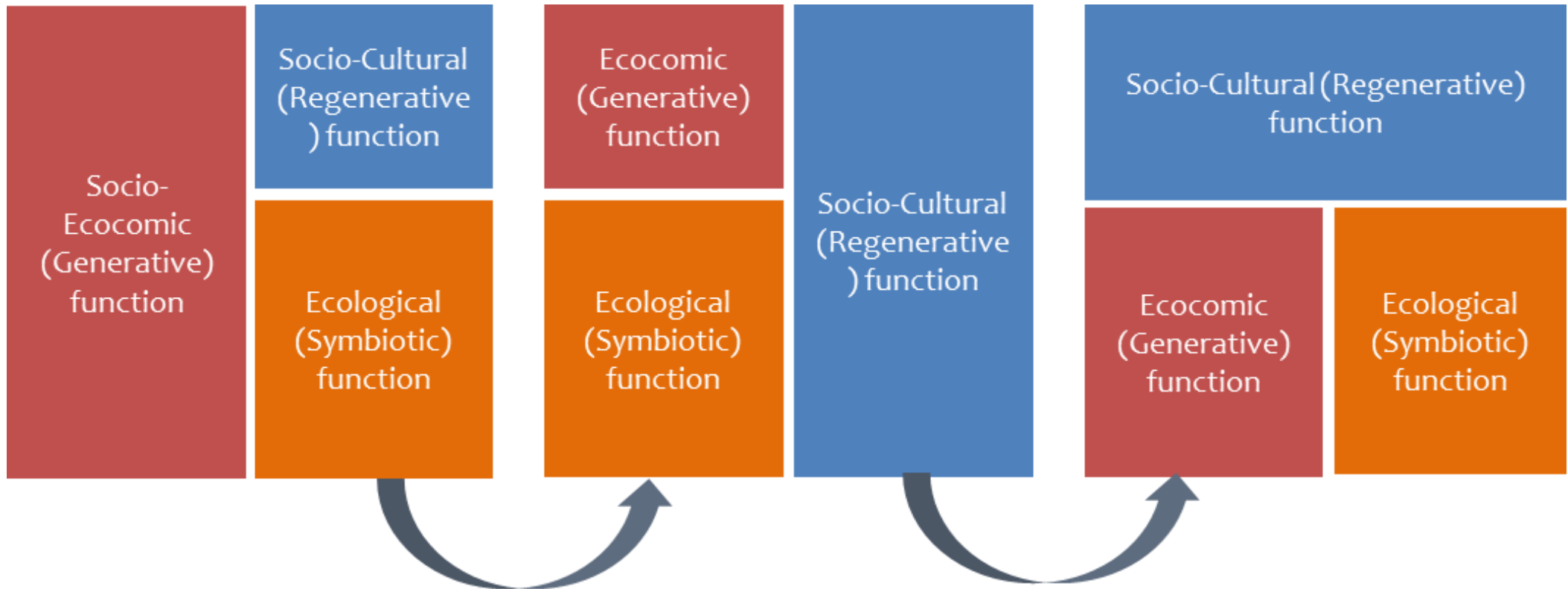
Discussione e
iterazione circolare

Terzo ranking di preferibilità (3 scenari)

Stakeholders

Comune di Salerno

Team di ricerca



Conclusioni

Gli strumenti di valutazione multicriterio possono essere utilizzati sia in fase **ex ante**, per supportare un processo decisionale partecipativo nella fase di pianificazione e progettazione, che in fase **ongoing** ed **ex post** per monitorare e misurare gli impatti multidimensionali degli interventi attuati.

Per progettare e pianificare **strategie di sviluppo** basate su modelli economici e territoriali circolari, le soluzioni devono essere caratterizzate da un approccio dinamico coevolutivo in cui criteri, pesi e alternative cambiano in una spirale evolutiva in base alle esigenze espresse dagli attori coinvolti nel processo. Quest'ultimo viene sempre più affinato e adattato fino al loro soddisfacimento.

Grazie per l'attenzione!

Francesca Nocca

Ricercatore, Università degli Studi di Napoli "Federico II"

Giuliano Poli

Ricercatore, Università degli Studi di Napoli "Federico II"

Martina Bosone

Ricercatore, Istituto di Ricerca su Innovazione e Servizi per lo Sviluppo (IRISS) del Consiglio Nazionale delle Ricerche (CNR)

PARTNER



MEDIA PARTNER



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