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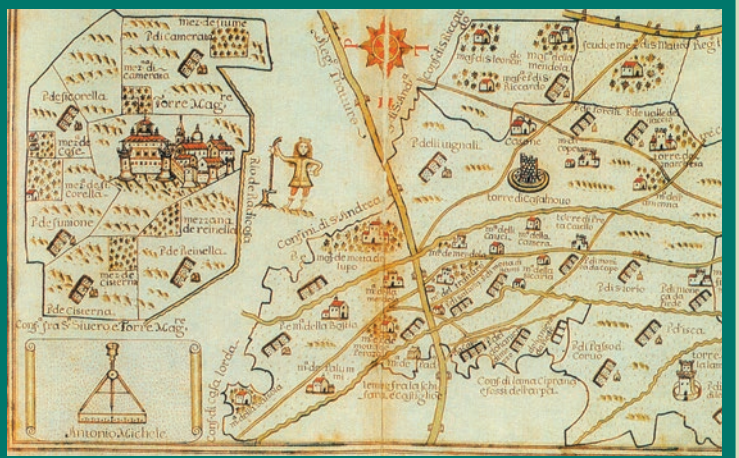

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Farmland value in the "Conegliano Valdobbiadene Prosecco Superiore PGDO" area. An application of the Hedonic Pricing method

In the last 30 years, numerous studies analysed the factors that affect land prices mainly using the Hedonic Pricing method. These studies have shown that many factors can affect land prices (e.g. land and surrounding territory characteristics, accessibility, proximity to urban area, etc.). However, they rarely addressed the analysis of the reliability of the models by comparing the estimated values to the observed one. Attempting to face this problem, our study analysed the land market of the "Conegliano Valdobbiadene Prosecco Superiore PGDO" area. Despite the quite high coefficient of determination (r^2 = 0.76) and statistical significance of the model parameters, we found that the percentage absolute deviation between observed and estimated value is higher than 30% in 34% of cases. Our results seem to suggest that future researches should devote particular attention to the analysis of the discrepancies existing between estimated values and market prices in order to support the appraisal activity of professional valuers.

1. Introduction

Farmland is a not negligible part of the Italian wealth. According to the Bank of Italy and ISTAT (2019) its value equals 294,347 million euro corresponding to about 2.73% of Italian wealth. Considering that such a figure is an underestimation of the farms' fixed capital because it does not consider the value of buildings, machinery and land improvements, it is possible to see that on the whole the agricultural assets also today play an important role in the Italian economy. This is of particular relevance if we consider that many times agricultural land is used to secure mortgage loans. A sound valuation is in this respect of particular relevance in order to prevent a financial crisis of the banking sector[1]. Hence the need to have valuation methods as reliable as possible and able to provide correct estimates of the agricultural land value.

At international level, in the last 30 years, numerous studies analysed the factors that affect land prices mainly using the Hedonic Pricing method (HP) (see for a

[1] "Lending institutions rely on sound valuations not simply for obvious reasons of commercial prudence in lending but also under the rules following the Basel III agreement governing their credit structures as applied to credit institutions in the EU by the Capital Requirements Directive 2013/36 and the Regulation (EU) 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms". (TEGOVA, 2016, p. 95)

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review De Noni et al., 2019; Perry and Robinson, 2001). The purposes of the investigations have been manifold. For example, numerous studies have tried to verify the effect of agricultural policy on land prices to understand whether the measures adopted can generate rent phenomena (Casini et al., 2015; Ciaian et al., 2010; Feichtinger and Salhofer, 2013; Kirwan, 2009; Latruffe and Le Mouël, 2009; Mela et al., 2012; Roberts et al. 2003). Another important field of investigation concerned the effects of territorial policy and urban growth on farmland prices (Abelairas-Etxebarria and Astorkiza, 2012; Delbecq et al., 2014; Géniaux et al., 2011; Guiling et al. 2009; Jaeger et al., 2012; Livanis et al., 2006; Plantinga et al., 2002). Especially in more recent years, many studies investigated the effect of various types of amenities on farmland prices also in order to measure their social value (Bastian et al., 2002; Borchers et al., 2014; Ma and Swinton, 2011; Sardaro et al., 2020; Uematsu et al., 2013; Wasson et al., 2013). Lastly, some scholars studied the effect of some intrinsic characteristics of agricultural land on their value (e.g. the availability of water, soil fertility, slope, shape of the plots, etc.) (Bastian et al., 2002; Drescher et al., 2016; Faux and Perry, 1999; Kostov, 2009; Maddison, 2009; Perry and Robison, 2001; Petrie and Taylor, 2007; Sundelin et al., 2015; Troncoso et al., 2010; Tsoodle et al., 2006; Xu et al., 1993).

In general, these studies have shown that there are many factors that can affect land prices, such as the intrinsic land characteristics, the characteristics of the territory where the agricultural land is located (e.g. proximity to urban areas, proximity to the road network, etc.), urban planning, presence of easements and proximity to various types of amenities (lakes, woods, rivers, etc.).

Regarding the intrinsic characteristics, numerous authors have pointed out that fertility (measured with various types of indexes) or productivity of soils have a positive effect on the price per unit of area (Bastian et al., 2002; Drescher et al., 2001; Faux and Perry, 1999; Kostov, 2009; Maddison, 2009; Sardaro et al., 2018b; Tsoodle et al., 2006; Troncoso et al., 2010; Xu et al., 1993; Perry and Robinson, 2001; Sardaro et al., 2021; Uematsu et al., 2013).

The presence of irrigation water and good drainage in general also increase the unit price (Bastian et al., 2002; Kostov, 2009; Ma and Swinton, 2011; Perry and Robison, 2001; Sardaro et al., 2020; Tsoodle et al., 2006) while slope has a negative effect (Erwin and Mill, 1985; Hilal et al., 2016; Ma and Swinton, 2011; Sardaro et al., 2020; Sardaro et al. , 2021).

As for the location of the farm and the characteristics of the territory surrounding it, many studies highlighted that distance from the road network (Drecher et al., 2001; Kostov, 2009; Sardaro et al., 2018b; Snyder et al., 2008; Tsoodle et al., 2006; Khalid, 2015; King and Schreiner, 2004; Ma and Swinton, 2011; Sardaro et al., 2020; Sardaro et al., 2021) and from major inhabited centers (Kostov, 2009; Maddison, 2009; Sardaro et al., 2018b; Snyder et al., 2008; Khalid, 2015; Sardaro et al., 2020; Sardaro et al., 2021) reduces the price per unit of area.

The researches that have analysed the effect of amenities on prices are not very numerous and their results are difficult to compare since they considered different types of amenities, sometimes using specific indicators for the investigated area. In this regard, of particular interest is the research carried out by Sardaro et al. (2020) who found that the effect of various types of amenities changes accord-

ing to the type of crop and the characteristics of the rural area (Rural area with specialised intensive agriculture; Rural area with development problems). Proximity to woods always reduces the price of land, but this effect is higher in Rural areas with specialized intensive agriculture and for vineyards. The distance from scenic sites and historical sites, on the other hand, reduces the price only in the case of olive groves and vineyards located in the Rural area with specialized intensive agriculture.

From an operational point of view, in some cases scholars have used values estimated by experts or by the farmers and not market prices (Boisvert et al., 1997; Borchers et al., 2014; Choumert and Phélinas, 2015; De Noni et al., 2019; Devadoss and Manchu, 2007; Drescher and McNamara, 1999; Lehn and Bahr, 2018; Maddison, 2000; Mela et al., 2012; Sills and Caviglia-Harris, 2009). As observed by some authors, the values derived by opinion survey tends to diverge from the market price and therefore its use cannot be considered correct for appraisal purposes (Bigelow et al., 2020; Ma and Swinton, 2012).

Moreover, these values often referred to large areas (e.g. provinces, counties or regions) that were very heterogeneous as regards the characteristics of the land and territory. In other cases, while referring to real prices, some characteristics of the farmland sold have been associated with information relating to a large area (e.g. municipality or county) (Drescher et al., 2011; Donoso et al., 2013; Gracia et al., 2007; Guiling et al., 2009; Khalid, 2015; Sklenicka et al., 2013; Uematsu et al., 2013).

Therefore many of these researches, while being useful to understand which factors affect land prices on a large-scale, have limited usefulness when the purpose of the analysis is to estimate the value of a specific plot or to understand the functioning of the land market at a local level. The effect of a given factor at provincial level can be completely different from that found in a given small territorial context since the land market often has a purely local connotation (Cotteleer et al., 2008).

Another problem neglected by previous researches is given by the fact that the statistical goodness of fit of a model is not in itself sufficient to guarantee its ability to correctly estimate market prices. Especially when the Ordinary Least Squares (OLS) method is used, a high coefficient of determination can actually be associated with consistent deviations between estimated and observed data. On the other hand, the standard error of the estimates provides a measure of the average deviation between estimated values and observed values only in the case of linear models, while this does not happen for example in the case of the semi-logarithmic models that have been used in most of the researches on the land market cited above. In this regard, it should be emphasised that only two researches to our knowledge has attempted to verify a posteriori the reliability of the HP method for the estimate of farmland values by comparing the estimated values with surveyed or market prices (Caggiati et al., 1982; Hilal et al., 2016).

As regards Italy, researches are much less numerous and market prices have only been used in a few studies (Sardaro et al., 2018a; Sardaro et al., 2018b; Sardaro et al., 2020; Sardaro et al., 2021; Tempesta and Thiene, 1997).

This research aims to verify whether it is possible to make sufficiently reliable estimates of market prices through HP. In this regard, the percentage deviation be-

tween observed and estimated values was analysed in the case of 85 sales of land located in five municipalities belonging to the Protected and Guaranteed Designation of Origin (PGDO) "Conegliano e Vadobbiadene Prosecco Superiore" (hereinafter Prosecco PGDO). It is a hilly area characterised by considerable environmental and landscape variability that affects both the crop mix and land prices. In much of the land sold, there are more crops and it is necessary to use multivariate analysis such as HP for the estimation.

Furthermore, in the territory under examination, the land market presents elements that are in some ways unique and still little explored by research. The growing international success of Prosecco wine has led to a significant increase in the land demand for viticulture, which has progressively extended from vineyards to areas occupied by wood, arable land or meadows. The price offered by buyers often does not refer to the crops actually cultivated but to the income that could be obtained from the conversion of these crops into vineyards. However, there are some limitations to the possibility of planting vineyards where other crops are currently cultivated.

As is well known, the common agricultural policy has imposed considerable restrictions on the planting of vineyards since the 1970s. With EEC Regulation 822/87 the possibility of transmitting planting rights to another winegrower was allowed. Until 2013 to plant a new vineyard it was necessary to have planting rights that could be purchased by other winemakers (Galletto, 2014). With Regulation (EU) no. 1308/2013 from 1 January 2016 a new scheme came into force that allows the planting of new vineyards within the maximum annual limit of 1% of the national vineyard area.

It is possible to suppose that the EU wine market organisation and Protected Designation of Origin can potentially modify the functioning of the land market by increasing the market power of the landowners. This is particularly true in the case of wines that have a relevant market success such as Prosecco. Furthermore, the procedures for granting planting rights can lead potential buyers to believe that in the future, an arable land or a forest can be converted into a vineyard and therefore the price paid will not correspond to that of these crops but to the price of the vineyard discounted to the actuality (hope price).

This study presents some elements of novelty compared to other land market analyses.

First of all, it is one of the few HP applications in Italy where real market prices have been used and that addressed the problem of estimating the value of land in which there are different crops, as often happens in hilly and mountain areas. It is also one of the few national and international studies that have concerned vineyard land market (Gracia et al., 2007; Sardaro et al., 2018a; Sardaro et al., 2018b; Sardaro et al., 2020; Sardaro et al., 2021).

Second, by analysing the difference between actual and predicted value we tried to verify whether HP can be considered a reliable method for estimating farmland value.

The paper is structured as follows. The study area is briefly described in section 2 and the methodology is illustrated in section 3. The results are reported in

section 4, before discussing the findings and drawing our conclusions in the last section (5).

2. The study area

The study area is the territory of the Prosecco PGDO that is located in the northern part of the province of Treviso (Figure 1) and has a total area of 21,460 ha. From an administrative point of view, 15 municipalities belong to it, albeit to varying degrees (Table 1).

Morphologically, the territory can be subdivided into two distinct landscape systems. There is a first system that is further north and is made up of hills located in an east - west direction with steep slopes and deep valleys. In this area, the cultivation of vineyards was made possible by the construction of narrow grassy terraces starting from the sixteenth century. It is therefore one of the oldest areas of diffusion of the vine in specialised cultivation in the Veneto Region. In these hills the main cultivation activities are conducted mainly by hand given the steep slope of the land with only partial use of agricultural machinery.

The second system is instead composed of hills whose ridges tend to have a north - south direction, where the slopes are less pronounced and which are therefore easier to cultivate. Until the 1960s the vine was cultivated in the traditional "piantata di viti" in which arable fields were bordered by rows of vines and mulberries.

Average annual rainfall varies from 1,100 mm in Conegliano to 1,250 mm in Valdobbiadene, ensuring sufficient water supply for the Glera vine (from which the grapes used to produce the Prosecco wine are obtained), which are sensitive to both stagnation and drought. The altitude is between 100 and 500 m above sea level.

The Prosecco PGDO territory presents a considerable variability that strongly influences the quality of the grapes and wines produced. In this regard, the small area

Figure 1. The study area.

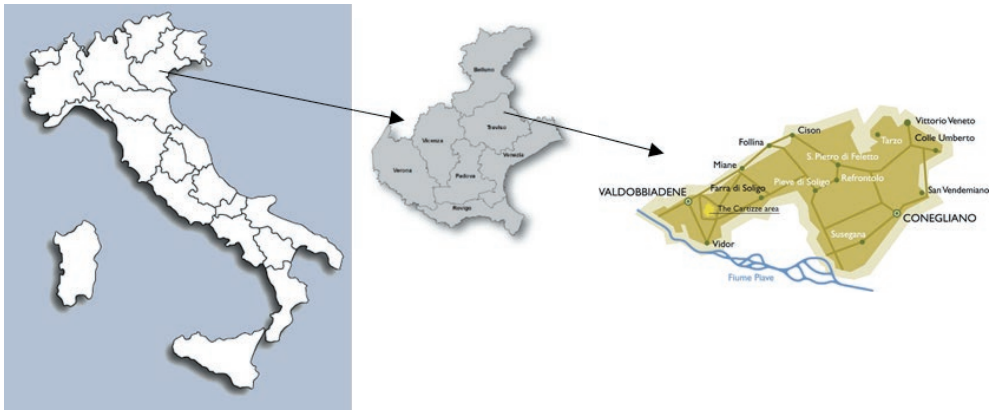

Table 1. Municipalities belonging to the "Conegliano Valdobbiadene Prosecco Superiore" PGDO.

Municipality	Municipal area	Surface belonging to the Prosecco PGDO	
		ha	%
Cison di Valmarino	2,880.04	578.98	20.1
Colle Umberto	1,360.42	333.77	24.5
Conegliano	3,636.14	3,052.60	84.0
Farra di Soligo	2,825.66	1,484.37	52.5
Follina	2,420.70	698.50	28.9
Miane	3,090.04	1,109.15	35.9
Pieve di Soligo	1,901.22	1,401.68	73.7
Refrontolo	1,304.69	1,303.74	99.9
San Pietro di Feletto	1,945.48	1,944.00	99.9
San Vendemmiano	1,843.13	166.50	9.0
Susegana	4,395.82	2,607.62	59.3
Tarzo	2,384.53	1,199.44	50.3
Valdobbiadene	6,086.27	2,699.41	44.4
Vidor	1,357.14	469.81	34.6
Vittorio Veneto	8,272.07	2,410.75	29.1
Total	45,703.35	2,1460.32	47.0

of Cartizze, which occupies 108 hectares in the municipality of Valdobbiadene, assumes particular importance. In it, due to the particular exposure and nature of the soils, a superior quality product is obtained, which has a considerably higher price than that obtained in the other parts of the Prosecco PGDO.

Indeed, in the 2020 harvest the average price of Cartizze grapes was 4.05 €/kg, compared to an average price of 1.25 €/kg for grapes produced in the other parts of the Prosecco PGDO.

The vine-growing area, which at the beginning of the 2000s amounted to about 4,000 hectares, has progressively increased, so much so that by 2018 it was 8,446 hectares. There are many reasons for this trend, but an important role has certainly been played by the growing success of Prosecco on national and international markets (Boattoet al., 2019). The strong demand for areas to be used for vineyard cultivation has meant that land has reached extremely high prices. According to the Crea-PB database[2], the price of vineyards in 2019 was around 35-50 €/m^2, while annual rents

[2] The cited data can be downloaded at the following website: https://www.crea.gov.it/web/politiche-e-bioeconomia/dettaglio-servizio/-/asset_publisher/PfOBDvsvmM6v/content/indagine-mercato-fondiario

Table 2. Distribution of the collected real estate transactions among the municipalities under investigation.

Municipality	N.	%
Colle Umberto	12	14.1
Conegliano	14	16.5
San Pietro di Feletto	14	16.5
Susegana	11	12.9
Valdobbiadene	31	36.5
Vittorio Veneto	3	3.5
Total	85	100

were between 4,000 and 7,000 €/ha in the Valdobbiadene area and between 3,500 and 6,000 €/ha in that of Conegliano.

3. Materials and Methods

3.1 Data collection

To analyse the land market, we collected 91 sales, which took place between 2008 and 2018. Land not classified as agricultural by the urban plan was excluded from the database. Furthermore, sales with unusually low prices compared to those of the area where they are located were excluded. Overall, the final sample is made up of 85 trades that took place in six municipalities of the Prosecco PGDO area that can be considered representative of the entire territory (Table 2).

Since sales are distributed over a rather long period, prices have been converted into constant prices using the GDP deflator provided by ISTAT to remove the effects of inflation.

The information reported in Table 3 has been extrapolated from the deeds of sale. This information is useful for knowing, in addition to surface area, price, degree of fragmentation and presence of buildings, also the presence of various factors that may limit the owner's property rights. These limitations may derive above all from environmental and urban planning restrictions which may constrain or preclude the transformation of the land into a building area or affect the possibility of changing the crop currently cultivated.

For example, in the presence of a forest restriction, the transformation of a forest into a vineyard becomes more difficult[3]. The presence of some easements that

[3] However, note that according to Article 5 of Legislative Decree 3 April 2018, no. 34 "Testo unico in materia di foreste e filiere forestali", cannot be considered woods: land registered in the "National Register of rural landscapes of historical interest, agricultural practices and tra-

Table 3. Data collected in the deeds of sale.

Date of the deed of sale
Cadastral map information (parcel and sheet number)
Surface
Price
Number of plots into which the sold land is divided
Pre-emption right
Buyer and seller information (person or company, *professional agricultural entrepreneur*; presence of kinship between the parties)
Presence of easement: right of way, gas pipeline, high-voltage overhead transmission line, water line.
Presence of rural building
Rented land
Hydrogeological, forestry and landscape restrictions indicated in the certificate of urban destination
Type of zone defined by the municipal general urban plan

could affect the type of cultivable crops (for example, methane pipeline or power line) may also be important.

Lastly, the importance of the characteristics of the parties who participated in the transaction should be recognised since, as pointed out by some authors (Cotteleer et al., 2008; Perry and Robinson, 2001), they can affect the agreed price.

However, the deed of sale does not contain information relating to many factors, both intrinsic and extrinsic, which can affect the price of agricultural land. To make up for this deficiency, the lands were first georeferenced using cadastral data. For this purpose, the WMS cadastral cartography based on the Web Map Service 1.3.0 standard, present in the Revenue Agency's Cadastral Cartographic Geo-portal, was consulted. This procedure allowed an integrated visualization with other territorial data and to interface the cadastral data with Google Earth. Through the use of placemarks, the precise location of the land on Google Earth and the geographical coordinates of its central point were identified.

Through Google Earth it was possible first of all to analyse the historical aerial images to learn the land use at the time of sale and the current one. Crops were divided into three classes: vineyards, herbaceous crops and woods. Given the quality of the images, it was not possible to distinguish with certainty the arable land from the meadows and therefore it was decided to group them into a sin-

ditional knowledge", established by the Ministry of Agricultural Food and Forestry that were cultivated in the past. In this regard, it should be noted that the northern part of Prosecco PGDO, which has an area of 10,802 ha, belongs to this Register.

Table 4. Shapefiles of the Geo-portal of the Veneto Region used in the study.

Road network
Level curves
Regional hydrographic network
Soil map
Soil permeability map
USDA Hydrologic Soil Group
Map of the texture and gravel within the first 50 cm of soil
Land use map
"Historical Centres" and "Minor Historical Centres" taken from the Atlas of the historical centres of the Veneto Region.
Sites of Community Importance and Special Protection Areas
Areas under hydrogeological restriction
Areas under forestry restriction
Areas under landscape restriction
Other land use restrictions (road, railways, etc.)
"First rank regional centres"; "Second rank intermediate urban centres"; "Third rank local urban centres"; "Local urban centres of the fourth rank" and "Local urban centres of the fifth rank"

gle class. This information also allowed us to see if after the sale the cultivations changed and in particular if woods and herbaceous crops had been transformed into vineyards. This information is of particular relevance in an area such as the one under investigation since it is very likely that buyers' willingness to pay is considerably influenced by the possibility of planting a vineyard in the future.

Secondly, it was possible to interface the data relating to the location of the sold land with those inferable from the shapefiles relating to various territorial themes available on the Geo-portal of the Veneto Region (Table 4). It was thus possible to know the geomorphological and agronomic characteristics of the land and their position with respect to the road network and urban and rural settlements.

Using the information in Tables 3 and 4, the variables reported in Tables 5 and 6 were calculated and then used to select the statistical model described in the following section.

3.2 The HP model

Since in only 61% of the real estate transactions surveyed the land consisted of a single crop and the territory in question has a high geomorphological and microclimatic variability, it is not possible to use a single-parameter procedure to estimate the value of the land (e.g. mean price). In this case, the only approach that

can be used is Hedonic Pricing (HP), which is based on the estimate of a function that relates the price (p) to the characteristics of the property (x_i):

$$p = \sum_{i=1}^{n} \beta_i \cdot x_i \quad (1)$$

The meaning of the coefficient β_i changes according to the mathematical model used in the estimate. In the case of the linear models β_i corresponds to the marginal price of any property's characteristics. In the case of semi-logarithmic models, which are the most used in the analysis of the land market, for continuous variables the coefficient β_i multiplied by 100 is equal to the percentage change in the price determined by a marginal variation of a given characteristic. For dummy variables, on the other hand, the following equation holds:

$$\text{Percentage price variation} = 100\,[\exp(\beta_i)-1] \quad (2)$$

It is interesting to note that in the case of dummy variables the exponential of the regression coefficient conceptually corresponds to the coefficient used in the estimation models for differentiation coefficients or for merit scales. In fact, in the case of semilogarithmic functions the model (1) can be rewritten as follows:

$$p = \prod_{i=1}^{n} e^{\beta_i x_i} \quad (3)$$

The use of HP for appraisal purposes poses operational and interpretative problems of some importance. First, you need to decide whether to use price or price per unit area as dependent variable. In the case of agricultural land in almost all of the publications analysed the price per unit area is used and to our knowledge, only three studies used the price (Hilal et al., 2016; Petrie and Taylor, 2007; Tempesta and Thiene, 1997).

The choice of one or the other alternative has advantages and disadvantages that must be considered by the researcher. The use of the price has the advantage of making the appraisal easier when the land sold is characterised by the presence of many of crops and rural buildings. In this case, using the surface areas of the various crops and buildings as independent variables it is possible to estimate the average and marginal price of each of them.

However, it becomes more complex to determine the relationship that exists between some intrinsic and extrinsic characteristics and the price. Consider, for example, the case of the distance of agricultural land from main roads that, at least theoretically, should be negatively correlated to the price. If a larger farmland was located at a greater distance from the road, the model could identify a positive relationship between distance and price. The close relationship that exists between price and surface area could obscure the effect of other potential factors that might play an important role in the formation of prices.

When the dependent variable is the price per unit of area (p_u), the analysis of the effect of intrinsic and extrinsic characteristics becomes simpler, but it becomes

more complex to take into account the presence of different crops and buildings in the model.

In some researches, the problem has been addressed by estimating separate models for each single crop (for example: arable land, vineyards, horticultural crops, etc.) (Borchers et al., 2014; Sardaro et al., 2018a; Sardaro et al., 2018b; Sardaro et al., 2020; Sardaro et al., 2021) or by inserting dummy variables relating to the type of crops present in the farmland or the presence of buildings (Gracia et al., 2007; Hilal et al., 2016). The first solution is feasible only if the sales refer to specialised farms. The second procedure is not very correct from the appraisal point of view, since the estimated value is independent of the area actually occupied by crops. However, it can be useful to take into account small marginal areas or buildings of modest size which have the same characteristics among all the farmland analysed.

In our study, to take into account the presence of different crops, the percentage of land occupied by each of them was included among the model parameters (King and Schreiner, 2004; Ma and Swinton, 2011; Snyder et al., 2008; Tsoodle et al., 2006; Xu et al., 1993). As regards the buildings, considering their type and their small size, it was preferred to use a dummy variable (Donoso et al., 2013; Elad et al., 1994; Petrie and Taylor, 2007).

Following the approach of numerous researches, a semilogarithmic model has been estimated in which the dependent variable is the logarithm of the price per square metre (Borchers et al., 2018; Drescher et al., 2001; Maddison, 2009; Sardaro et al., 2018a; Snyder et al., 2008).

The p_u of each crop was estimated by calculating the exponential of 100 β_i. However, it should be noted that if the percentage of all crops is entered in the model, it is not possible to enter the constant and this makes it difficult to establish the reliability of the model since the coefficient of determination is not comparable with that of the models in which there is the constant. To overcome the problem Hoking (1996, p. 178) suggests estimating a regression between observed and estimated values and considering the coefficient of determination thus obtained as a measure of the goodness of fit of the model. In fact, according to Eisenhauer (2003 p. 80) "this measure is equal to the unadjusted coefficient of determination for the OLS model".

For purely comparative purposes, a linear model was also estimated in which the dependent variable is the price, which, however, as will be seen, does not contain information useful for understanding the factors that influence the selling price.

Two other problems arise in the use of HP that must be addressed by the valuers. First, you have to choose which independent variables to include in the model. In this regard, in the researches that used very large samples relating to large areas, all the characteristics that at least theoretically could affect the price, regardless of their statistical significance, were generally included in the models. This approach has the advantage of allowing you to see directly what are the factors that market operators actually consider when buying land and which ones play a marginal role in their choices.

Having small samples, as often happens when appraising farmland, it is in some ways more correct to use procedures that allow you to select the independent variables that are statistically significant. Furthermore, in the case in which the models are to be used for appraisal purposes, the presence of non-significant variables is substantially useless and, in general, parsimonious models are preferable with regard to the number of parameters.

In this study, the parameters were selected with a mixed procedure. Initially, through a stepwise regression, the variables best correlated to the p_u were selected from those reported in Table 5. Subsequently, considering the limits of stepwise regression[4], the variables selected by the statistical program at each step were analysed. Lastly, a regression function was estimated by means of the OLS method in which the statistically significant covariates of greatest estimative interest were inserted.

To estimate an HP model, various statistical approaches can be used, but from the valuer's point of view it becomes essential to have criteria that allow its reliability to be verified. As is known, to establish the statistical goodness of a model estimated with the OLS method, various statistical indices are used such as the standard error of the estimate, the coefficient of determination, Fisher's F and the statistical significance of the regression coefficients. Generally speaking, it can be said that a regression model provides estimates that are all the more reliable the lower the standard error and the higher the other indices.

From a professional valuer's point of view, for a model to be reliable, the deviation between estimated and actual values must be as low as possible and none of the mentioned indexes provide a direct and easily interpretable measure of the error that can be committed using the model for the estimation of real estate values.

In this regard, the analysis of residues is certainly more useful, as it allows you to verify how much the estimated values differ from the real ones and to calculate the average percentage deviation between them. In fact, it can easily be verified that for models that have a satisfactory coefficient of determination (for example higher than 0.70-0.80) the percentage deviation can be very high. Considering that, since the error committed in the estimate is similar whether the estimated value is higher or lower than the one observed, it is useful to calculate the percentage deviation in absolute value both in monetary and percentage terms.

In analysing the results, the following indices will therefore also be used:

$$\textit{Mean Absolute Deviation} = \frac{1}{n} \sum_{i=1}^{n} \left| \, p_{ui\ observed} - p_{ui\ estimated} \, \right| \tag{4}$$

$$\textit{Mean Percentage Absolute Deviation} = \frac{1}{n} \sum_{i=1}^{n} \frac{\left| \, p_{ui\ observed} - p_{ui\ estimated} \, \right|}{p_{ui\ observed}} \tag{5}$$

[4] As stated by Whittingham et al. (2006, p. 1183) the principal drawbacks of stepwise multiple regression include "bias in parameter estimation, inconsistencies among model selection algorithms, and an inappropriate focus or reliance on a single best model, where data are often inadequate to justify such confidence".

Table 5. Selling price and intrinsic characteristics of the farmland.

Variables	Unit of measure/type of variable	Mean	Min	Max	St. Dev.
Surface	m^2	11,173	360	190,628	22,846
Price	euro 2018	314,852	4,368	5,560,500	762,902
Price per square metre	euro 2018	28.71	3.89	159.06	27.56
Land use at the selling date:					
- Cartizze	m^2	366.08	0	28,596.57	3,104.65
- Other vineyards	m^2	6,061.00	0	156,314.96	18,618.90
- Herbaceous crop	m^2	3,185.46	0	50,496.00	6,744.33
- Wood	m^2	1,560.28	0	25,000.00	4,146.74
Land use in 2018:					
- Herbaceous crop	m^2	959.01	0	22,580.00	3,032.12
- Wood	m^2	1,317.14	0	25,000.00	4,054.20
- Herbaceous crops and woods transformed into vineyards after the sale	m^2	2,469.60	0	50,496.00	6,361.37
Land use in 2018 - percentage:					
- Cartizze	Land %	3.49	0	100	18.38
- Other vineyards	Land %	41.45	0	100	43.82
- Herbaceous crop	Land %	15.02	0	100	33.26
- Wood	Land %	11.31	0	100	26.55
- Herbaceous crops and woods transformed into vineyards after the sale	Land %	28.73	0	100	40.33
Plot shape	Dummy variable	0.31	0	1	0.464
Land shared in two or more plots	Dummy variable	0.07	0	1	0.258
Altitude	m above the sea level	168.25	68	350	79.447
Slope	%	14.08	1	70	16.84
Soil texture:					
- Loam	Dummy variable	0.64	0	1	0.484
- Clay loam	Dummy variable	0.36	0	1	0.484
Gravel within the first 50 cm of soil:					
- Scarce	Dummy variable	0.33	0	1	0.473
- Common	Dummy variable	0.18	0	1	0.383
- Frequent	Dummy variable	0.14	0	1	0.350
- Abundant	Dummy variable	0.29	0	1	0.458
- Very abundant	Dummy variable	0.06	0	1	0.237

Variables	Unit of measure/type of variable	Mean	Min	Max	St. Dev.
Permeability:					
- low	Dummy variable	0.39	0	1	0.490
- moderately low	Dummy variable	0.22	0	1	0.419
- moderately high	Dummy variable	0.39	0	1	0.490
Potential runoff:					
- moderately low	Dummy variable	0.15	0	1	0.362
- moderately high	Dummy variable	0.31	0	1	0.464
- High	Dummy variable	0.54	0	1	0.501
Small farm building	Dummy variable	0.07	0	1	0.258

4. Results

4.1 Sold land characteristics

Tables 5 and 6 summarize the characteristics of the independent variables considered to estimate the HP model. The average area of the land sold is 3.11 ha with considerably variable values ranging from 360 m^2 to 19 ha. However, it should be noted that in 75% of cases the areas sold were less than 1 ha and half of the sales concerned land of less than 0.5 ha.

The average price of land is 314,800 €, but also in this case there is a considerable variability (minimum price = 4,368; maximum price = 5,560,500). Due to the great diversity of crop prices, the variability is much greater than that of the surface area.

As can be seen in Table 7, vineyards accounted for about 57% of the cultivated areas at the time of sale. In the following years, however, 18.79 ha of herbaceous crops and 2.07 ha of wood were planted with vineyards, so that by 2018 almost 80% of the area was planted with vines. Among the vineyards, there are also 3.28 ha of Cartizze that, as will be seen, has very high land values.

The average p_u is 28.71 €/m^2 with a minimum amount of 3.89 €/m^2 found in a wood and a maximum amount of 159.06 €/m^2 at which a plot of Cartizze has been sold.

The analysis of the average prices of land in which there was only one crop can give a first overview of the land values in the area under investigation. As regards the Cartizze in the three plots surveyed, the average p_u was 145.1 €/m^2. In the other vineyards the p_u is considerably lower (41.7 €/m^2) and presents a considerable variability (95% confidence interval (CI); 30.2 €/m^2 ÷ 53.1 €/m^2; N = 19).

Herbaceous crops have an average p_u of 15.6 €/m^2 (95% CI; 12.9 €/m^2 ÷ 17.5 €/m^2; N = 25). This is certainly a very high amount given that in the plain areas of the province of Treviso, according to the CREA-PB land values database, the price per square metre of arable land in 2018 was equal to 7.92 € and in hilly areas 5.91 €.

Table 6 Extrinsic characteristics of the farmland and information about buyers and sellers.

Variables	Unit of measure/ type of variable	Mean	Min	Max	St. Dev.
Municipality where the land is located:					
- Colle Umberto	Dummy variable	0.14	0	1	0.350
- Conegliano	Dummy variable	0.16	0	1	0.373
- San Pietro di Feletto	Dummy variable	0.16	0	1	0.373
- Susegana	Dummy variable	0.13	0	1	0.338
- Valdobbiadene	Dummy variable	0.36	0	1	0.484
- Vittorio Veneto	Dummy variable	0.04	0	1	0.186
Distance from the nearest asphalt road	m	129.39	0	1000	191.91
Distance from the nearest provincial or state road	m	1,941.35	0	7000	1,874.72
Distance from waterways	m	160.47	0	800	197.00
Distance from built-up areas	m	957.88	0	4000	714.71
Distance from urban centres	m	4,355.88	400	9000	2,135.77
Land use restrictions:					
- hydrogeological	Dummy variable	0.36	0	1	0.484
- Landscape	Dummy variable	0.52	0	1	0.503
- Forestry	Dummy variable	0.33	0	1	0.474
- Road	Dummy variable	0.35	0	1	0.481
- Railway	Dummy variable	0.01	0	1	0.108
- Gas pipeline	Dummy variable	0.05	0	1	0.213
- Ecological corridor	Dummy variable	0.08	0	1	0.277
- Cemetery	Dummy variable	0.04	0	1	0.186
Easement:					
- None	Dummy variable	0.51	0	1	0.503
- Right of way	Dummy variable	0.40	0	1	0.493
- Gas pipeline	Dummy variable	0.06	0	1	0.237
- Water line	Dummy variable	0.06	0	1	0.237
- High-voltage overhead transmission line	Dummy variable	0.02	0	1	0.152
Pre-emption right	Dummy variable	0.01	0	1	0.11
Buyer: company	Dummy variable	0.26	0	1	0.44
Buyer: Professional Agricultural Entrepreneur	Dummy variable	0.64	0	1	0.48
Buyer: relative of the seller	Dummy variable	0.11	0	1	0.31

Table 7 Crops surface area at the date of the transaction and in 2018.

Surface area at the date of transaction

	ha	%
Cartizze	3.11	3.28
Other vineyards	51.65	54.39
Herbaceous crops	26.94	28.37
Wood	13.26	13.96
Total	94.97	100.00

Surface area in 2018

	ha	%
Cartizze	3.11	3.28
Other vineyards	72.51	76.35
Herbaceous crops	8.15	8.58
Wood	11.20	11.79
Total	94.97	100.00

Surface area change

	ha	var %
Cartizze	0	0.00
Other vineyards	20.86	40.39
Herbaceous crops	-18.79	-69.75
Wood	-2.07	-15.58

These values can only be explained by the strong expectations of vineyard planting which can make it possible to considerably increase the land rent. This is all the more true in the case of the woods for which in the five sales where there were no other crops on average a price of 17.2 €/m^2 was paid and in two cases price exceeded 20 €/m^2.

Generally, the land sold consists of a single plot (93%) with an irregular shape (69%); they are located at an altitude between 68 and 350 metres above sea level (Table 5). The average slope is 14% and varies from 1% to 70%. On 19% of the land sold, the slope is higher than 20% and vine cultivation involves very high costs since most of the activities cannot be mechanized.

With reference to the other intrinsic characteristics, the soils have a loam or clay loam texture, about 34% of the cases have a high presence of gravel, while the permeability is rather variable. Probably due to the high slope, the soils have high (54%) or moderately high (31%) potential runoff.

In six of the transactions there were farm tool sheds. These buildings, especially in the past, were used to leave some of the equipment used to cultivate the

land on the fields. Currently they are often abandoned and, due to their architectural characteristics and location, cannot be used for other purposes.

Turning to the extrinsic characteristics, the average distance from the nearest asphalt road is 129 m and 45% of the land sold faces a road. However, land located far from the easier access roads is quite frequent: in 20% of cases it is in fact necessary to travel over 200 m of dirt road to reach asphalt roads, a situation that in hilly areas can make access to the land difficult, especially on rainy days. The distance of the provincial and state roads is much greater, being on average 1941 m.

Since in the territory in question, as in general in the whole Veneto Region, there are numerous small urban centres, from the surveyed land it is possible to reach them by covering less than 1 km on average and the maximum distance is about 4 km. The distance from urban centres (Conegliano, Vittorio Veneto and Valdobbiadene) is also quite limited (on average 4.3 km). In general, therefore, all land sold is in a fairly favourable position with respect to the presence of urban services.

As regards the presence of land use constraints, landscape (52%), hydrogeological (36%), road (35%) and forest (33%) constraints are particularly widespread. In 51% of cases the land sold is not burdened by easements of any kind while there is a right of way on 40%. Finally, as regards the characteristics of the subjects involved in the transaction, in 26% the buyer was a company, and in 11% the parties were relatives. Only one buyer used the pre-emption right to purchase the land.

4.2 The HP models

Table 8 shows the model in which the dependent variable is price. In this case, we have estimated a linear model as it has a better goodness of fit than other

Table 8. The price model.

Dependent variable: price (euro 2018)

Variables	B	Standard error	95.0% Confidence interval		VIF
			Inf.	Sup.	
Constant	7,007.94	9,627.38	-12,158.70	26,174.58	
Cartizze area at the selling date	135.70***	2.31	131.09	140.31	1.05
Other vineyards area at the selling date	32.29***	0.74	30.80	33.77	3.91
Herbaceous crop area at the selling date	12.23***	0.99	10.25	14.20	1.02
Wood area at the selling date	12.12***	4.21	3.74	20.50	3.83
Buyer; company	39,031.62**	17,421.19	4,348.70	73,714.55	1.20
Buyer and seller relatives	-54,992.95**	23,598.92	-101,974.79	-8,011.11	1.09

Note: *** significance 99%;** significance 95%. N = 85; adjusted r squared = 0.993; standard error of estimation = 64186.4; F = 1964.7 ($p<0.001$); Breusch - Pagan test = 26.75 ($p=0.0004$).

mathematical models. The determination coefficient is 0.993. However, note that the model is heteroskedastic (Breusch - Pagan test = 26.75; p = 0.0004). Multicollinearity problems are substantially absent (parameters VIF <5). Six independent variables were selected through stepwise regression: the area of Cartizze, other vineyards, herbaceous crops and woods at the date of sale, and two variables relating to the characteristics of the subjects who participated in the sale (company buyer; transaction between relatives).

In the model there are no variables related to the intrinsic or extrinsic characteristics of the properties sold since they do not have a statistically significant relationship with the price.

The coefficients of the selected variables are statistically significant with 95% probability, while the constant is not significant. As noted above, the regression coefficients of the cultivated areas correspond to their marginal price, while the p_u tends to decrease as the area increases. With reference to the minimum, maximum and mean values of the surface areas sold, the following p_u can be estimated:

	Area		
	min	max	mean
Cartizze	142.6	135.9	136.4
Other vineyards	46.5	32.3	32.9
Herbaceous crop	47.3	12.3	13.4
Wood	43.8	12.4	14.1

The confidence interval of the coefficients is quite low for vineyards and herbaceous crops and is instead very broad for woods whose marginal price with 95% probability is between 4.71 and 20.50 €/m^2. As mentioned, there are also two variables in the model relating to the subjects who participated in the sale. When the buyer is a company, the price is higher on average, while in the case of sales between relatives the price is considerably lower than when non-related parties are involved in the transaction. Also in this case the confidence interval is very wide. It can be deduced that the companies are interested in the purchase of higher-priced funds while exchanges between relatives involve funds with a lower price.

As for the appraisal reliability of the model, although the model explains more than 99.3% of the price variability, it has very high margins of error in estimates. The standard error of the estimate is 64,186 € (20.4% of the mean price), while the Mean Absolute Deviation is 43,110 € (13.7% of the mean price). Considering the Mean Percentage Absolute Deviation, it can be seen that on average the estimated values differ from the real ones by 58.3%. Only in 35% of sales the margin of error of the estimated values is less than 20% while in 22.4% of cases it is greater than 70% (Table 9).

The p_u model is more complex than the previous one (Table 10). Through the stepwise regression, 12 independent variables were selected concerning the intrinsic characteristics (percentage of land occupied by each crop, land divided into several

Table 9. Distribution of sales by class of percentage absolute deviation between estimated value and real value in the case of the price model (Table 8).

Percentage absolute deviation	N	%
lower than 5%	14	16.5
from 5 to 9.9%	5	5.9
from 10 to 14.9%	3	3.5
from 15 to 19.9%	8	9.4
from 20 to 24.9%	5	5.9
from 25 to 29.9%	12	14.1
from 30 to 34.9%	5	5.9
from 35 to 39.9%	3	3.5
from 40 to 49.9%	5	5.9
from 50 to 59.9%	3	3.5
from 60 to 69.9%	3	3.5
higher or equal to 70%	19	22.4
Total	85	100.0

Note: Mean Percentage Absolute Deviation = 58.43.

plots and slope), extrinsic characteristics (distance from an asphalt road, municipality where the land is located) and a feature relating to the parties involved in the transaction (land purchased by a company). The model has a coefficient of determination equal to 0.76, that can be considered satisfactory given the results of other researches, and does not present heteroskedasticity problems (Breusch - Pagan test = 13.82; p = 0.2420). Multicollinearity problems are also absent in this model.

The regression coefficients are significant with 99% probability, with the exception of the variables: slope, company buyer and municipality of Colle Umberto where the significance is 95%. Using the model, it is possible to estimate the p_u of the crops and the effect exerted on this amount by the other independent variables. As regards the first aspect, it is possible to estimate the following values:

	Mean value	95% confidence interval	
		inf	sup
Cartizze	203.6	124.0	334.2
Other vineyards at the sale date	36.1	29.1	44.7
Herbaceous crop in 2018	15.8	12.4	20.1
Wood in 2018	16.3	10.5	25.3
Herbaceous crops and woods transformed into vineyards after the sale	21.1	17.0	26.0

Table 10. Price per square metre model.

Dependent variable: p_u logarithm

Variables	B	Standard error	95.0% Confidence interval		VIF
			inf	sup	
% Cartizze area at the selling date	0.0532***	0.0025	0.0482	0.0581	1.381
% Other vineyards area at the selling date	0.0359***	0.0011	0.0337	0.0380	2.816
% Herbaceous crop area in 2018	0.0276***	0.0012	0.0252	0.0300	1.361
% Wood area in 2018	0.0279***	0.0022	0.0235	0.0323	2.240
% Herbaceous crops and woods area transformed into vineyards after the sale	0.0305***	0.0011	0.0284	0.0326	1.685
Buyer: company	0.2131**	0.1008	0.0123	0.4139	1.697
Land shared in two or more plots	-0.3763**	0.1621	-0.6994	-0.0532	1.198
Distance from nearest asphalt road	-0.0006***	0.0002	-0.0011	-0.0002	1.656
Slope	-0.0120***	0.0031	-0.0183	-0.0058	3.017
Colle Umberto	-0.3313**	0.1290	-0.5885	-0.0742	1.518
Vittorio Veneto	-0.7949***	0.2274	-1.2481	-0.3417	1.178
Valdobbiadene	0.3062***	0.1081	0.0908	0.5216	2.484

Note: *** significance 99%; ** significance 95%; N = 85; r squared = 0.760; standard error of estimation = 0.3122; F = 531.9 ($p<0.01$); Breusch - Pagan test = 13.82 ($p = 0.2420$).

In considering these values, however, it should be noted that they refer to flat land bordering an asphalt road sold as a single unit, located in the municipalities of Conegliano, San Pietro di Feletto and Susegana, where the buyer is not a company. However, the values are similar to those estimated with the previous model or calculated with the average of the sales prices in which the land sold was cultivated with a single crop.

The confidence interval of the average values is very broad for practically all crops. It is also interesting to note that, at least basically, the land that at the time of the sale was cultivated with herbaceous or forest crops and subsequently transformed into vineyards has a higher value than those in which the land use has not changed.

As regards the effect of the covariates, it can be seen first of all that if the sold land is divided into several separate plots, its price drops by 31%. The territorial location of the land is also important; in the municipalities located further east the prices are considerably lower (Vittorio Veneto -54.8%; Colle Umberto -28.2%) while in the municipality of Valdobbiadene, which is perhaps the most renowned production area of Prosecco PGDO, the land is worth an average of 35.8% more, even excluding the Cartizze that can only be grown in this municipality.

The abacus reported in Table 11 was constructed to understand the effect of distance from an asphalt road and slope. It can be deduced that, for example, the

Table 11. Percentage reduction of the price per square metre caused by distance from an asphalt road and slope.

Distance from asphalt road (m)	Slope (%)							
	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00
0	0.00	-11.35	-21.41	-30.34	-38.24	-45.25	-51.47	-56.98
100	-6.10	-16.76	-26.21	-34.59	-42.01	-48.59	-54.43	-59.60
200	-11.83	-21.84	-30.71	-38.58	-45.55	-51.73	-57.21	-62.07
300	-17.21	-26.61	-34.94	-42.32	-48.87	-54.68	-59.82	-64.38
400	-22.26	-31.09	-38.91	-45.84	-51.99	-57.44	-62.27	-66.56
500	-27.00	-35.29	-42.64	-49.15	-54.92	-60.04	-64.57	-68.60
600	-31.46	-39.24	-46.14	-52.25	-57.67	-62.48	-66.74	-70.51
700	-35.64	-42.95	-49.42	-55.16	-60.25	-64.77	-68.77	-72.31
800	-39.57	-46.43	-52.51	-57.90	-62.68	-66.92	-70.67	-74.00
900	-43.25	-49.70	-55.41	-60.47	-64.96	-68.93	-72.46	-75.59
1000	-46.72	-52.77	-58.13	-62.88	-67.09	-70.83	-74.14	-77.08

p_u of a land with a slope of 30% with direct access to an asphalt road is reduced by 30%. The p_u of a flat land located 300 m from the nearest asphalt road is reduced by 17%. It is also possible to see the combined effect of these two characteristics. The p_u of land with a 30% slope and located 300 m from an asphalt road is reduced by 42%.

Finally, the model highlights that if the land was purchased by a company, the p_u was 24% higher.

As noted, the coefficient of determination can be considered quite high for this kind of model. The Mean Absolute Deviation between observed and estimated values is 7.75 € (26.9% of the average p_u) while the Mean Percentage Absolute Deviation is 27.9%. The margin of error of the model is therefore far from negligible: in 56.8% of cases it is less than 20% and in 8.2% it is above 70% (Table 12).

5. Discussion and conclusions

The results of the study are partially consistent with what emerged in the national and international literature. The negative effect of slope on land value has also been found in other researches (Erwin and Mill, 1985; Hilal et al., 2016; Ma and Swinton, 2011; Sardaro et al., 2020; Sardaro et al., 2021). Compared to these studies, however, the effect of slope on the price is much less. This is probably due to the fact that in the area under investigation, land with a high slope is much more widespread and the cultivation systems have long been adapted to the geo-

Table 12. Distribution of sales by class of percentage absolute deviation between estimated value and real value in the case of the price per square metre model (Table 10).

Percentage absolute deviation	N	%
lower than 5%	7	8.2
from 5 to 9.9%	17	20.0
from 10 to 14.9%	7	8.2
from 15 to 19.9%	10	11.8
from 20 to 24.9%	7	8.2
from 25 to 29.9%	8	9.4
from 30 to 34.9%	8	9.4
from 35 to 39.9%	6	7.1
from 40 to 49.9%	5	5.9
from 50 to 59.9%	2	2.4
from 60 to 69.9%	1	1.2
higher or equal to 70%	7	8.2
Total	85	100.0

Note: Mean Percentage Absolute Deviation = 27.95.

morphological characteristics of the territory. It also has to be considered that the slope modifies the microclimate and can positively influence grape quality.

The negative effect of distance from the road network has also been highlighted in numerous studies, although the methods adopted to analyse it have been different. The results are therefore only partially comparable with those of our study. To analyse the effect of land accessibility many authors used a dummy variable relating to whether the land was adjacent to a road or not (Drecher et al., 2001; Kostov, 2009; Sardaro et al., 2018a; Sardaro et al., 2018b; Snyder et al., 2008; Tsoodle et al., 2006; Khalid, 2015; King and Schreiner, 2004; Ma and Swinton, 2011; Sardaro et al., 2020; Sardaro et al., 2021). In general, it emerged that land adjacent to roads has a higher value even if the type of road considered in the various studies is different (motorways, provincial or state roads or paved roads). Only in one other case, to our knowledge, was the distance between the land and road network measured. Troncoso et al. (2010) found a negative relationship between price and distance from the nearest paved road. However, note that in our study a negative relationship emerged only with regard to access to asphalt roads, while the distance from state and provincial roads was not included in the model since it is not statistically significant.

This difference is probably due to the fact that the Prosecco PGDO area has a high specialization and only the costs to access the land starting from the farmstead to carry out cultivation activities and those necessary to transport the grapes to the cellars can affect the viticulture profitability. From this point of view,

it should be remembered that, as in the whole of the Veneto Region hills, in the study area there is a scattered settlement structure and the farmstead is generally located near the farmland. In addition, the cellars that process the grapes are mainly located within the Prosecco PGDO area and it is therefore not necessary to travel long distances to transport the grapes from the vineyards.

Only one other study analysed the effect of fragmentation of the property and its shape, highlighting that the p_u drops if the land sold is divided into several separate plots and if the shape is not regular (Sundelin et al., 2015). The results of our study seem to confirm that fragmentation reduces the price while the shape does not have a significant effect probably because in the case of small plots its role is less important. The effect of fragmentation on the price may be due to the increase in the costs necessary to reach the farmland to carry out cultivation activities.

It is interesting to point out that some intrinsic and extrinsic characteristics, unlike other studies, were not found to be significantly correlated with the p_u. This happens, for example, in the case of the distance from major inhabited centres which, according to some authors, reduces the p_u (Kostov, 2009; Maddison, 2009; Sardaro et al., 2018a; Sardaro et al., 2018b; Snyder et al., 2008; Khalid, 2015; Sardaro et al., 2020; Sardaro et al., 2021). However, in all those studies the maximum distance from built-up areas was much greater than that found in the land sales analysed, which is 4 km for built-up areas and 9 km for urban centres.

It should also be considered that in an area with a strong product specialization and in which the cultivation profitability is very high, as in the Prosecco PGDO area, there is little interest in buying land with the hope of achieving a significant capital gain following their inclusion in a residential or industrial zone by the urban plan.

A second characteristic that has often been investigated in previous research is the size of the land sold, which in our investigation is not related to the unit price. In this regard, it should be noted that the results reported in the literature are not univocal. With one exception (Perry and Robison, 2001), all research conducted abroad identified a negative relationship between unit price and surface area sold (King and Schreiner, 2004; Kostov, 2009; Maddison, 2009; Ma and Swinton, 2011; Snyder et al., 2008; Roos, 1996; Troncoso et al., 2010; Tsoodle et al., 2006). On the contrary, a positive relationship was identified in four studies conducted in Italy (Sardaro et al., 2018a; Sardaro et al., 2018b; Sardaro et al., 2020; Sardaro et al., 2021).

A possible explanation for this discrepancy is the diversity of the surface areas involved in transactions that tend to be bigger abroad than those in the Italian studies. It can be assumed that in the case of small-sized land, as the surface area increases, the profitability of farming increases due to the effect of economies of scale. Conversely, in the case of very large properties, due to the small number of potential buyers, unit prices tend to decrease. The relationship between unit price and land area could therefore have a parabolic trend and an inverted U shape.

The model highlights that, all other factors being equal, the price of land differs considerably within the Prosecco PGDO area. It is interesting to note that this territorial variability essentially reflects the diffusion of specialised viticulture at the date of the agricultural census of 1929. In the municipality of Valdobbiadene

there were 582 ha of specialised vineyards, while in Vittorio Veneto there were only 7 ha and 2 ha in Colle Umberto.

As we noted above, while in the western part of the Prosecco PGDO area, due to the steeply sloping hills, vineyards are mainly cultivated on narrow terraces, in the southern and eastern part, vines were mainly cultivated in association with arable land in the traditional "piantata di viti". In 1929 75% of the specialised viticulture of the whole territory was concentrated in just four municipalities (Valdobbiadene, Farra di Soligo, Cison di Valmarino and Follina). Evidently, the analysed covariates relating to the physical characteristics of the land and the surrounding territory cannot fully account for the characteristics of the terroir and the fame that derives from it for the production of wines.

An element that emerged in the study, which is not reflected in other researches, is the effect of the planting expectations of a vineyard on the price of arable land and woods. As seen, the prices of these crops are very high and certainly not commensurate with their actual profitability in a hilly environment. It was also seen that the price was higher in the event that woods and arable land were quickly transformed into vineyards in the years following the sale. This is an effect similar to that highlighted by other authors in relation to the increase in the price of land resulting from the urbanization expectations of agricultural soils (Plantiga et al., 2002; Tempesta, 2018, p. 9) that in general can be defined as a "hope value[5]".

As pointed out by Plantiga et al. (2002, p.1) "current farmland prices are influenced by the potential for future land development". Buyers tend to capitalize the expected price increase in the current price and their willingness to pay depends on the amount of the price increase, the probability that it will occur and the time needed for the increase to take place.

However, it should be noted that correctly defining these elements is very complex and can easily lead to an overestimation of the property value due to the numerous cognitive biases that can affect the behaviour of buyers, such as the money illusion (Fisher, 1928; Shafir et al., 1997) and the use of heuristics in determining the probability that an event will occur (Tversky and Kahaneman, 1974). If expectations are irrational they can lead to the formation of speculative bubbles that can affect the stock market (Shiller, 2005), housing market (Lind, 2009) and farmland market (Engsted, 1996; Baker et al., 2014).

Our research also found that some subjective characteristics of the parties could influence the price paid. It has in fact been seen, that if the buyer was a company, the unit price was on average 24% higher. Few other studies have analysed this aspect of the land market. For example, Tsoodle, Golden and Featherstone (2006, p.1) found that "Transactions between related parties resulted in a 43% discount on the

[5] The concept of "Hope value is used to describe an uplift in value which the market is willing to pay in the hope of a higher value use or development opportunity being achievable than is currently permitted under development control, existing infrastructure constraints or other limitations currently in place" (TEGOVA, 2016, p. 24).

per acre sales price". A similar result was obtained by Perry and Robinson (2001) who pointed out that in sales between relatives or neighbours the price is significantly lower than when other parties are involved in the transactions[6].

To explain the price difference that we found, it is possible to suppose that companies and other types of buyers, at least partially, belong to different land market segments. In this regard it should be noted that the land purchased by companies has on average a larger surface area (2.45 ha against 0.65 ha) and a higher price (840,000 € against 130,000 €). On the other hand, one could assume that companies for financial reasons are induced to declare the true amount paid in the deed of sale, while other individuals declare a price value lower than the real one to reduce the transaction tax.

From the appraisal point of view, however, the problem arises of establishing what the real market value of the land is, since the presence of subjective factors can make the prices recorded by the deeds scarcely reliable. Moreover, as noted, the purchase of land can be motivated by two only partially overlapping purposes: economic and financial. In the first case, the aim of the purchase is to obtain a higher land income and this favours an improvement in the economic system and an increase in the value of land due to the transfer of land from inefficient farms to more efficient ones.

If the purposes are mainly financial and equity, people buy the land hoping to obtain a capital gain, like what happens in the stock markets.

However, while the purchase for economic purposes is based on budgetary data that are substantially objective, the purchase for financial purposes is influenced by highly subjective assessments on the future evolution of real estate values.

In this case, the decision biases mentioned above can become particularly important and often, as observed by Shiller (2005), the behaviour of market operators is influenced by the "telling story" that spread over time, information can often lack a real and objective confirmation[7]. The presence of price increase expectations determines the existence of disturbance factors in the land market which, especially in certain contexts, can make it extremely complex to identify the factors that contribute to the price formation. The problem therefore arises of understanding how reliable market prices are for estimating land values.

There are also other factors, of a more strictly operational nature that can affect the reliability of estimates based on market prices, such as the possibility that the sales samples detected may not be representative of reality as they consist of land that is more likely to be sold (sample selection bias) (Bigelow et al., 2020).

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[6] Note however that in our study the variable relating to transactions between relatives was not statistically significant.

[7] "When prices go up a number of times, investors are rewarded sequentially by price movements in these markets, just as they are in Ponzi schemes. There are still many people (indeed, the stock brokerage and mutual fund industries as a whole) who benefit from telling stories that suggest that the market will go up further. There is no reason for these stories to be fraudulent; they need only emphasize the positive news and give less emphasis to the negative" (Shiller, 2005 p. 67).

Lastly, according to our results, it should be pointed out that also by mean of HP models that have a high goodness of fit (e.g. high coefficient of determination, significant parameters, etc.), very relevant errors can be made in estimating the real estate values. Therefore, HP models have to be used cautiously in the professional appraisal practice.

Obviously, the limits of the research conducted cannot be overlooked from this point of view. First, it was not possible to detect the age of the vineyards or other temporary characteristics of the land. Secondly, the use of shapefiles relating to the various characteristics of the soil may have led to errors related to the scale of the maps dealing with the various themes considered or to the difficulty of a precise overlap between them and the cadastral maps. It was also not possible to elaborate productivity or unitary profitability indices, which would probably have improved the soundness of the estimates. As regards the easements, it was not possible to analyse the surface of the plots they occupy and the use of dummy variable can be misleading in this respect.

Now, however, it does not seem that models estimated with the HP method can be applied tout court by the valuers, despite their undoubted usefulness. The information obtained with these methods will certainly be useful for the appraiser who, however, will have to adapt it to the asset that he must evaluate, also in relation to the purposes of the estimate. Furthermore, in the scientific field, there remains the need to understand which other factors, in addition to those normally considered in the research conducted in this field, may influence the formation of prices at a local level. Moreover, particular attention should be paid to analysing the discrepancies existing between estimated values and market prices.

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Urban sprawl and air quality in European Cities: an empirical assessment

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In this paper we estimate the relationship between urban sprawl and a measure of air quality, namely the number of days in which the PM10 concentration exceeds safeguard limits in European Union cities. Building on a multidimensional representation of sprawl, the paper employs several indicators to account for built-up area development, population density, and residential discontinuity. The paper employs generalised additive models to disentangle the non-linear effects in the variables and the interaction effects of the three sprawl dimensions. A significant and robust effect of urban morphology emerges after controlling for socio-economic, demographic, and climatic factors and the geographical location of the city. We find that urban sprawl impacts positively on pollutant concentration, but the effect is highly context-specific because of threshold effects and interactions.

Keywords: *Air pollution, Urban sprawl, European cities, Additive models*
Parole chiave: *Inquinamento atmosferico, espansione urbana, città Europee, modelli additivi*
JEL codes: *Q53, R14, C21*

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1. Introduction

Air pollution can seriously threaten human life. A recent estimate (Lelieveld et al., 2019) reports 800,000 people prematurely dying in Europe as a consequence of air pollution. According to the same research, the average European citizen loses two years of life due to the breathing of polluted air. In addition, the geographical concentration of deaths caused by the spreading of the COVID-19 pandemic has brought researchers around the world to investigate the potential impact of air pollution of COVID-19 related morbidity and mortality, and the results suggest that the most polluted cities have experienced relatively higher death rates (Coker et al., 2020; Cole et al., 2020; Conticini et al., 2020; Oygen, 2020).

Cities are where the consequences of air pollution are most severe because air quality is the lowest due to transport and residential emissions (European Environment Agency, 2019) and the exposure is the highest. Cities are now home to more than half the world's population, and that share is projected to increase up to 68% by 2050, with 2.5 billion people moving to urban areas (UN DESA, 2019).

Traffic and especially vehicular particulate matter contribute to outdoor air pollution the most (European Environment Agency, 2017). Solutions to improve the quality of life in cities involve better pollution control (Dupont, 2018) through more accurate testing of vehicles on the road and stricter control, the limitation of vehicles in dedicated zones (Ferreira et al., 2015), the use of electric cars

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(Liu, 2014), the promotion of public and shared mobility (Santi et al., 2014), and the greening of cities (Guo et al., 2019). Compact urban growth has the potential to contribute to reducing air pollution by limiting the number and the average length of trips by car, making public transportation more viable and effective.

However, evidence from the past decades suggests that urban sprawl in Europe was the dominant form of urban spatial expansion (Guastella et al., 2019). From 1950 to 2014, urban population passed from 30% to 54% and, in response to this rapid growth, urbanisation changed rapidly. Not only has the extent of the built-up areas increased, but changes in lifestyles and people's housing preferences have led to patterns of urban development characterised by low population densities and a high discontinuity of residential areas. These specific conditions describe the phenomenon of urban sprawl (EEA-FOEN, 2016), which is considered especially harmful for the environment as it entails the conversion of greater portions of agricultural and natural land into artificial areas, resulting in the loss of ecological soil functions (Ewing, 2008), changing local climatic conditions (Zhou et al., 2004), and a loss of soil biodiversity (Turbé et al., 2010) among the other environmental damages. Sprawling cities are expected to display a higher concentration of transport-related emissions (Newman & Kenworthy, 2006) due to both the longer average distance commuted in a low-density area and the increased frequency of trips in places where urban services are not geographically concentrated. Above all, urban sprawl makes it more difficult for the public transportation network to efficiently serve the public, thus increasing the costs for service provision as well as the complexity of implementation and management plans, especially for the commute across neighbouring municipalities. All these aspects together with income growth are expected to shift consumers' preferences towards car-based commuting.

Compact urban development also has some drawbacks. First, in compact cities, people are concentrated in the core where the exposure to pollutants is the highest and the higher average height of buildings impedes natural ventilation processes favouring the trapping of air pollutants near the ground (Martins, Miranda, & Borrego, 2012). Second, compact urban development leaves less space for green urban areas, threatening mental health and well-being of citizens (White, Alcock, Wheeler, & Depledge, 2013) and limiting the quantity and quality of the ecosystem services provided (Daniels et al., 2018) in the core. Additionally, the reduced presence of vegetation prevents residents from having a valuable source of air-cleaning and pollution reduction (Janhäll, 2015; Litschike & Kuttler, 2008).

The literature about the relationship between air pollution and urban morphology comparing cities in cross-section has already documented the significant impact of urban form on air quality. Many of these studies have focused on CO2 emissions (Bart, 2010; Cirilli & Veneri, 2014; Glaeser & Kahn, 2004; Lee & Lee, 2014; X. Liu & Sweeney, 2012; Sovacool & Brown, 2010) rather than on the actual concentration of pollutants. McCarty and Kaza (2015) address the effect of urban size and urban discontinuity in US counties in 2006, finding a negative effect on PM2.5 exceedances of the total urban area and a positive effect of spatial fragmentation and, for both variables, the effect shows up to be larger in counties

located in metropolitan areas. Cárdenas Rodríguez et al. (2016) estimate a similar relationship in EU cities with more than 100,000 inhabitants and find that both the share of the artificial area and the number of fragments positively correlate with the annual mean PM10 concentration of cities. In contrast, Cho and Choi (2014) find no evidence in support of the hypothesis that a compact urban form helps reduce PM10 concentration after controlling for specific local characteristics. She et al. (2017) provide comprehensive evidence based on simple correlations of the relationship between the concentration of several pollutants and multiple measures of urban form in the cities of the Yangtze River Delta, China. Lu and Liu (2016) explore the effects of urban form on the density of NO and SO2 in China's prefectural cities, finding lower densities in more compact cities.

The PM10 concentration is generally considered as the air quality indicator that has the greatest impact on human health. It includes all particulate matter whose diameter is smaller than 10 μm and can, thus, be inhaled. Health effects due to the inhalation of such PM include respiratory and cardiovascular morbidity such as the intensification of asthma and respiratory symptoms as well as mortality resulting from cardiovascular and respiratory diseases and lung cancer (World Health Organization, 2012). PM exposure may also be responsible for a chronic inflammation status that induces the hyper-activation of the immune system and the life-threatening respiratory disorders caused by COVID-19 (Shi et al., 2020). The described effects are due to exposure over both the short- and long-term to a PM10 concentration level exceeding certain values. For this reason, both the European Union and the World Health Organization have set threshold levels of PM10 concentration over which people's exposure is risky. The former established as a safe level exposure of not more than 35 days/year with a daily mean concentration exceeding 50 μg/m3 whereas the WHO set as a threshold level an annual mean concentration of 20 μg/m3.

The aim of this study is to analyse empirically the relationship between air pollution, measured by PM concentration, and urban sprawl. Following the most recent literature on sprawl conceptualisation (Arribas-Bel et al., 2011; EEA-FOEN, 2016; Schwarz, 2010), this paper adopts a multi-dimensional definition of urban sprawl that shows three of the most important characteristics: the spatial expansion of the built-up area, the decline in population density, and the increase in the discontinuity of urban settlements. Theory suggests that less dense and more dispersed cities are more polluted due to the higher frequency and length of commutes, but the extent to which the indication holds for both large and small cities is unclear. We thus estimate a regression of PM concentration on urban sprawl measures and controls and use Generalised Additive Models (GAMs) to allow a more flexible specification of the non-linear effects to understand how urban sprawl characters affect air pollution in different types of cities. One advantage of GAMs is that it is possible to model the effect of local specific geographical characteristics that are usually unobservable to the econometrician as a function of geographical coordinates.

In addition to the annual mean concentration, we use in the econometric model the number of days in excess of PM10 concentrations according to the safe

limits set by the European Union. The extant literature suggests a positive short-term association between a variation in PM10 concentration and morbidity and mortality (Janssen, Fischer, Marra, Ameling, & Cassee, 2013; Stafoggia et al., 2015) and, to date, a no-effect threshold has not been identified, thus, any increase in PM10 concentration should be considered dangerous. However, comparing estimated effects across samples, the evidence suggests that the effect is estimated to be larger when the sample includes cities that exceeded the WHO threshold (WHO, 2006), as in Pascal et al. (2014). Using the number of days in exceedance, we avoid possible compensation effects that may result by only accounting for the annual mean concentration. In addition, we are better informed about the presence of high concentration peaks to which the most dangerous consequences for health are associated.

The results add to the existing scientific literature that advocates greater attention to urban sprawl in Europe, which until now has been a seemingly ignored challenge based on its adverse effects on the quality of the environment, health, and, ultimately, life. Most importantly, the paper provides new results on the environmental consequences of discontinuity, a feature that increasingly characterises the trend of sprawling cities. We show that in Europe, discontinuous development is especially undesirable in large cities.

The remainder of the study is structured as follows. The next section surveys the literature about the relationship between urban form and air quality. Section three details the empirical approach and the data used. We present the empirical results in section four. Section five concludes the paper with a discussion of the results and policy implications.

2. Linking urban form and air quality

Numerous studies have already documented the effect that a compact city model, based on high density around the core, can have on air quality. The literature has approached the topic using a variety of methods from computer simulation (Bandeira et al., 2011; Borrego et al., 2006; Stone et al., 2007) to empirical research (Barla et al., 2011; Cirilli & Veneri, 2014; Frank et al., 2000). The evidence from different approaches converges with the idea that more compact cities effectively reduce the average length commuted by car and the number of trips made, favouring walking and cycling, which also affects energy consumption, ultimately contributing to better air quality. The drawback of the compact city model is that, under certain conditions, it increases the exposure to pollutants in the places where most people live. For instance, higher levels of emissions are related to the congestion caused by the concentration of production (Cho & Choi, 2014) and to the obstruction of wind transition that slows the dispersion and dilution processes that favour the recycling of air (Martins et al., 2012).

The increasing availability and quality of small-scale land use data has allowed for the computing of landscape metrics, which have the merit of representing the spatial distribution of the urbanised area beyond the synthetic measure of density

that was previously used to define the compact city. Shape or landscape metrics are used to track the evolution of leapfrog development, what sprawl studies refer to as the discontinuity (as opposed to clustering) or fragmentation of urbanised areas. These measures have been introduced in studies that empirically estimate the relationship between urban form and air quality. For instance, McCarty and Kaza (2015) use many landscape metrics ranging from total urban area to the number of urban patches to the mean and standard deviation of patches for the United States, finding that more fragmented cities (where the number of urban patches is higher) show a significantly lower air quality. They do not include a measure of density although they find air quality to be positively related to the total population. Landscape metrics are also used in Cárdenas Rodríguez et al. (2016) who compute the number of urban patches (fragments) for EU functional urban areas with more than 100,000 inhabitants and find a positive relationship between this measure and the average concentration of PM10 and other pollutants. Similarly, they find that an increase in the share of the artificial surface, in addition to its fragmentation, positively contributes to PM10 concentration, while there is no significant evidence concerning population density. Finally, Lu and Liu (2016) explore the effect of sprawl on air quality in China using different, albeit related, landscape metrics.

With this paper, we want to contribute to this literature by analysing the effects of sprawl on the average and exceeding concentrations of PM10. In so doing, the conceptualization of urban sprawl is relevant since it accounts not only for morphological factors, but also for socio-economic aspects. Accordingly, economists, geographers, sociologists, and planners have provided different definitions and conceptualisations reflecting their different perspectives. For many, the simple conversion of agricultural and natural soil to urbanisation is a matter of sprawl. For others, especially economists, the conversion of land must be excessive to be characterised as sprawl (Brueckner, 2000; Brueckner & Fansler, 1983). In particular, sprawl is understood as excessive compared to land take for housing needs as determined by demographic and economic trends. The existing conceptualisations of sprawl often mix the physical character of sprawl with its causes and consequences instead of focusing solely on its physical representation (Guastella et al., 2019). What these definitions have in common, however, is the need to adopt a multidimensional conceptualization of sprawl. This need comes from the observation that sprawl is not only population density, as two areas with the same population density can show very different shapes of urbanisation. Galster et al. (2001) are among the first scholars to operationalize the concept of sprawl and recognize its multidimensionality, proposing a measurement of the concept based on eight dimensions. Frenkel and Ashkenazi (2008) define sprawl as the result of three main components (density, scatter and land-use composition), while Arribas-Bel et al. (2011) conceptualize it in terms of six main dimensions. Schwarz (2010) collected multiple indicators related to the shape, population, and socio-economic conditions of European cities and found that three main synthetic indicators (total size, density, clustering) explain almost half of the total variance and can effectively describe the variety of patterns of sprawl in EU cities. These dimensions are recalled

in the recent report by the EEA (EEA-FOEN, 2016) that uses high-resolution data for 32 countries to compute a sprawl indicator obtained combining information on the built-up area (size), land uptake per person (the inverse of density), and dispersion. The latest OECD report on urban sprawl (OECD, 2018) also depicts sprawl as multidimensional, underscoring the need to account for the spatial distribution of population and urbanisation to properly measure urban sprawl. The latter three dimensions of sprawl are shared by all the definitions provided. What has been understood as the main characteristic of sprawl is the association with a low and declining density at the peripheries of the cities as the density of the urbanised areas increases. Nonetheless, density alone is only a part of the story: to be defined as sprawl, low population density has to come in tandem with a fragmented urban area, where housing types, prevalent transportation modes and intended land uses are significantly different between the core and the peripheries of a city. Of course, for these two dimensions to exist, the spatial extension of cities needs to be sufficiently large.

However, while well documented from a theoretical perspective, what is lacking in the sprawl research agenda is empirical evidence on such multidimensionality and the understanding of how these diverse dimensions of sprawl interact and jointly contribute to pollutant concentration. In this paper, we try to fill this gap by adopting a methodology which allows not to establish a priori the shape these interactions should assume. Rather, the non-parametric estimation ensures such interactions to be determined by the model fitting.

3. Data and empirical approach

3.1 Description of the database

The variable of interest in our empirical model is the city-level PM10 concentration, and the reference year for the analysis is 2014. The EU considers an average daily concentration of PM10 that is lower than 50 μg/m3 to be acceptable. Annual air pollutant concentration data are freely available at the EEA website as of 2010. The values of PM10 are provided at the station level on an annual basis and known to be representative of the exact location of the station, not of the whole city. For each city, we select only the stations that are geographically located within the borders by matching station coordinates with city geometries and take the mean value among stations. This variable should be taken carefully because the aggregation ignores whatever value of concentration in zones not covered by stations and the city-level aggregate may not reliably represent the true value. On average, there are 2.04 stations per cities in the database and the figure decreased slightly when excluding suburban stations (1.96). 57% of these monitoring stations are classified as “background” station and the remaining are “traffic” stations. Even though the city average may not represent well the real values of city-level concentration, the difference between the observed values and the real ones are also expected to be non-systematic and not correlated with the urban

form, hence this measurement error is expected not to affect the estimation of the coefficients and to add to the stochastic part of the model. Among the other studies investigating the relationship between urban form and air quality, only Cho and Choi (2014) use station level data and avoid aggregation, while McCarty and Kaza (2015), Cárdenas Rodríguez et al. (2016), and She et al. (2017) aggregate monitoring station data at the US county, European Large Urban Zones, and Chinese cities levels, respectively.

The definition of a city adopted in this article is that of functional urban areas (FUAs). The concept of FUAs, which is the result of a collaboration between the EU (Eurostat) and the OECD, responds to the growing need for a harmonised definition of urban areas as "functional economic units", overcoming the limitations linked to administrative units. This definition includes both the core city and its main surrounding areas. The main character of a FUA is the presence of one or more municipalities in which more than 50% of people live in areas with a population density greater than 1500 inhabitants per km2. These municipalities shape the core of the FUA while the periphery is made of all the municipalities functionally related to the core. Accordingly, FUAs have common urban features, although in some cases natural and agricultural areas may occupy significant shares. The choice of the FUA as the unit of analysis is dictated by the need to have a harmonised definition of the spatial units for which the observed phenomena, PM10 concentration and urban sprawl, can be measured consistently. Following an extensive literature on urban sprawl in Europe (see Arribas-Bel et al., 2011, Guastella et al., 2019 and Schwarz, 2010 for a review), the FUA is the best spatial unit over which computing urban sprawl as it considers also the peripheries and suburbs, where low-density and high-discontinuity residential settlements concentrate. In the remainder of this article, we use the terms "city" and "FUA" interchangeably. Concerning the concentration of pollutants, the presence of "suburbs" stations in the EEA dataset ensures that peripheries are also represented in the city-level aggregate measure.

For each station, the dataset reports the yearly annual mean PM10 concentration in μg/m3 and the number of days in which the daily mean concentration exceeded the EU safeguard threshold. We use this information to construct the two variables used in the empirical model as dependent variables. The first is the annual mean concentration, computed as the simple average of the reported mean concentration at the different stations located in the i^{th} city. The second is the number of days in the year in which the concentration exceeded safeguard limits, computed as the simple average of the reported number of days in exceedance across the stations in each city. Table 1 describes all the variables included in the dataset, how the measures are constructed, the relative sources and their main descriptive statistics.

Our primary independent variables are the three main dimensions of sprawl, as emerging from the literature. The first variable is the total artificial area (Artif), which measures the total spatial extent of the city. It includes residential and commercial areas, areas under construction, and green urban areas according to the definition provided by the EEA (Corine Land Cover database, year 2012). The second variable is population density (Dens), as measured by the total number of inhabitants per square kilometre of an urbanised area. The third variable is the disconti-

Table 1. Descriptive statistics – Means and Standard Deviations of the variables.

Variable	Description of the variable	Measure	Mean	SD
Dependent variables				
Y^M	Annual mean concentration of PM10 – EEA Air Quality database (average among stations)	$\mu g/m^3$	24.572	7.724
Y^E	Number of days in which PM10 concentration exceeds 50 μg/m3 – EEA Air Quality database (average among stations)	n of days	24.755	27.258
Independent variables				
Artif	Total artificial area (CLC nomenclature level 1) – EEA Urban Atlas	km^2	260.64	339.405
Dens	Population density – population sourced from Eurostat Urban Audit and artificial area from EEA Urban Atlas	inhabitants per km^2 of artificial area	2082.783	846.660
Disc	Share of discontinuous urban fabric on total artificial area – Urban Atlas EEA	%	0.945	0.043
Control variables				
ArtifSh	Share of artificial area on total area– EEA Urban Atlas	%	0.163	0.101
AgriSh	Share of employment in the agricultural sector –Urban Audit Eurostat	%	0.055	0.072
ManuSh	Share of employment in the manufacturing sector – Urban Audit Eurostat	%	0.252	0.086
NCars (ln)	Number of private cars registered (log) – Urban Audit Eurostat	n of cars	4.209	0.969
Altitude	Altitude– EEA Air Quality database	m	151.949	152.393
Prec	Annual average rainfall rate at the at the FUA level of original 0.5° x 0.5° grid data – NASA Global Land Data Assimilation System (GLDAS)	kg/m ^ 2/s	6.934	2.824
Temp	Annual average surface temperature at the FUA level of original 0.5° x 0.5° grid data – NASA Global Land Data Assimilation System (GLDAS)	kelvin	11.333	2.421
Wind	Annual average near surface wind magnitude at the FUA level of original 0.5° x 0.5° grid data – NASA Global Land Data Assimilation System (GLDAS)	m/s	4.649	1.151
Geographical coordinates				
Long	Longitude – GISCO – Eurostat	decimal degrees	9.677	10.19387
Lat	Latitude – GISCO – Eurostat	decimal degrees	47.95	6.194464

nuity of residential plots (Disc), computed as the ratio between the percentage of discontinuous residential area and total residential area. Both variables are sourced from the Corine Land Cover database: the numerator corresponds to the sum of plot areas classified with the code "112 - discontinuous urban fabric", and the denominator is the sum of plot areas classified with the code "11 – urban fabric".

We also include several control variables in the regression, accounting for the main sources of PM10 concentrations. Karagulian et al. (2015) identify vehicle traffic, combustions and agriculture, industrial activities, domestic fuel burning, natural sources and unspecified sources of human origin as the main sources of PM10 and PM2.5, globally. Car-dependency, the prevalent use of cars for daily trips to work and for leisure purposes, is partly the consequence of urban morphology (García-Palomares, 2010). Small, dispersed and discontinuous urban environments make the provision of urban transportation infrastructure less viable: the small size of the city does not allow for economies of scale, and the dispersed and discontinuous form requires huge network investments to reach the users. However, car-dependency is also a result of a household's behaviour, which is influenced by the socio-economic and cultural context. Including the (log of the) number of registered cars (NCars) in the regression allows to isolate the effects on air pollution of urban forms that require longer and more frequent commuting (which is less feasible using public transportation) from those caused by the use of automobiles that reflects preferences and socio-cultural norms. Moreover, we control for the composition of the economic activity in the city by including the employment shares in the agricultural (Agri_Sh) and manufacturing sectors (Manu_Sh). Further, we include the share of artificial area (Artif_Sh) as a measure of the degree of urbanisation, to which the sources of pollution are connected independently of the specific urban form (compact, dispersed, fragmented). The variable is an important control to isolate the effect of urban form on air quality from other causes of poor air quality not related to the characteristics of urban morphology. Unfortunately, some information is not available for selected cities that are consequently dropped from final database used for the estimation of model parameters. The final sample includes 348 observations.

In addition to these controls, we consider meteorological aspects that may influence air pollution and the geographical position of the region. These are the average temperature measured at the surface, the precipitation rate considering liquid precipitation only, and the average wind speed (Giri et al., 2008; Yi et al., 2010). Higher temperatures are associated with higher mean concentration and a higher probability that the concentration exceeds safeguard limits. More abundant precipitation is expected to lower mean concentration and the probability of exceedance. The effect of wind is controversial. On the one hand, wind helps dissolve particulate matter in the air that otherwise remains trapped on the ground. On the other hand, it brings particulate matter from pollution sources to other places, including cities. The final effect is city-specific, depending on the wind direction and the location of the city with respect to the pollution sources. Hence, it is impossible to disentangle these effects when modelling the average city, as we do in this study. All the meteorological values are sourced from the NASA

Global Land Data Assimilation System (GLDAS). The original files are provided in 0.5°x0.5° grid point estimates and aggregated at the city level as the average of all point estimates within the city's geometry.

We consider the altitude of the city, which is provided as part of the AirQuality EEA database, and expect it to negatively affect the dependent variable. It can have a negative impact on PM10 concentration because pollutants tend to be trapped on the ground, especially under certain meteorological conditions.

Finally, we consider the geographical position of the city by including in the modelling framework the spatial coordinates (latitude and longitude) among the covariates.

3.2 The empirical model

To understand how urban sprawl affects air pollution we estimate different cross-city econometric models. We begin from the simple linear model in equation (1) in which we relate the dependent variable (Y), measured as either the mean concentration level (Y^M) or the number of days in exceedance (Y^E) to the three dimensions we use to measure urban sprawl, namely, ARTIF, DENS, and DISC. In the latter case, the log-transformation of the dependent variable is applied to correct the excess skewness of the distribution due to the high values on the right tails.

$$Y = \alpha + \beta_1 ARTIF + \beta_2 DISC + \beta_3 DENS + \gamma' X + \varepsilon \quad (1)$$

In equation (1), X is a matrix with all the control variables without the geographical coordinates. According to our research hypothesis that air pollution is higher in larger, more discontinuous and less dense cities, we expect $\beta_1>0$, $\beta_2>0$, and $\beta_3<0$.

Geographical coordinates are introduced in equation (2) through a penalised thin plate smooth function $s(\cdot)$ to capture the trend surface and add smooth spatial structure from the residuals to the fit.

$$Y = \alpha + \beta_1 ARTIF + \beta_2 DISC + \beta_3 DENS + \gamma' X + s(long,lat) + \varepsilon \quad (2)$$

The smooth function $s(long,lat)$, or "spatial trend" using a parallel with time series, allows the expected value of Y at one point in space to be conditional on the geographical location of the observation, expressed by longitude and latitude, by considering their interaction (Wood, 2017). The spatial trend surface captures systematic variations of the phenomenon concerned over a region based on geographical locations. Differently from spatial econometrics approaches, where a connectivity or adjacency matrix captures the spatial dimension of the data, the observations' longitude and latitude are included directly as inputs in the model without considering the relationship with neighbouring observations. The smooth function reflects the fact that the outcome is not a linear function of either longitude or latitude but rather is an unknown function of both and their interaction

and the functional form are estimated non-parametrically[1].

More specifically, the model is estimated via Penalized Iteratively Re-weighted Least Squares: an iterative algorithm selects the smoothing degree (and, hence, the shape of the non-linear function) weighting the explanatory power of the smooth terms on the one hand and the excessive complexity of the functional form on the other through the Generalised Cross Validation criterion. Equation (2) is a GAM and represents the core structure of the empirical approach of this research[2]. The advantage of additive over linear models is the possibility of accounting for and easily estimating non-linear relationships. The non-linearity can be either expressed as a function of one variable, as in the case of polynomial functions, or as function of more variables, as in the case of interaction terms, to use a parallel with generalised linear models.

To account for these complex non-linear relationships between urban sprawl and air pollution, we also introduce smooth functions to the sprawl variables in two different ways. In the first, we introduce the smooth functions separately. This approach leads to equation (3), from which we can test whether the effect of each characteristic of sprawl on air pollution is non linear. In the second, in equation (4), we introduce a smooth function of density alone and a smooth function of artificial area and discontinuity combined to test the hypothesis that the impact of discontinuity is conditional on the total artificial area.

$$Y = \alpha + s_1(ARTIF) + s_2(DISC) + s_3(DENS) + \gamma'X + s(long,lat) + \varepsilon \quad (3)$$

$$Y = \alpha + s_{12}(ARTIF,DISC) + s_3(DENS) + \gamma'X + s(long,lat) + \varepsilon \quad (4)$$

In terms of model structure, GAMs are equivalent to generalised linear models with whom they share the families of models and the link functions for the conditional expectations. Accordingly, the same assumptions of generalised linear models apply. In our case, we assume the normal distribution for both the mean concentration and the number of days in exceedance and, accordingly, the only assumption made for the purpose of estimation is the residuals' normality.

4. Main Results

4.1 Presentation of results

Table 2 summarises the empirical results. In the first two columns (models (a) and (b) – corresponding to equation (1)), we report the estimates of the lin-

[1] For further details about the algebraic formulation of the smooth function refer to Hastie, T. and R. Tibshirani (1986,1990) and, for a general introduction, to Wood (2017, Ch 3).

[2] The *mgcv* R package by Simon Wood has been used for estimation. We estimated all the models with the *gam* function and the penalised smoother s() available in the package.

Table 2. PM_{10} concentration determinants in EU cities, 2014.

	Linear		Additive		
	mean concentration (a)	log days in exceedance (b)	log days in exceedance (c)	log days in exceedance (d)	log days in exceedance (e)
Intercept	43.9200***	5.7690***	1.0780	1.9030***	2.0167***
	(7.8760)	(1.2000)	(0.8700)	(0.5682)	(0.5751)
Artif	0.0034***	0.0005***	0.0002***		
	(0.0009)	(0.0001)	(0.0001)		
Dens	-0.0010*	-0.0002**	-0.0001**		
	(0.0005)	(0.0001)	(0.0001)		
Disc	-24.6500***	-2.6080**	0.9930		
	(7.9080)	(1.2050)	(0.6308)		
ArtifSh	1.9300	1.0620	0.2439	0.2741	0.2438
	(5.1620)	(0.7885)	(0.5988)	(0.6097)	(0.6211)
AgriSh	55.9200***	5.0830***	1.6460***	1.3796***	0.9592**
	(4.5520)	(0.6976)	(0.4230)	(0.4281)	(0.4668)
ManuSh	24.7700***	4.1070***	0.4314	0.5957	0.3979
	(3.8700)	(0.5902)	(0.4323)	(0.4417)	(0.4817)
log(NCars)	1.4100**	0.1566*	0.3065***	0.3003***	0.3479***
	(0.6160)	(0.0953)	(0.0622)	(0.0661)	(0.0729)
Altitude	-0.0085***	-0.0015***	-0.0015***	-0.0016***	-0.0017***
	(0.0021)	(0.0003)	(0.0003)	(0.0003)	(0.0004)
Prec	-0.1503	-0.0446**	0.0112	0.0119	0.0113
	(0.1166)	(0.0178)	(0.0151)	(0.0150)	(0.0144)
Temp	-0.1297	-0.0469**	-0.0043	-0.0069	-0.0155
	(0.1354)	(0.0206)	(0.0253)	(0.0251)	(0.0249)
Wind	-1.4360***	-0.2967***	-0.0637	-0.0936	-0.1224*
	(0.3142)	(0.0481)	(0.0760)	(0.0751)	(0.0726)
			Additive terms		
s(Artif)				2.8330	
				[0.0195]	
s(Dens)				3.5120	4.7880
				[0.0306]	[0.0000]
s(Disc)				1.3980	
				[0.3800]	
s(Artif,Disc)					2.3810
					[0.0000]
s(Long,Lat)			8.889	8.7820	9.1460
			[0.000]	[0.0000]	[0.0000]
Adj R^2	0.53	0.43	0.74	0.74	0.76
Dev Explained %			76.1	76.7	79.3

Note: standard errors in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. For the additive terms, the values of the F statistics are reported in the table with the relative p-value reported in square brackets. The deviance explained is computed following Wood (2017).

ear regression of the annual mean PM10 concentration (a) and days in exceedance (b). Both models return the expected results concerning the effects of urban sprawl on air quality. The coefficients are always significant at the 5% level except for Dens in model (a) that is significant at only 10%. The spatial expansion of cities affects positively PM10 concentration. An increase in the total artificial area of the amount of one standard deviation, approximately 340 km2, corresponds to an increase in the mean concentration of 340*0.0034=1.156 μg/m3 and a 340*0.0005=17% increase in the number of days with emissions exceeding the threshold, other aspects being equal.

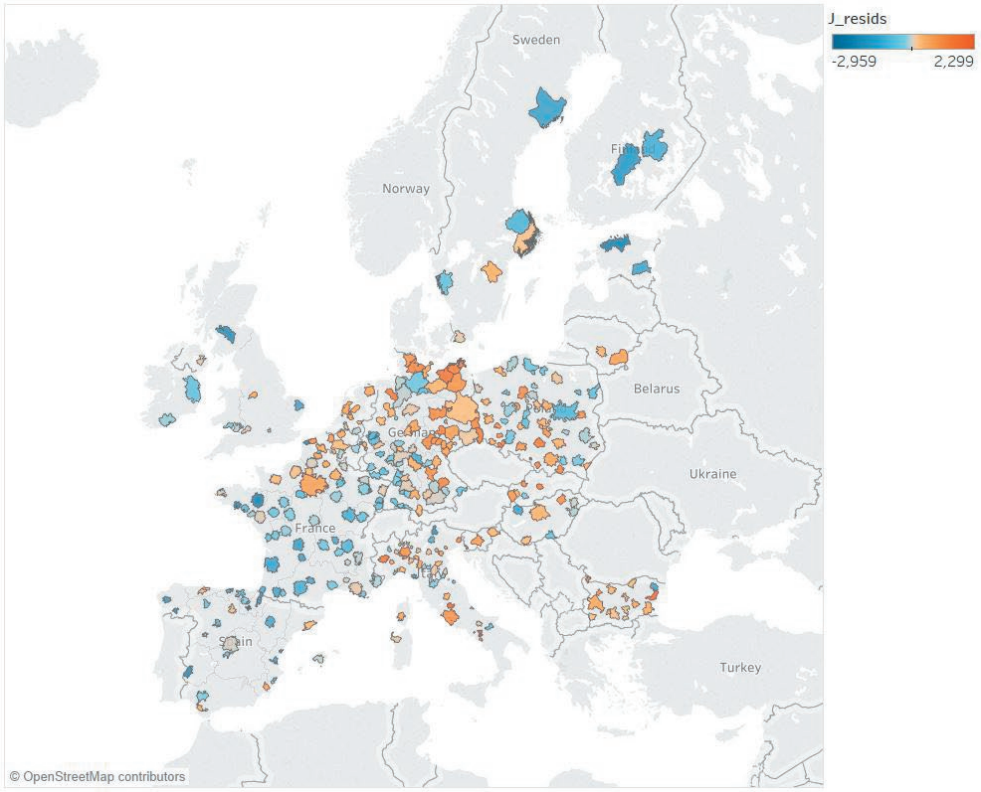
As expected, the effect of density is negative. A decrease in density by the amount of its standard deviation (approximately 850 inhabitants per km2) is associated with an increase in the mean concentration of 850*0.001=0.85 μg/m3 and a 850*0.0002=17% increase in the number of days in exceedance. The use of population density in empirical modelling is instrumental in capturing the increased demand for miles travelled caused by the longer average distance commuted in a low-density built environment. In addition, the average density captures the diversity in transport modes as public transportation services are likely provided less (or less efficiently or altogether not provided) in low-density areas, which encourages the use of private transportation. Longer commutes and higher car dependency as well as more frequent daily trips to access primary services are also expected in fragmented areas, which are favoured by the spatial mismatch between the location of residential plots and that of daily basic services.

In this first specification the effect of urban discontinuity is also negative. An increase in the share of the discontinuous urban fabric equal to its standard deviation, approximately 4%, corresponds to a decrease in the mean concentration of 1.05 μg/m3 and an 11% decrease in the number of days in exceedance.

All the control variables' coefficients are statistically significant in the model with the number of days as the response variable (b) while only precipitation and temperature coefficients are not significant in the model which explains the average concentration (a). Only the coefficient of the share of artificial area is not statistically significant. Overall, increasing shares of agriculture and manufacturing contribute to increasing air pollution in both models. Worsening air quality is also the result of the high use of cars as a transport vehicle. Finally, bad air quality is negatively associated with the city's altitude, the average precipitation rate, the average temperature, the average wind speed in the city.

Specifications (a) and (b) returned internally consistent results and evidence that is coherent with the existing empirical studies concerning the role of city size and density, confirming that urban sprawl affects the mean concentration of pollutants as well as the probability of having dangerously high values of concentrations in a large number of days in the year. Nonetheless, both the models show specification problems related to missing factors that explain air pollution. The issue becomes clear by reviewing the spatial distribution of the residuals, which is similar in both models. Figure 1 plots the value of the residuals computed based on the estimates of model (b). Cities with high levels of unexplained numbers of days in exceedance are geographically concentrated in East-

Figure 1. Spatial distribution of linear model residuals.

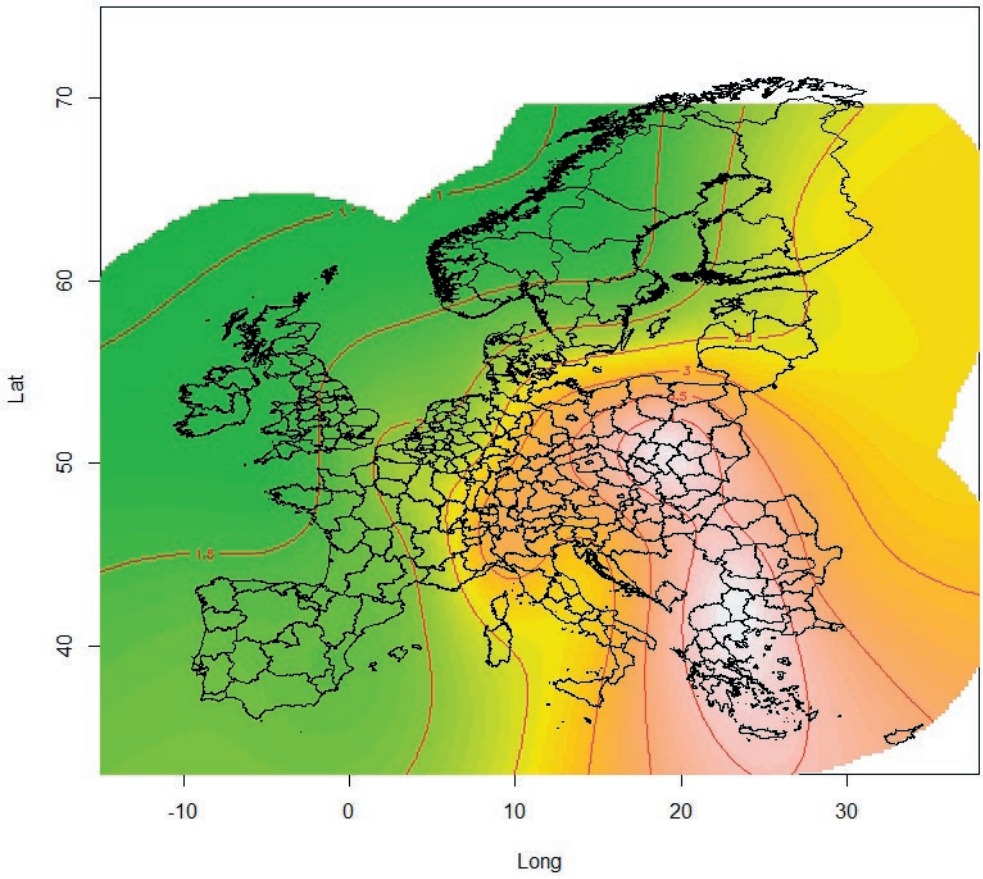


Note: The figure plots the city-level map of the residuals of the linear model with the log of the exceedance days as dependent variable. The values are presented using a colour grade scale from green (low value) to red (high values).

ern Germany and Southern Poland, in Romania, and in Northern France and the Benelux area. Particularly high values are visible close to Germany's border with Denmark. The spatial concentration of high/low values of the residuals in neighbouring cities violates the independence assumption of the linear model, invalidating the estimates.

The model in equation (2) solves this issue by introducing geographical coordinates into the model via a penalised smooth function, and the results of the GAM are summarised in the third column (c). The smooth function of the geographical coordinates represents a spatial trend that can account for the geographical concentration of the unobserved factors. The previous evidence concerning the role of the artificial area and density holds even after including the spatial trend whereas the counterintuitive result about discontinuity disappears as the coefficient here becomes correctly sloped but statistically insignificant. With the inclusion of the spatial trend, all the control variables retain their sign and signifi-

Figure 2. Location and air pollution – plot of the smooth function of geographical coordinates from the estimates in model (c) in Table 2.



Note: The figure plots the expected values of days in exceedance conditional on the geographical position of the city, as expressed by latitude (Lat) and longitude (Long). The values are presented using a colour grade scale from green (low value) to red (high values).

cance, except for the meteorological variables, whose coefficients becomes not statistically significant. The significance of the spatial trend is assessed with standard ANOVA tests in the lower part of the table. In correspondence with the value of $s(\cdot)$ the value of the F statistic of a test comparing the additive model and the same model but without the specific additive component is reported. In the case of the spatial trend, the test compares the model with the trend (c) and the model without (b), and the p-value (reported in square brackets) suggests rejecting the null hypothesis that the geographical position of the city does not affect its pollutant exceedance.

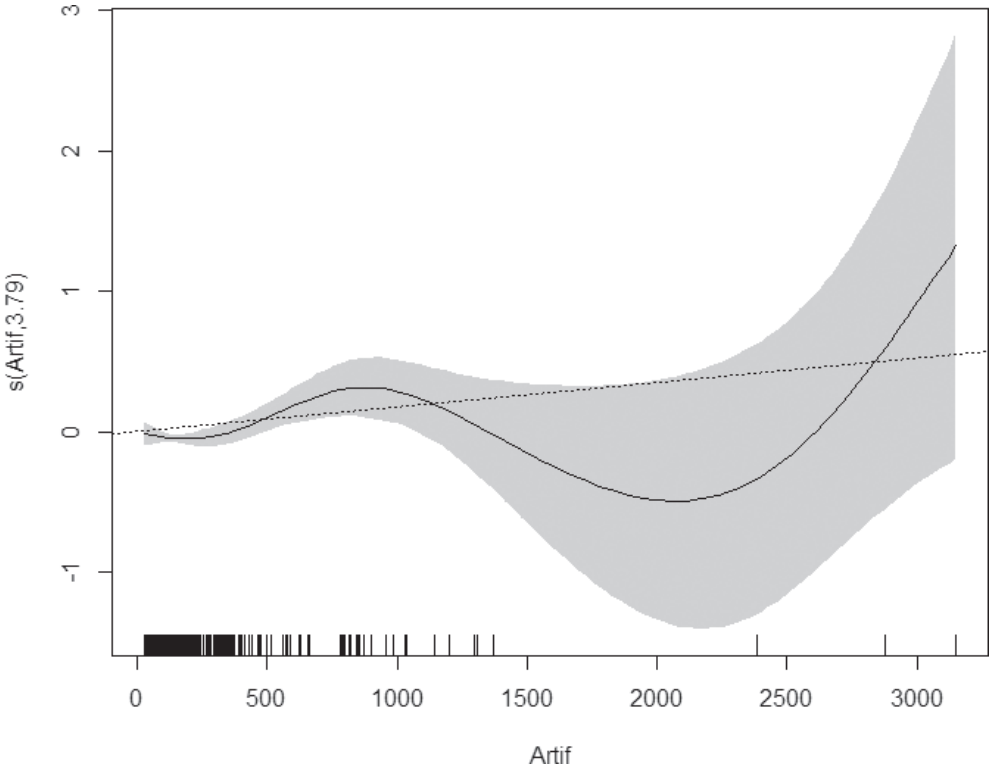
The estimated value of the spatial trend is presented in Figure 2: the figure shows, for each pair of coordinates, the component effect of each of the smooth

term model, which adds up to the overall prediction. In the case of geographical coordinates, the figure appears as a set of level curves, each level representing the value of the smooth term: the higher the value of the smooth term (the trend), the higher is the level of the curve. We used a band with graded colours from green (low) to red (high) to indicate the estimated contribution of the geographical position to air pollution. The spatial trend well captures the spatial concentration of high levels of pollution in northern Italy, Germany, and Poland, which also extends to Romania. As a result of the improved capacity of this specification to explain the variation in air pollution levels, the R2 of the model increases compared to the previous models from 0.43 to 0.74, which is a substantial increase, considering that the gain is obtained by adding only two variables .

In model (d), we extend the use of penalised smooth functions to the urban sprawl variables using the specification in equation (3). The coefficient estimates of the linear part of the deterministic component of the model; hence, the control variables and the meteorological variables are consistent with the results of the other models, from which they retain sign and significance. Instead, the additive part offers significant insights into the relationship between urban sprawl and air pollution that has not been previously captured. First, there is no evidence of the effect of discontinuity on air pollution, as it is not possible to reject the null hypothesis that the smooth function of discontinuity can be excluded from the model according to the F statistic (p-value = 0.38). Second, it is confirmed that both the spatial size of the city and the average density have an impact on PM10 concentration; however, their effect is largely non-linear. This last evidence emerges from the plot of the smooth function against the value of the respective covariates. Again, the plot shows the component effect of each of the smooth term in the model, which adds up to the overall prediction. In the horizontal axis the value of the variable is reported, in the vertical axis the value of the component, which is the part of the linear predictor ascribed to the related variable. These plots are presented in Figure 3, for the artificial area, and in Figure 4, for the density. The solid line in the plot represents the value of the predictor component and the shaded areas its confidence interval. To facilitate the comparison with the linear model, we also include a dotted line representing the value of the component in the case of the linear predictor, $\beta_1 ARTIF$ and $\beta_3 DENS$ respectively, where $\hat{\beta}_1$ and $\hat{\beta}_2$ are taken from table 2, model c.

In Figure 3, the relationship looks very similar to a polynomial function of the fourth degree. Nonetheless, excluding the three largest cities (with artificial area greater than 1500 km2), the function looks like an inverted U. In the cities below the approximate threshold of 800 km2, for example, Torino, Odense, Antwerpen, Nantes, Hannover, Ostrava, Glasgow, or Helsinki, a spatial expansion will result in increased air pollution. Beyond that threshold, instead, further spatial expansion leads to improvement in the air quality. We tentatively link this evidence to the presence of scale effects in the provision of public services, which contribute substantially to reducing PM10 concentration. In small cities, the provision of public transportation services is not economically viable because the scale of the city and the potential demand do not justify an expansion of the network to allow full pro-

Figure 3. Effects of city size on air pollution – plot of the smooth function of artificial area from the estimates in model (d) in Table 2.



Note: The figure plots the expected values of days in exceedance conditional on the population density (Dens) for each possible density value present in the sample.

vision of service. Thus, an expansion of the city likely translates into longer and more frequent car-based trips. In contrast, in large cities, the economies of scale make the provision of public transportation affordable; the larger the scale, the more efficient this provision is, allowing car-based trips to be limited and air pollution to be contained.

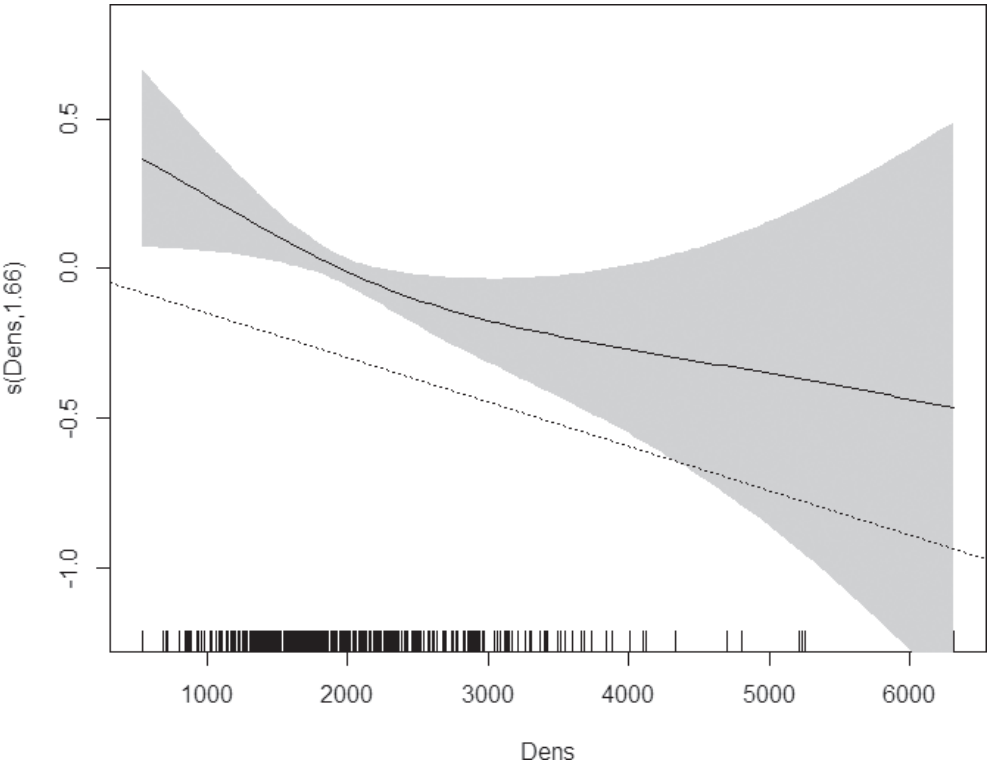
In Figure 4, the relationship appears to be only slightly non-linear. The negative effect of density on air pollution is confirmed; however, this effect is found to decrease marginally in cities with a density that is higher than approximately 2.5 thousand inhabitants per square kilometre.

Finally, in model (e), we search for a combined effect of artificial area and discontinuity following the specification in equation (4). The control and meteorological variables exhibit consistent coefficient signs and significance values. Additionally, the effect of density on urban air pollution is confirmed in terms of statistical significance ($p<0.001$), and the plot of the smooth function appears to be very similar to that presented in Figure 4. In contrast, evidence about the combined ef-

fect of artificial area and discontinuity add new information on how PM10 concentration is influenced by discontinuous urban development in small and large cities. The figure plots all the possible combinations of artificial area (in the horizontal axis) and discontinuity (in the vertical axis) and associates a colour graded from green (low impact on air pollution) to red (high impact) to represent the estimated effect.

The largest effect on air pollution is generated by the combination of high artificial area and high discontinuity, the upper right part of Figure 5. Indeed, as emphasised by Dupont (2007), peri-urban planning is non-neutral from a political perspective. Polluting and heavy industries usually tend to be relocated in the peripheries of large cities so as to reduce pollution in the city centre. In contrast, discontinuity does not contribute to worsening air pollution in small cities (Artif<500 Km2) as the estimated effect on air quality remains low (the green area in the left part of the figure) independently on the level of discontinuity.

Figure 4. Effects of population density on air pollution – plot of the smooth function of population density from the estimates in model (d) in Table 2.



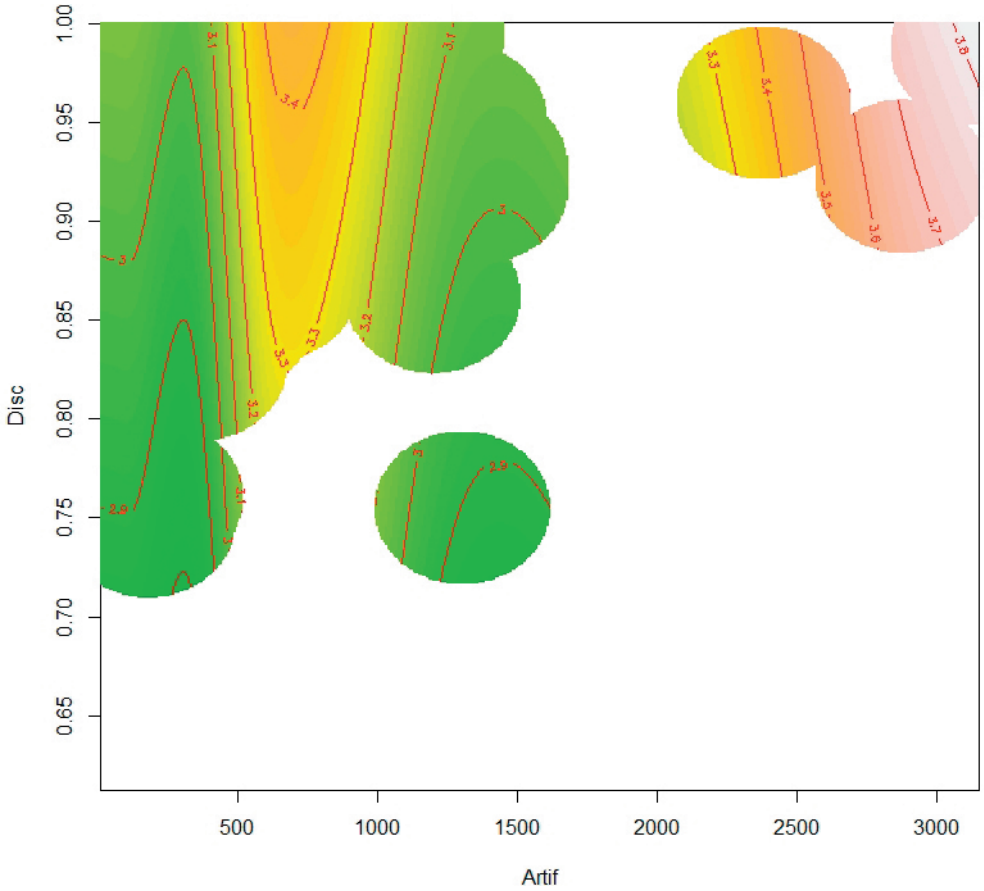
Note: The figure plots the expected values of days in exceedance conditional on the population density (Dens) for each possible density value present in the sample.

4.2 Discussion

The empirical results presented are consistent with the findings of previous empirical analyses about the relationship between air quality and urban form. As anticipated in the introduction, most of the literature focused on CO2 emissions rather than air pollution to understand the impact of urban form and, hence, the results of the empirical analysis are not directly comparable. Nonetheless, we found interesting parallels.

A significant impact of artificial area on air quality is found in Bart (2010), Cirilli and Veneri (2014), McCarty and Kaza (2015), and Cárdenas Rodríguez et al.

Figure 5. Effects of combinations of total size and share of discontinuous settlements on air pollution – plot of the smooth function of total artificial area and discontinuity from the estimates in model (e) in Table 2.



Note: The figure plots the expected values of days in exceedance conditional on the levels of artificial area (Artif) and settlement discontinuity (Disc) for each possible combination of Artif and Disc present in the sample. The values are presented using a colour grade scale from green (low value) to red (high values).

(2016). Such evidence suggests that air pollution, either measured as CO2 emission or pollutant concentration, linearly increases with the size of cities. We find a similar result as well, with a linear coefficient associated to artificial area positive and statistically significant in both the regressions of mean concentration and days in exceedance (table 2, models a and b). We show, however, that such linear relationship masks a more complex inverse U pattern: urban area growth impacts positively air pollution in small (Km2<800) cities, then the impact turns negative in medium size cities (1500>Km2>800) to become positive again in large metropolitan areas (Km2>1500).

Concerning density, all the existing studies converge to the same result: air pollution increases when the density of a city decreases. Cirilli and Veneri (2014) report a negative coefficient for density in the CO2 emission per passenger regression. McCarty and Kaza (2015) find the geographical concentration of high density counties to affect negatively the exceedances, in particular Ozone exceedances. Cárdenas Rodríguez et al. (2016), in contrast, find a positive association between density and SO2 concentration and a lack of explanatory power of density in the regression of PM and NO2. The result may look in contrast to other existing evidence. It is worth noting, however, that coal fired power stations rather than traffic is the main source of NO2, and the link with density may reflect the location of power plants in the proximity of urban areas in specific regions of Europe where coal is a relevant source of energy production, like Poland. Compared to the existing literature, our result confirms that that higher densities are associated to lower concentrations of pollutants and, hence, a better air quality. Oppositely to the case of total urbanised area, we do not find strong evidence of non-linearity in the effect of density (other than those captured by the log-transformation of the dependent variable).

The most interesting result concerns the fragmentation of urbanised area, also defined as spatial discontinuity of urbanisation. McCarty and Kaza (2015) use several indicators of spatial discontinuity and find that exceedances increase with the increase in the number of patches, the decrease in the mean urban patch size, and the increase of its standard deviation. When the analysis focuses on PM, however, only the number of patches shows a significant relationship with air quality. The effect of the number of fragments is also found positive in Cárdenas Rodríguez et al. (2016), even though weakly significant ($0.05<p<0.1$) in the analysis of PM. In our study, the estimated coefficient on fragmentation is statistically significant but negative. It turns insignificant when the spatial trend is added to the model and becomes significant again when considered alongside total urbanised area. The overall effect is positive for large urban areas only, accordingly, meaning than an increase in discontinuity (equivalent to an increase in the number of patches or fragments in the other studies) has a positive effect on the number of exceedances.

In summary, the evidence suggests that the spatial expansion of cities per se is not the cause of the deteriorating air quality, at least in medium size cities. Density has a clear effect but most of the problems related to the urban form involve primarily large cities and metropolitan areas, at least when the spatial expansion comes in tandem with an increase in discontinuity and generates leapfrog urban development. Based on these evidences, we confirm that the development of new

suburban employment clusters within the boundaries of metropolitan areas as an important factor inducing the spatial expansion of cities as in Felstenstein (2002). This has important consequences in terms of air pollution: a first effect is certainly given by emissions generated by additional industrial activities, which is confirmed in our results by the positive effect brought about by the share of manufacturing. Further, new suburban employment clusters allegedly attract workers to reside in their proximity which, in their turn, demand for the presence of retail and entertainment in the vicinity, thus resulting in higher land conversion (Herzog and Schlottman 1991; Malecki and Bradbury 1992) and domestic fuel consumption.

5. Conclusion

The extent to which integrated transport and planning policies can effectively mitigate the pollution of air remains an open question for policymakers and especially urban planners. Intuitively, more compact urban forms that require a lower dependency on private transportation should benefit air quality. The existing research has focused on the effect of compact urban form to investigate this link, and the results demonstrate that a lower PM10 concentration can be associated with a more compact urban structure. Despite this clear evidence, urban structures continue to evolve in the direction of low-density urban development on the peripheries that are also increasingly becoming characterised by a spatial discontinuity of the built-up area, especially residential settlements.

In this paper, we document the overall negative effects of urban sprawl, considered in its multiple dimensions of low-density and high-discontinuity urban development on the annual average PM10 concentration and the number of days in which PM10 concentration exceeds the safeguard threshold for citizens in EU cities. The empirical analysis contributes to the existing literature about urban sprawl and air quality considering the different characteristics of urban sprawl and their interaction. The evidence shows that these negative effects come from both low-density urbanisation and high spatial discontinuity; however, the latter effect is evidenced only in highly urbanised contexts, likely large cities. The results of the paper are robust to the inclusion of controls for city-specific characteristics, climatic conditions and unobservable characteristics related to the geographical location of the city.

For many years, urban sprawl has remained an ignored challenge. Emotional sentiments in favour of or against the spatial expansion of built-up areas and the sealing of soil have mainly driven the debate about urban sprawl, which has additionally been fuelled by disagreements about measures of sprawl. As a result, the discussion about the potential environmental consequences of sprawl is confined within the boundary of the comparison between the compact model of urban growth and its possible alternative. Most of the recent streams of research on urban sprawl shed light on the multiple dimensions of urban sprawl. Low-density but also a high discontinuity of residential settlements led by changing household preferences and the diffusion of cars are shaping the urban form of modern citi-

es, especially the largest ones. Documenting the environmental damage coming from the combination of these factors should raise awareness of the consequences of the current trends in urban development in Europe and prevent urban sprawl from continuing to be an ignored challenge. At the same time, the evidence in this paper relates pollution concentration to some specific characteristics of urban sprawl, indicating that the effect is highly context- and location-specific and caution is needed when translating this evidence into a policy message.

While air quality remains one of the many indicators of the quality of the urban environment and, consequently, of citizen's health that can be affected by urban sprawl, it is a critical one, and more research and evidence is needed to adequately assess the impact of urban sprawl on our lives.

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Sustainability of traditional markets post-revitalization: a case study of Bulu and Peterongan markets in Semarang, Indonesia

Bulu and Peterongan are traditional markets with a history related to Semarang City, Indonesia. They have both been transformed into new markets with better and more complete buildings and facilities. It was conducted by the government to realize the people's market revitalization program and sustainable development goals (SDGs) because sustainability is very important for historical buildings. This however, has reduced their conservative buildings due to the reconstruction of the Bulu Market after a fire accident and almost 75% of the buildings in Peterongan Market. The development caused a reduction in the demand of traders to sell and customers to shop due to the discomfort provided by the post-revitalization buildings. Therefore, a qualitative method was applied in this study to explain the phenomenon and sustainability of the post-revitalization of these two markets, and the findings are expected to be used in forming the strategy to encourage the sustainability of these markets.

1. Introduction

Sustainability is a concept observed to be important to urban development as discussed at the UN Conference in Quito, Ecuador 2016 and added as one of the indicators of Sustainable Development Goals (SDGs) (Sutopo et al., 2014). The SDGs were designed as the new development agenda to accommodate all the changes experienced post-2015, especially regarding the world situation since 2000 on the issues of depletion of natural resources, environmental damages, climate change, social protection, food, energy, security, and development for the poor. It is, however, possible to develop a city through its traditional market by using revitalization programs which is a method proposed to preserve contemporary architecture's heritage to accommodate funding (Penica et al., 2015). The Government of Indonesia has implemented this program to revive traditional markets in the country but its implementation has not been effective as observed from the quietness and unsustainability of the revitalized markets.

The existence of traditional markets in Indonesia is based on local people's cultural heritage (Prastyawan et al., 2015) and they are usually visited by several people from different ethnicities, races, and characters, thereby, making the markets to be rich in culture. Some of the advantages of these traditional markets include cheaper and negotiable prices of quality goods than modern markets and this is the reason for their preference by customers. Meanwhile, their existence is being threatened by the emergence of modern markets such as supermarkets

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and minimarkets which are growing significantly due to the influence of globalization, thereby, making competition with the traditional markets inevitable (Jeong and Ban, 2020; Prabowo et al., 2017). Several facilities of the traditional markets have also been reported to be incomplete and inadequate (Wibowo and Istiqomah, 2018) and this has led to the closure of some of them due to their inability to compete in the industry. Moreover, customers have been observed to be shifting to modern markets due to poor planning, uncomfortable access, overcrowded trading activities, lack of air circulation, and poor sanitation in traditional markets (Tanuwidjaja and Wirawan, 2015).

This means revitalization efforts are needed to sustain traditional markets (Sari et al., 2020) by repairing untreated buildings to make them tidier and cleaner but rebuilding instead of revitalizing tends to obscure the values and identity of these markets (Senasaputro, 2017). As previously stated, revitalization is a method proposed to preserve contemporary architectural heritage (Penica et al., 2015) to maintain the physical, social, cultural, and local identity aspects of the significant buildings (Kusrini and Kismanto, 2011). This is necessary due to the ability of globalization to affect the architectural form of buildings and sometimes eliminate their identity and local culture (Sudikno, 2017). Therefore, traditional markets are often renovated using the theme "revitalization" to make their building to be more well-groomed and tidier but the cultural values embedded for a long time are mostly ignored by the stakeholders involved in the development process, thereby, leading to the loss of these values, levelled to the ground, and covered with new materials.

Bulu and Peterongan markets in Semarang City, Indonesia showed in Figure 1 are two of the largest historic markets in the city. Meanwhile, history is no longer depicted in the Bulu Market due to its utter revitalization in 2012 which led to the replacement of the original building materials or structures with the latest designs and materials. The same was also observed in the Peterongan market but it maintains its original building and has not changed much of its spatial layout. It is important to note that revitalization efforts are usually implemented to revive the functionality and maintain the existence of the buildings in these markets (So-

Figure 1. Location of Bulu and Peterongan Markets in Semarang.

Source: Developed by the author, 2020.

ewarno et al., 2018) but it most times require demolishing old buildings to build new ones, as shown in Bulu Market and this means the market is no longer sustainable. The case is, however, different from the Peterongan Market which is fully sustainable. Moreover, the uncomprehensive revitalization standard is one factor causing all traditional markets to be unsuccessful after they have been revitalized (Anggraini et al., 2017).

Several studies have discussed the physical changes in post-revitalization of traditional markets with some focused on the revitalization methods to preserve historical landmarks, provide a new function, and adapt historic buildings to modern requirements (Penica et al., 2015). Another example is the revitalization of Indies building through the application of new functions (Wibisono et al., 2020) which increased the retail property value around the building (Jayantha and Yung, 2018). Some of the implications of these efforts is a change in tradition, market building structure, market patterns, a decrease in traders' profit, and loss of livelihoods (Aprilia, 2017; Gumilang et al., 2017). However, these studies only focus on the physical changes of a building. The discussion that was carried out did not extend to other aspects and also the sustainability of the market itself, remembering that the market buildings studied were historical buildings as well as Indies buildings.

Based on these several studies, researchers want to see not only the physical changes, but their impact on the sustainability of the market itself. The success of a building revitalization program is not only determined by how much physical changes are made, but whether the building is in accordance with the needs of its users. Besides, other non-physical aspects also need to be considered such as cultural values or local wisdom embedded in these buildings, because the principle of sustainability does not only pay attention to economic, social and environmental aspects, but cultural aspects are also included (Appendino, 2017). By examining case studies using these aspects, an optimal and sustainable revitalization strategy will be obtained. The outcome is expected to be used in increasing the sustainability of the post-revitalized Bulu and Peterongan Markets.

2. Methodology

A qualitative method was used in this study to determine the phenomena in the post-revitalization of Bulu and Peterongan markets after approximately 3-5 years of operation. These markets were selected as a case study because their revitalization programs are similar as observed in the complete revitalization of their historical buildings, non-functioning stalls, decreasing number of traders and customers, and several others. The factors causing the lack of customers in both markets were also explored due to the fact that they have never been without customers. Moreover, the two markets selected even though others have similar cases due to their influence on the people of Semarang up to the present moment.

Field observations were used to determine the current physical conditions using several variables designed to assess the physical aspects including the cons-

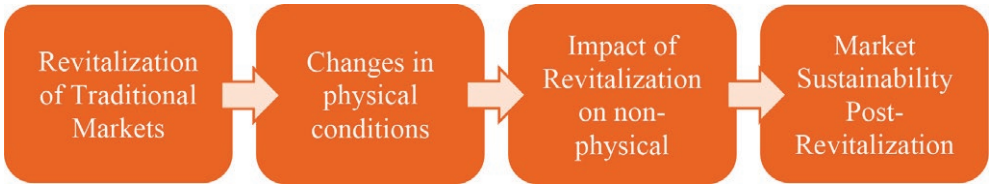
truction year, building area, building floors number, building materials used, part of the existing market, stall number, facilities, lighting systems, waste processing systems, and parking lots (Linggasani, 2015). Researchers will use these aspects to identify changes that occur in both markets before and after revitalization. The changes are usually seen in space capacity, so that building area, building floor number, stall number, dan parking lots will clearly have differences with the previous building. Besides, the two markets that are historical buildings will be examined whether there are preservation efforts, remembering that government regulations prohibit historic buildings from using the latest building materials and maintain the existing elements. Of all these physical changes, the results will be grouped into a table of physical aspects.

Physical changes in both markets have had an impact on a non-physical basis. This non-physical condition is the attribute of customers who are disturbed or uncomfortable with the market's physical condition. These attributes include accessibility, condition of goods, the reputation of the market, shop's atmosphere, in-store services, existence of public facilities, price of goods, and shopping safety (Prabowo and Rahadi, 2015). Different forms of the market will make customers either difficult to access or not. The shop atmosphere will also be different because there are no elements commonly found in previous buildings, such as local elements, ornaments, or other traditional elements. Even though it has been transformed into a new building, it will be seen whether the services provided by traders, the price offered, the condition of the merchandise are still the same as before or not. The existence of public facilities also needs to be considered whether they are easy to reach and find. If all the answers are not, then it is clear why the market is empty of visitors, and there is a need for a strategy to strengthen the sustainability of traditional markets.

These aspects will be used as material for interviews with informants. The questionnaire was structured with open-ended questions so that informants could answer freely according to their experiences. Interviews were conducted directly by the researchers using purposive sampling methods with the criteria being they are managers, traders, and consumers patronizing the markets before and after revitalization. The researcher selected several traders directly affected by market revitalization, such as traders asked to move from outside into the market. Researchers obtained informants as many as 32 traders and 24 customers from each market. This number represents the number of traders who feel the negative impact of the revitalization of traditional markets because the informants' answers are more or less the same.

From the information obtained from these informants, researchers will group their answers into a table of non-physical aspects and elaborate on the results of observations in the field. A descriptive analysis was applied to explain the impact of the revitalization process on the physical and non-physical aspects of the buildings. This involved using the observation results for the physical changes and the findings from the interview to determine the impact of revitalization on non-physical changes in both markets. These were further analysed to develop appropriate strategies to maintain the sustainability of the traditional markets af-

Figure 2. Research thinking.



Source: Developed by the author, 2020.

ter the revitalization. The research thinking used in explaining the structure of the study is, however, presented as shown in Figure 2.

3. Results and Discussion

3.1 Post-Revitalization Physical Conditions

Bulu and Peterongan are two traditional markets of much interest before revitalization as indicated by the number of people patronizing them and also famous for keeping the history of Semarang City. The observable deteriorating condition of the markets, however, made the Indonesian Government implement the "Revitalization of the People's Market" program as stated in the Law of the Republic of Indonesia Number 7 the Year 2014 concerning trade to improve the quality of the markets' management in order to increase their competitiveness. This effort changed the face of the markets and the Bulu market was completely revitalized because it is not listed on the heritage site even though it has satisfied the 50 years of existence required by the law. Meanwhile, the Peterongan market was not completely revitalized but the façade and space were reconstructed due to its designation as a cultural heritage site by the Mayor of Semarang (2015) and this means its original shape and materials were not allowed to be changed.

Bulu Market which was established in 1930 is located on Mgr Sugiyopranoto Street, Barusari, west side of Semarang, and occupied a land area of 1092 m^2 which was expanded to 13,733 m^2 in the 1960s with only ± 6,146 m^2 being as a place to trade. The market was revitalized on August 17, 2012, as a result of a fire accident that burned all the structures in the area and was re-opened for operation on December 29, 2014, with a new face and a more modern look. The market now has a land area of 8,451 m^2 and a building area of 12,726 m^2 and has become a public spotlight due to the significant changes made to the structures when compared with the original design as shown in Figure 3. It is also situated in Semarang's historic area including Tugu Muda, Lawang Sewu, and Mandala Bakti Museum as well as the business district consisting of government offices and hotels which is a highlight for tourists. Bulu Market was, therefore revitalized with the new face to maintain synergy with other buildings in that area and Semarang's spatial plan (Maulana et al., 2013).

Figure 3. Bulu Market pre-revitalization (left) and post-revitalization (right).

Source: Survey documentation, 2020.

Another traditional market revitalized is the Peterongan Market which is located on MT. Haryono 936 street, Peterongan, east side of Semarang. It was established in 1916 and has a modern market (Rukayah and Supriadi, 2017). Its initial design had only two floors constructed with permanent concrete which makes it the first market building constructed using concrete in Semarang. The market was revitalized in April 2015 to preserve its cultural heritage, ensure more comfortable, and to become attractive and inaugurated on January 17, 2017. The façade of the market has not changed much unlike the Bulu Market and several building parts are maintained and not completely redesigned as shown in Figure 4.

The two traditional markets experienced significant physical changes both in the exterior and interior even though one had some parts changed while the other complete reconstruction. The components analysed to have physically changed include the construction year, building area, building floors number, building materials used, part of the existing market, stall number, facilities, lighting systems, waste processing systems, and parking lots (Linggasani, 2015) and the results are presented in the following Table 1.

Figure 4. Peterongan Market pre-revitalization (left) and post-revitalization (right).

Source: Survey documentation, 2020.

Table 1. Physical changes in Bulu Market and Market Peterongan.

Component	Bulu Market		Peterongan Market	
	Pre-Revitalization	Post Revitalization	Pre-Revitalization	Post Revitalization
Development year	1930	2016	1916	2014
Building floor number	1	2	2	3+1 basement
Building area	±3556 m^2	±3700 m^2	±6.146 m^2	±12.726 m^2.
Architecture design	Tropical	Tropical-modern	Tropical	Modern
Buildings materials	Reinforced concrete	Concrete steel roof trusses, roof galvalume	Reinforced concrete, spans columns made of steel, wood frame	Concrete, ACP variations on the facade, metal roof frame, the roof galvalume
Portion retained		Front facade, stall layout, and the tamarind tree		None
Stalls number	±382	±405	±1.388	±2.547
Facilities	Toilet	Toilet, prayer rooms, hydrant	Toilet	Toilet, prayer rooms, hydrants, escalators, TV
Lighting systems	Indirect lighting	Indirect lighting	Indirect lighting	Artificial lighting
Waste processing systems	Dump	Cleanliness officers, dump	Dump	Cleanliness officers, dump
Parking lot	Roadside	Roadside	Roadside, market court	Basement, market court

Source: Observation result, 2020.

The difference between the two markets is in the number of floors. with the Bulu market observed to be having 4 floors after the revitalization including a basement which serves as the vehicle parking lot and a loading dock. The 1st floor is the dry goods segment for convection traders, souvenirs, groceries, accessories, watches, and shoe services, the second floor is the wet goods segments for traders of vegetables, fruit, grocery, meat, chicken, and food stalls while the third floor is for bulky goods such as glassware and pottery. The Peterongan market is, however, different and found to be consisting of only two floors without any significant physical change due to the location of the second floor behind the market. The spatial arrangement has also not changed very much due to its consistency with the existing pattern for the cultural heritage buildings.

The post-revitalization Bulu market building is designed using a modern concept and this is associated with the fact that it was reconstructed from zero and this made it possible for the stakeholders to make the design different from the original. The word 'modern' is defined as the use of latest construction techno-

Figure 5. Roofing material for Bulu (left) and Peterongan Markets (right).

Source: Survey documentation, 2020.

logy and materials as observed in the use of steel frame for the roof, ACP panels for the façade, and latest materials applied in designing the spaces (Riyadi et al., 2019) (see Figure 5). The market does not look like a traditional market but a supermarket at the first glance and this formed with the discussion of the public at the venue of the inauguration with most of the people reported to have complained the design and materials used are far from traditional and historical terms. A slightly different observation was made at the Peterongan Market with the old building structure constructed using concrete found to be existing with only a few materials such as iron support poles and galvalume roofs replaced because they are weathered by age and affected by climate as indicated in Figure 5 (Imran, 2013).

It was impossible to preserve anything from the old Bulu Market building as a result of the fire disaster as shown in Figure 6 and this means it had to be levelled to the ground to provide a space to build another structure. This is different from Peterongan Market which is a cultural heritage building with several parts such as the shape of the roof, spatial patterns, building technology, and tamarind tree retained for authenticity because they are thousands of years old as presented in Figure 6 (Asiyah et al., 2019). Moreover, the tree area has been centripetal for a very long time and has a special meaning for the Semarang people. It used to be inside the building but now exposed through the restoration of the parts covering the tree in order to make it the centrepiece and axis of the building's symmetry.

The facilities of both markets after the revitalization program were complete and adequate as observed in the prayer room, bathroom, sink, hydrant installation as indicated in Figure 7, and the loading dock area. The selling stalls' arrangement is also tidier, a large parking area is provided, and an escalator is also installed in Bulu but not in Peterongan market as shown in Figure 7 to make it easier for customers to reach the 3rd floor. However, despite the complete availability of these facilities, some traders complain about those considered to be inappropriate such as fewer large stalls, a drop-off area outside the building which blocks customers from passing, and a lack of easy access from drop-off to the stalls. The stalls

Figure 6. Original column of Bulu Market (left) and Tamarind tree of Peterongan Market (right).

Source: Survey documentation, 2020.

Figure 7. Escalator facilities at Bulu Market (left) and hydrant at Peterongan Market (right).

Source: Survey documentation, 2020.

on the 2nd and 3rd floors were also reported to be difficult for people carrying large and heavy goods and this means the sellers are not satisfied with the overall design of Bulu Market even though the escalators are working effectively.

The stalls on the 2nd floor of the Peterongan Market are also very far from the entrance or loading dock area and this makes several sellers on this floor move to the 1st-floor to avoid difficulties in moving their goods. Space is also only provided with stairs unlike the Bulu Market as shown in Figure 8 and they are also too steep and less wide, thereby, troubling the traders and customers. This leads to the abandonment of the 2nd floor as shown in Figure 8 due to the fact that all goods are already available on the 1st floor. This means the stairs are not functioning optimally even though they have convenient designs because the convenience of the users and customers are not considered by the stakeholders in the design and construction process. It shows the planners, government, or other stakeholders did not involve the traders in the revitalization planning process.

The two markets have a roomy impression when entering the building due to the height and breadth of their spaces. The Peterongan Market is designed using

Figure 8. Staircase facilities (left) and second-floor stalls (right) at Peterongan Market.

Source: Survey documentation, 2020.

the process of "indirect daylighting" on the ceiling and roof of its buildings (Ekomadyo, 2017) to provide direct natural light and eliminates artificial light, especially during the day as shown in Figure 9. This was made possible through the use of one floor which allows the entrance of light from the gaps in the roof to illuminate every part of the market. However, this method was not applied in Bulu Market because it has four floors and natural light can only enter the top floor while artificial lighting is provided for the remaining ones as observed in Figure 9 where lights are switched on, even during the day time. This means the market design is not in line with the principle of sustainable development by meeting the present's needs at the expense of future generations' needs (Brundtland, 1987). The utilization of significant electrical energy for a traditional market undoubtedly has the ability to affect the market's sustainability for the next generation.

The same garbage collection system which comprises individual and communal methods is implemented in both markets. Every trash produced by each

Figure 9. Peterongan Market with natural lighting (left) and Bulu Market with artificial lighting (right).

Source: Survey documentation, 2020.

Figure 10. Waste condition in Bulu Market (left) and Peterongan Market (right).

Source: Survey documentation, 2020.

trader is collected in containers such as trash baskets, buckets, gunny sacks, and plastic bags or thrown directly into the nearest trash can or even immediately dumped on the surrounding floor (Aryanti, 2009) as presented in Figure 10. It is, however, important to note that some traders throw their garbage into their stall's trash after which it would be transported by the officers to the dumpsite. Moreover, several traders and customers litter the floor and cause the market to become dirty and smelly even though the market manager has provided wet and dry trash bins and cleaners. This is mostly associated with their thought that the market is a dirty place and it is normal for them to drop things at will and this behaviour was observed to be copied by both the customers and sellers.

Another problem often faced apart from the cleanliness of the market environment is the parking of vehicles. Most of the vehicle parking spaces in Indonesian traditional markets are unorganized and this usually causes traffic congestion (Nuzuluddin, 2015) due to the inability to accommodate customers' vehicles (Andre et al., 2017). This was observed in Peterongan Market where there is no adequate parking space despite the revitalization and this makes the customers park on the roadside and even though a whole basement is used for parking space in Bulu market as shown in Figure 11, customers still park anywhere even at their destination stalls instead of the basement.

3.2 Post-Revitalization Physical Conditions

Non-physical conditions in both markets are inseparable from the influence of the physical conditions and this means the shape and arrangement of the buildings affect the non-physical aspects. The atmosphere is also associated with the local culture and this is evident from the fact that the local people believe local wisdom has the ability to provide them with the strength and comfort to perform certain activities in the market (Tricana et al., 2015). An example of this is the Tamarind tree which has spent thousands of years in Peterongan Market and preserved up to the present moment due to the belief of the local people that it gives

Figure 11. Basement parking space at Bulu market (left) and roadside parking at Peterongan market (right).

Source: Survey documentation, 2020.

strength to the market and provides comfort to the sellers and customers. This unreasonable belief was considered by the government and stakeholders during the implementation of the revitalization program. A different scenario was observed in the Bulu market due to the complete change in the original design with the history and past stories destroyed and merged with the ground and, even though the supporting pillars remained, a new market building was constructed. The traders seem to have been forced to occupy the space as they and the market managers were not included in the design process by the stakeholders.

Another problem is that the expectations of the customers, traders, and market managers are not fulfilled (Fatmawati and Lantu, 2017). The customers have the power to either shop at a traditional or modern market (Terano et al., 2015) based on their functional and emotional desires (Linggasani, 2015) and the inability of a market to accommodate these desires means the possibility of a shift in their loyalty to other markets (Natalia and Kusuma, 2013). Some of the factors considered important include accessibility, condition of goods, the reputation of the market, the atmosphere of the shop, in-store services, the existence of public facilities, price of goods, and shopping safety (Prabowo and Rahadi, 2015). These attributes determine the patronage of a market irrespective of the type, traditional or modern and this further indicates the physical and non-physical conditions in a market have the ability to stimulate individual emotional levels which subsequently influence the market users (Linggasani, 2015). Therefore, the non-physical conditions observed at the Bulu and Peterongan markets are presented in the following Table 2.

Frequent customers of Bulu Market undoubtedly know the appropriate routes to get to the market but it will be difficult for those visiting for the first time due to the lack of clear directions to enter the market area and park vehicles. Some of the vehicles were observed to have been parked up to the 2nd and 3rd floors as shown in Figure 12 even though they are not allowed at upper floors but those with the experience of the terrain usually move to these floors while those visiting for the first time usually park in the basement. This usually leads to inconvenien-

Table 2. Non-physical conditions of Bulu and Peterongan markets.

Attributes	Bulu Market	Peterongan Market
Accessibility	Customers are accustomed to entering the market from the back door and then directly going up to the floor where the motorbike is intended. The basement and front door are rarely accessed because they are far from the stalls	Customers enter the market from the front door / main door easily, because the access is still the same as before
Goods condition	Clean but those in the unhealthy environment are neglected	Clean and placed in the appropriate territory stalls
Market services	Traders offer goods to customers without force, still the same as the traditional market sales system in general	Traders offer goods to customers without force, still the same as the traditional market sales system in general
Existence of public facilities	The existence of a toilet and prayer room is difficult to find. Moreover, customers are also reluctant to use these public facilities	The existence of toilets and prayer rooms is easy to find because there are clear signs even though customers rarely use these public facilities
Prices of goods	Affordable and bargainable. Customers can get the best price of the goods they want to buy	Affordable and bargainable. Customers can get the best price of the goods they want to buy
Security shopping	No officer's security makes customers feel insecure and shop quickly	No officer's security makes customers feel insecure and shop quickly
Market atmosphere	The market atmosphere is tranquil, unlike before, because many elements of the building have changed	The market atmosphere is tranquil, unlike before, because many elements of the building have changed

Source: Interview result, 2020.

ces in shopping with some of the customers becoming jealous and uncontented for having to walk while others use vehicles. Moreover, the smoke of the motorbikes driven close to the stalls makes the place uncomfortable for the customers and sellers and this further shows the habit of their community is also reflected in the market despite its modernity.

The goods in both markets are not treated hygienically with those in Bulu market observed to be displayed on the floor of the street corridor and not neatly arranged in the traders' stalls, thereby, creating a blockage to the customers' path as shown in Figure 13. The same was also discovered at Peterongan Market with the traders recorded to be putting their goods in the corridor due to the inability of their stalls to accommodate the number of goods they have as also indicated in Figure 13. These, however, make the customers consider their options on buying the goods and this is one of the non-physical conditions determining customers' convenience in selecting traditional markets for transactions.

The two markets apply a bargaining system and this means the traders generally offer their goods to customers after which the price is bargained as indi-

Figure 12. Customers park vehicles right in front of the stalls (left) and customers park in the basement then go up to the next floor by stairs (right).

Source: Survey documentation, 2020.

Figure 13. The condition of goods placed in the corridor of Bulu Market (left) and Peterongan Market (right).

Source: Survey documentation, 2020.

cated in Figure 14. Meanwhile, the prices of goods in traditional markets tend to be cheaper than those in supermarkets and despite the little difference between the price tag and the expectations of the customers, there is an opportunity for an appropriate bargain. The buyer and seller usually reach a compromise and this only happens in traditional markets but some customers that are not willing to compromise their position on the price usually stop visiting the markets and this means everything still depends on the customer's choice.

The two markets have a tremendous amount of space for facilities but the customers were observed to rarely use the restrooms due to their uncleanliness and unpleasant odours. The same is also found with other facilities such as the prayer room which is not effectively utilized due to the fact that customers do not stay too long in the market and prefer to pray at home than at the market prayer room. These observations further intensify the fact that the physical condition of the facilities affects their non-physical conditions with the comfort of the custo-

Figure 14. Services at Bulu Market (left) and Peterongan Market (right).

Source: Survey documentation, 2020.

mers discovered to be disturbed by the unmaintained facilities. Moreover, customers are also unsure about the comfortability of using the facilities even though the officers are cleaning them.

The two markets do not have a security system such as security guards or CCTV and this means traders and customers are allowed to conduct their buying and selling activities without security despite the usual crowd associated with traditional markets and observed to be the source of crimes such as theft, pickpocketing, and several others. The absence of the security apparatus is related to the tendency of the markets being empty and the customers have been reported to be uncomfortable with the insecurity mainly due to the possibility of more explicit crimes in quiet corridors unlike the general crimes usually committed in secret. The situation is different in supermarkets where there is usually a qualified security system which aids smooth experience for the customers.

The atmosphere and the environment of the market were discovered to have become lifeless due to the lack of activities. Traditional markets are generally usually alive due to the crowd provided through the transaction between the traders and customers and this means they both depend on each other to make the market a lively place. Meanwhile, the traders' environment also affects customer behaviour (Susilo, 2012) and this means the absence of customers is due to the inappropriate management of the markets and their environment. The customers are also not willing to visit empty stalls as shown in Figure 15 but they prefer crowded stalls, close access, without upstairs, affordable prices, and friendly service. The inability of a market to satisfy any of these factors usually leads to the emptiness of the stalls and this means the traders need to find other places supported and visited by more customers.

3.3 Post-Revitalization Market Sustainability

The phenomena at the two traditional markets showed the sustainability of a historical building depends both on the physical and non-physical aspects. It is

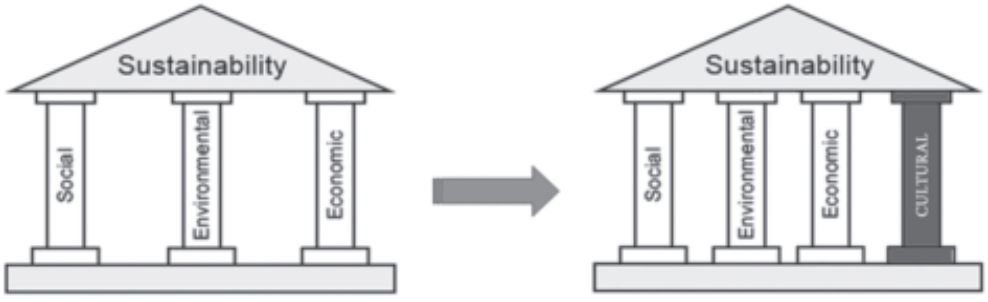
Figure 15. Stalls atmosphere at Bulu Market (left) and Peterongan Market (right) post revitalization.

Source: Survey documentation, 2020.

important to note that sustainability was initially based on three pillars which are the environmental, economic, and social factors but has been developed over time to become a more complex and holistic concept with the inclusion of culture as the fourth pillar as shown in Figure 16 (Appendino, 2017). Culture is essential in sustainable development due to the existence of some values such as customs required to be preserved and applied by the next generation to ensure the continuation of the culture. Moreover, cultural aspects can be physical and non-physical but they are often marginalized and not considered in sustainable development (Bandarin and Oers, 2012) on the grounds of times and adherence to modernization. Therefore, old buildings are often torn down and replaced with new modern buildings as observed in Bulu and Peterongan markets.

Some stakeholders in the modern era currently believe a building's physical appearance is a benchmark for its successful construction. Modern architectural designs are presently being recommended because they are related to the latest technological developments and building materials which accommodate the expressions and creativity of the stakeholders (Sumardiyanto, 2012) and the

Figure 16. Pillars of sustainable development.



Source: (Appendino, 2017).

Table 3. Swot Analysis of the Revitalized Traditional Markets.

Internal / External	**Strengths**	**Weaknesses**
	· Better market appearance, in terms of the facade and spatial arrangement · Have a big name/image and is well known to the public · The building area is adequate for visitors and traders · More complete facilities · Parking space available · Better merchant service · Goods in traditional markets are diverse	· The design of the building does not reflect the history · Old materials were not used in the construction and this reduces the conduciveness of the atmosphere and obscures the history of the market · Many stalls are empty without occupants · Goods are placed in the corridors and this makes the visitors uncomfortable · Facilities such as bathrooms and mosques are available but visitors are reluctant to use them · Entry and exit of the market confuse the visitors · Customers are uncomfortable using too many and steep stairs
Opportunity · The existence of a program to revitalize the people's market towards improving its competitiveness · The role of a team of cultural heritage experts in the implementation of the revitalization programs · The Government supports the revitalization of the traditional markets	**Strategy SO** · Government and market users are required to collectively keep the market intact for the future by taking care of the materials to avoid weathered ingested age · The use of space, facilities, and services of traders need to be optimized to improve competitiveness	**Strategy WO** · A team of cultural heritage experts needs to review the market building to ensure it complies with standards as regards the use of old materials and elements which embody the history of the market's establishment · The satisfaction of visitors and traders needs to be evaluated in relation to spatial planning, accessibility, and public facilities in order to create market revitalization in line with the needs of the market users
Threats · Modern markets have become competitors for traditional markets · Globalization makes modern building design a trend or popular · Few investors want to be involved in the development of traditional markets · Not many traders want to trade in traditional markets	**Strategy ST** · Government and market users need to collectively increase competitiveness to avoid losing to the modern market · Embrace other traders in traditional markets due to the availability of more complete facilities than ever before · Invite shoppers to shop in traditional markets due to the availability of a wide selection of goods at affordable prices	**Strategy WT** · The Government and stakeholders need to limit the influence of globalization on historic markets to avoid changing the appearance to modern design · The government and market users need to improve market management to increase the interest of investors in historical markets · Market users are to be involved in the planning process to ensure traders return to trading in traditional markets and also to increase the interest of the customers.

Source: Analysis result, 2020.

non-physical aspects are marginalized again. It has also been discovered that modern architecture does not consider the diversity in the social and aesthetic values in society (Sumardiyanto, 2012). There is, therefore, the need to link all the aforementioned four aspects not only to respect cultural heritage but also to maintain a building's sustainability in the present and the future (Baca and Lopez, 2018).

Cultural heritage is, however, defined as a relic of the past in a building which includes its work and workers' history which are not often recognized due to the focus on architectural products rather than processes (McCarthy and Glekas, 2020). Moreover, SWOT analysis of the revitalization programs in the Bulu and Peterongan markets was conducted to have an optimal strategy to sustain the traditional markets.

The two markets were observed to have several shortcomings after the revitalization and it is possible to formulate adequate strategies to improve their sustainability through the use of SWOT analysis. This does not involve demolishing the structures again to plan a new revitalization program but by evaluating the management practices and involving users in the planning process to achieve the appropriate programs that satisfy their needs. Moreover, the shortcomings can also be resolved by focusing on one aspect at a time. Starting from the physical aspect, this involves reusing old materials and restoring the atmosphere of the market to establish a relationship with their users (McCarthy & Glekas, 2020). Meanwhile, the convenience of market users is one of the most important factors considered from the non-physical aspects. Community participation has also been reported to be essential to the revitalization process of the traditional market (Prastyawan and Isbandono, 2018) due to the fact that the people are expected to occupy and visit the market after completion. This process was not followed in the markets studied and this caused the traders to oppose and refuse to occupy the revitalized buildings (Sandharini and Marom, 2016). Moreover, the historical aspects also need to be considered due to the fact that the shape of historical buildings, especially heritage buildings, cannot be changed to avoid eliminating their historical value. It is, however, possible for the government to improve infrastructures, environment, and plan more conveniences for the users through the revitalization programs without neglecting the value of conservation and sustainability (Darmawan et al., 2015). The physical and non-physical elements are expected to be linked together in time to revive the market in order to gradually maintain the traditional markets' sustainability (Hermawan et al., 2018).

4. Conclusion

The Bulu and Peterongan markets experienced a significant impact of the revitalization program with the physical changes observed to be affecting the non-physical aspects. One of the visible impacts is the change in the market's shape which makes the users uncomfortable with the activities within the market and this was found to be due to the non-involvement of the users in the planning process which led to the implementation of a design which is not in line with their expectations and needs. Moreover, the SWOT Analysis showed both markets have more weaknesses than strengths and the same was also observed with the opportunities and threats. Several strategies are also recommended to maintain sustainability in both markets after the revitalization and of these is the evaluation of the users' satisfaction and use the response to improve the market in line

with their expectations and needs. This is expected to increase the interest of the people to trade and shop in the revitalized traditional markets. It was also recommended that the program should be implemented and run optimally to improve competitiveness in order to maintain the sustainability of the markets through the sustenance of the four pillars of sustainable development.

It was discovered that the revitalization programs were expected to restore the liveability of the traditional markets but the reality is the opposite and this was majorly due to the non-inclusion of the indigenous people of Semarang in the planning process. These people understand the history and conditions of the traditional markets and observed their expectations are not satisfied due to the elimination of the market building's history after the revitalization. Therefore, governments and stakeholders need to understand a building or region's historical value before revitalization. Moreover, the findings also contribute to previous studies on conservation and sustainability development which are necessary considering the current transitional age where history is no more very important. A virtuous generation, however, needs to continually maintain historical value in whatever form, such as buildings, due to the inappropriateness of revitalization programs to eliminate local wisdom (Fraser et al., 2002). It is possible to use this research as a bridge for further studies due to the possibility of variations in case studies but the strategies recommended may not be applicable in other case studies elsewhere or the future. Therefore, several shortcomings observed in this research need to be addressed in further studies related to the formulation of more optimal and effective strategies to maintain the sustainability of traditional markets.

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A mixed method study on recognizing the areas of influence by urban planners in fostering social interactions in public spaces: evidence from Iran

Keywords: *Social interactions, Public spaces, Iran, SEM, Mixed method*

Parole chiave: *Interazioni sociali, Spazi Pubblici, Iran, SEM, Mixed method*

JEL codes: *C2*, *H1*, *H7*, *R5*

Due to the negative consequences of the rapid growth of urbanization in Iran, public spaces have suffered a lot of damage in recent years. Public spaces, which are generally areas for the formation of social interactions, have distanced themselves from their original concept in recent years in Iran. The main objective of this study is to investigate the promotion of social interaction in Iranian public spaces through urban planning interventions. Data used in this study were obtained through semi-structured interviews with practitioners and researchers in urban planning and questionnaire. Thematic analysis was used to analyze the interviews and the findings of the quantitative section were analyzed through the structural equation modeling (SEM) approach in Smart PLS 3. Our findings show that promoting social interactions in public spaces requires intervention in three pillars: the built environment, urban management and citizens' demanding approach.

1. Introduction

Air pollution can seriously threaten human life. A recent estimate (Lelieveld et al., 2019) reports 800,000 people prematurely dying in Europe as a consequence of air pollution. According to the same research, the average European citizen loses two years of life due to the breathing of polluted air. In addition, the geographical concentration of deaths caused by the spreading of the COVID-19 pandemic has brought researchers around the world to investigate the potential impact of air pollution of COVID-19 related morbidity and mortality, and the results suggest that the most polluted cities have experienced relatively higher death rates (Coker et al., 2020; Cole et al., 2020; Conticini et al., 2020; Oygen, 2020).

Cities are where the consequences of air pollution are most severe because air quality is the lowest due to transport and residential emissions (European Environment Agency, 2019) and the exposure is the highest. Cities are now home to more than half the world's population, and that share is projected to increase up to 68% by 2050, with 2.5 billion people moving to urban areas (UN DESA, 2019).

The disproportionate distribution of the activities and employment on the one hand and the empiric policies adopted by state managers on the other hand in third world countries have made metropolises become the main centers of income and employment (Rafiee et al., 2009). A complicated situation that has caused a series of problems, all of which originate in metropolitan areas (Sarvestani et al., 2011). Recent developments in urbanization and the problems arising from them have caused ur-

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ban public spaces to be more significantly exposed to the adverse effects of urban development (Tayyebi et al., 2011). Physical development has exposed cities to congestion, traffic jams, reduction of recreational space, reduction of open spaces, and lack of livability. The access difficulties and traffic problems, overlapping between inconsistent activities, and extra dependency on vehicle activities city centers, are common issues of almost all developing countries such as Iran (Dadras et al., 2015).

Moreover, in the absence of efficient urban management, the physical expansion of cities and their transformation into the main centers of employment and income has led to the emergence of many economic, social and environmental problems, for example the loss of environmental capital, declining groundwater levels are the main environmental consequences of this rampant growth, while the formation of large socioeconomic class gaps along with dilapidated structures and the formation of informal settlements can be the main socio-economic of such consequences (Dadashpoor et al., 2019). In response to this unbridled growth, various theories and programs have been proposed by researchers and urban planners, from which the concept of sustainable development is amongst the most important one (Bihamta et al., 2015). Sustainable development draws our attention to the fact that merely physical development is wasteful without considering the social and economic consequences (Tayyebi et al., 2011b). One of the main areas of sustainable development is the concept of social impacts. Social sustainability is a clear emphasis on the social nature of residents that is often overlooked in the physical development of metropolises. Resulted from such emphasis, we have witnessed the emergence of various movements such as pedestrianisation and re-emphasis on paying attention to the social needs of metropolitan residents in previous decades. Because residents are social being and have social needs.

Public spaces play a key role in promoting social interaction (SI) in today's cities (Dadashpoor et al., 2019).The physical expansion of cities along with the uncontrolled migration to big cities has made the role of public spaces in the big cities of the world more than in recent years (Dadashpoor and Nateghi, 2017). Public spaces are a good place to experience a sense of solidarity, collective action and participation due to the facilities they provide to citizens (Dezhkam et al., 2014). It is in public spaces that citizens repeat civic behaviors and implement the concept of citizenship by forming new social groups. Given the importance of public spaces in the lives of citizens, returning collective activities and vitality to public spaces is one of the goals of urban planners and designers (Sakieh et al., 2015)

Studies of global experiences about public spaces reflect the fact that a public space does not simply mean a place where cars are not allowed in (Moein et al., 2018). In fact, a real public space has capabilities and characteristics that give citizens the opportunity to be present and help them to stay in space and get involved in group activities (Arsanjani et al., 2013). Such a public space requires various characteristics such as being inviting, responsive and democratic. As a result, if our definition of public space is merely an open space with green space, our project is undoubtedly lost

Conflict in the use of public spaces in Iran between new generation and the government is of great importance for social activists and urban planners (Shah-

raki et al., 2011). The new generation in Iranian society has different values and standards than those of government and Iranian cities are witnessing a huge change in cultural values and space consumption. Cities in general and public spaces in particular are witnessing these changes, and therefore reading the type of behavior of the young generation in public spaces and the reactions of the government well expresses these conflicts best (Asgarian et al., 2018). In recent years, these conflicts have entered new phases. The adoption of laws such as the ban on urban nightlife by municipalities and the prohibition of services by restaurants and cafes after the last hours of the night and the intense desire of the young generation to nightlife is a good example of such conflicts. Public spaces in Iran today are under the control of the municipality (state), and the municipality, as a symbol of governing power, designs and plans public spaces based on its interests and desires (Dadashpoor and Nateghi, 2017).In such a situation, the role of an urban planner and designer is nothing more than legitimizing the goals of government organizations such as the municipality. Urban planners, by preparing intervention plans, induce more and more government institutions in the urban space.as if they either work in the public sector, such as municipalities, or in the private sector such as consulting firms, preparing urban development plans and in both cases, urban planners are nothing more than a scientific tool in the hands of a powerful government (Shafizadeh-Moghadam et al., 2021). As a result, if the conflict between how the young generation wants to use space and the way the government prefers, is to be resolved by urban planners, it needs to change the roles that planners have already accepted and displayed

In this study, our goal is to identify areas where urban planners can increase the publicity of public spaces through intervention and planning. By publicity we mean the qualities by which an urban space can foster social interactions among users. In the following, while examining the literature review of public spaces and social interactions, we review all the articles published on this topic in recent years to determine the main areas of study investigated by other researchers and their findings. Then, while explaining in detail the methodology used, we introduce the case study and then present the findings extensively.

2. Research background

Everybody accepts that public space is significant, but the reason needs more investigation (Anderson, 2019). We realize that a high quality public space is the establishment of a harmonic society (Kärrholm and Wirdelöv, 2019). The social needs of citizens are met in public spaces (Aram et al., 2019). The best public spaces cultivate a feeling of solidarity among residents. Public spaces give citizens the opportunity for cooperation and collaboration together (Franco, 2020). It is in public spaces that the concept of citizenship becomes concrete, and citizens can move into new social groups beyond the existing invisible economic boundaries (Hopkins, 2019). It is in a public space that citizens find leisure opportunities and identify through interaction with each other (Johnston et al., 2020). Urban spaces give citizens the opportunity to

experience higher social and individual values and to recognize their place through interaction with each other (Liempt and Aalst, 2015). If we look at the services that the city provides to the citizens from the angle of the Maslow pyramid, then we can consider public spaces at the top of the pyramid (Padawangi, 2013). This perception is due to the fact that the function of public spaces is not to meet the basic needs of citizens (Kang et al., 2019), but public space helps citizens to be something more than passive citizens. So we conclude that public spaces are places for social interaction (Latham and Layton, 2019). Recent studies (Marques et al., 2020, Mondada, 2019, Qian, 2020, Vlibeigi et al., 2020, Zhang, 2020) have shown that a space formation is not a spontaneous process, but the product of the interaction and confrontation of different forces that interact with each other at different levels (Saha, 2020). Thus, the formation of public space is influenced by the various forces which determine the social capability of that public space (Ujang et al., 2018). In this study, our goal is to identify the components that affect the formation of social interactions in public spaces. Various studies have been conducted on the relationship between public spaces and social interactions. A review of these articles confirms that most of the research tried to address following issues:

1. To identify the challenges of fostering the level of social interaction in public spaces.
2. To identify the different and potential types that urban interactions may take place in public spaces.
3. And finally identifying the consequences of the enhancing social interactions in public spaces at different levels.

To show the leading challenges in improving the level of social interactions Hornecker and Buur (2006) suggest a framework that centers on the intertwining of the physical and the social, and provides concepts and perspectives for considering the social aspects of tangible interaction. In another study Wiesemann (2012) examines the way prejudices are formed and challenged by everyday experiences in public spaces. This study concludes that despite the facilitating role of public spaces in reducing racial tensions, the publicity of space in controversial cities is questionable. In this regard, Saha (2020) addresses the challenges of youth and the elderly engagement in public spaces. This study highlights the importance of edges and public civic activities in fostering interaction among younger generations. The findings of this study confirm that the unparalleled needs of different generations in public space lead to dissimilar consumption of space and thus the formation of a kind of conflict.

The second spectrum of research focuses on different forms of social interaction in public spaces. These studies address how and in what ways social interactions can occur in public space, and basically in relation to social interactions, what places can be public space. Hampton and Gupta (2008) researched the community and social interaction in the wireless cities and Wi-Fi use in public and semi-public spaces. This research revels differing strikingly uses for wireless internet and competing consequences for the society. This study deals with the role of social media in public spaces and claims that in the future, cyberspace will have a greater share of social interactions in public spaces.

Simões Aelbrecht (2016) researched the informal public spaces (referred to the fourth place) as the contemporary public settings for informal social interaction among strangers. This paper considers the fourth places as a novel category in informal social settings along with the third places (old public spaces such as streets and parks). The findings of this study states that more informal spaces built on a human scale that encourage friendly activities such as getting involved in informal group activities will replace traditional public spaces such as parks and streets in the distant future. Accordingly, the main tendency in public spaces will be towards informal behaviors and relationships. However, the role of traditional spaces such as empty parks can still not be overlooked because in metropolitan areas, public parks still play an important role in promoting local identity. In this regards, Moulay et al. (2019) researched the role of neighborhood parks in fostering social interaction and social sustainability. The findings highlight the vital role of legibility in the planning and design of public spaces for encouraging residents to stay longer in public spaces and accordingly achieving social sustainability. Social interactions in public spaces, however, are not just activities in an urban space, but depending on the ability of an urban space, another range of activities can attract citizens. In this regard, Kang et al. (2019) conclude that re-reading the historical and identity values of a space can be an incentive to attract visitors to the public spaces. As a result, social interactions cover a wide range of activities from generic activities such as playing and eating to specialized functions such as visiting historical architecture (Cerreta et al., 2010).

The third category of studies on the relationship between public space and social interactions is related to the consequences of this interaction. Research shows that the formation of social interactions in public spaces has different effects at different levels. Improving the level of belonging to the city, increasing the level of social capital, social solidarity, social sustainability and better urban management are all among these consequences. In this regard, for example Cattell et al. (2008) researched mingling, observing, and lingering: Everyday public spaces and their implications for well-being and social relations. These researchers support that social interaction in spaces result in relief from everyday life pressure, People's tolerance also increases and it is in such an atmosphere that social ties between people are strengthened and the sense of unity and oneness among citizens' increases. In another effort, Rubegni et al. (2011) investigated the role of using large public spaces in increasing social interaction among strangers. These researchers conclude that gesture-based interfaces support the natural diffusion of social interaction patterns in public spaces through the observe-and-learn model, and that sensory-motor patterns can aid social interaction in public, as they act as conversation starters between both strangers and acquaintances. Francis et al. (2012) support that the perceived quality of neighborhood public open spaces and shops are associated with sense of community both significantly and positively. This relationship is unaffected by the rate at which people use these spaces. High quality public spaces are important settings for enhancing sense of community within newcomer residents.

Social cohesion is another product of social interaction in public spaces. According to Peters et al. (2010) suggest that public parks serve a vital locality where

every-day experiences are shared different groups of people. The design of a park, the location and citizen's image of the park in combination with the cultural characteristics of various ethnic groups provide a platform for intercultural interactions. Place attachment and commitment is also being triggered as one of the results on enhancing social interaction in public spaces. According to Ujang et al. (2018) the necessity of multi-functional spaces to show various forms of social interactions. They show that street has an important role to produce group activities. However, spaces for people to sit and stay remain sparse, and are mostly consumed by extended commercial use. With the expansion of commercialization of streets, opportunities for social interaction are limited. As a result, place attachment is strongly related to the significance of the places, commercial and tourism functions. The findings of this study show that participants in public spaces are more willing to interact with their acquaintances and family than strangers. In this regards the results of Aguiar et al. (2018) also confirm the positive role of social interaction in increasing place attachment. These researchers confirm that transFORM embodies our understanding of how a responsive, cyber-physical architecture can augment social relationship and increase place attachment.

As we have seen in this section, social interactions in public spaces is a target that takes place in many forms. A review of research in the field of public space and social interaction reveals a theoretical gap that this study seeks to address. In fact, what has not been researched so far is what planning interventions are needed to foster social interactions in public spaces and how urban planners can foster enhance interactions in public spaces. As a result, the question that this research answers is that: How can urban planning lead to an increase in the level of social interaction in public spaces?

3. Methodology

In this study a mixed method approach is used to gather and analyze data. The reason for using mixed-method is to use the opinions of experts as well as users of public space together. In fact, in the first step, we want to identify areas through which social interactions can be promoted in public spaces by planners through open interviews with experts who have related research background, and in the next step, our goal is to receive feedback from the users of our public space. In other words, the findings of the first part help us to theorize, while the findings of the questionnaire show us how generalizable our theories are.

In the first part of the study, I will interview experts in urban planning and urban design to find main areas of intervention that can foster social interaction and vitality in public spaces. At this stage we asked general questions to the interviewees and allowed them to determine the direction of the interview based on their theoretical and practical experiences. Experts were asked as follows:

1. How important do you think social interactions are in public spaces?
2. What do you think is the role of public spaces in promoting social interactions?

3. How can urban planners increase the level of social interaction in public spaces?

In the next section, the goal is to verify this model through a questionnaire. The data collection tool in this section is a questionnaire designed according to 5 scales Likert from strongly agrees to strongly disagree.

For data collection, in the first part, semi-structured interview is used. Totally 25 researchers and urban planners and urban designers who have visited 15 Khordaad pedestrian street are interviewed. Number of interviewees is determined according to saturation level. In qualitative research, unlike quantitative research, the number of samples is not a function of statistical formulas. Rather, because the goal is to describe the phenomenon, sampling usually continues until a general description of the phenomenon is obtained. This stage, in which the description of the phenomenon is almost complete, is called theoretical saturation. In a more precise sense, it should be said that the characteristics of a theoretical category or class have been saturated. This happens when no more data that causes the existing theory to be developed, modified, enlarged or added to the research is included. In this case, the new data entering the research does not change the existing classification or make a proposal for a new class, that is, in fact, according to Strauss and Corbin (1997), it is these categories that are saturated.

Interviewees included those researchers who have published related articles about social interactions and public spaces and practitioners who were involved in pedestrian project of 15 Khordaad Street. All interviews were conducted in late 2018 and 2019. All interviewees know this space for at least ten years and are well acquainted with this place. The interviews were semi-structured and during the interview, the interviewees were asked what factors shape your social interaction in our case and the role that urban planners and designers might have. The interviews continued until no new knowledge was generated and the data reached a theoretical saturation level. The interviews were written line by line and read over and over again. Thematic analysis is my approach to analyze qualitative data. Thematic analysis is a method of determining, analyzing, and expressing patterns (themes) within data (Gavin, 2008). This method at least organizes the data and describes it in detail (Braun and Clarke, 2012). But it can go beyond this and interpret different aspects of the research topic. The team analysis process begins when the analyst considers patterns of meaning and topics that are of potential interest (Braun and Clarke, 2014). This analysis involves a continuous flow between the data set and the encoded summaries, and the analysis of the data that is generated. Writing the analysis starts from the first step. There is generally no single way to start studying team analysis (Joffe, 2012).

All interviews are written and manually coded though open coding, axial coding and selective coding (Braun and Clarke, 2014). Findings of the qualitative section helped us to identify areas where urban planners can intervene to improve the level of social interaction. The generalizability of these findings was later confirmed by a questionnaire filled out by our case study public space user, visitors, marketers and residents. The objective of quantitative phase was to confirm/reject qualitative findings. In quantitative phase, both descriptive and inferential statistics have been used in the analysis of questionnaires. The structural equation

modeling (SEM) is used to measure the findings of the qualitative phase. The reason for using the SEM in this research is as follows.

First, basic statistical methods consider only a limited number of variables simultaneously that are incapable of dealing with more advanced and complex theories. Using a small number of variables to understand complex phenomena is constrained, while SEM allows the researcher to statistically model and test complex phenomena (Ullman and Bentler, 2003).

The second reason is about the high importance of the validity and reliability of observation and scores of measuring instruments. In particular, measurement error has become a major issue in all similar researches and methods but t in classical statistical methods, measurement error and statistical analysis of data are done separately (Bowen and Guo, 2011). When analyzing data statistically, SEM techniques also take into account measurement errors (Savalei and Bentler, 2010)

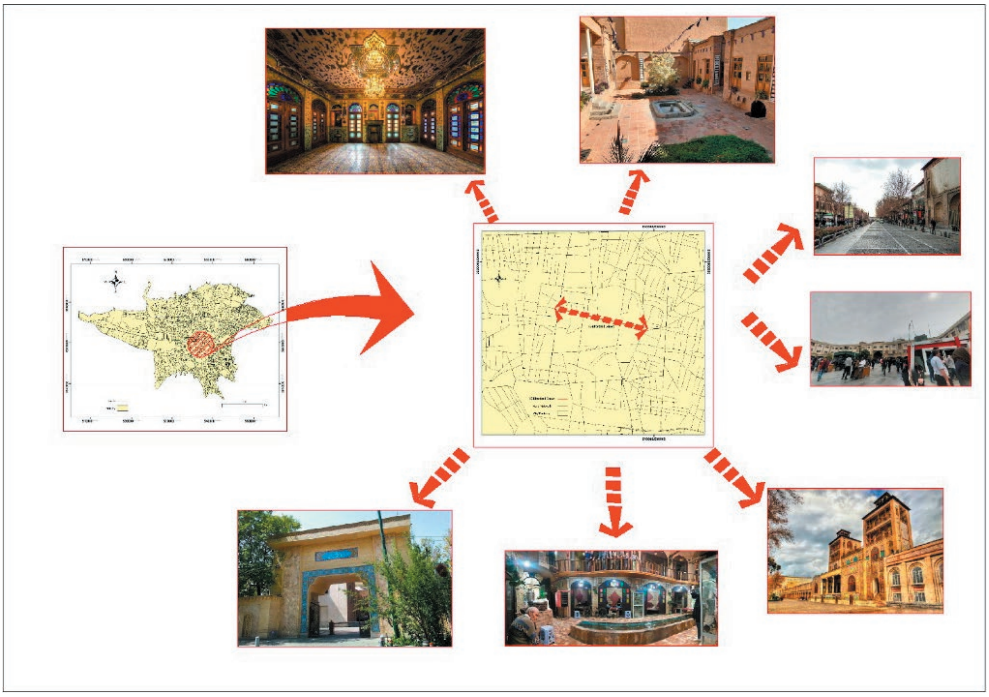
The third reason is especially related to the ability of SEM to analyze advanced theoretical structural models and finally, the simplicity of SEM is the last reason we have used this approach. With regard to above-mentioned reasons, to verify our qualitative findings, We employed SEM (Kline, 2015).The findings of both phases are presented below.

4. Case study

As we explained in the methodology section, in the qualitative stage, we interviewed urban planning and urban design experts and identified the main areas of intervention in order to increase social interaction. Our second goal was to find out how generalizable the findings of the interview were to the public. For this purpose, we turned the themes extracted from the interviews into questionnaires and made them available to the public. In this part, we wanted to give the questionnaires to those residents who visit a public space in Tehran at least once a week. As a result, we took all the questionnaires to one of the public spaces of Tehran and provided them to the users of that space. In choosing this public space, we had to choose among one of the many public spaces in Tehran that welcome the people. So to make sure the public space we choose is the best space possible, we chose the one that is most visited in a daily base according to Tehran municipality website i.e. 15 Khordaad Pedestrian Street.

Our case study consist of the users of 15 Khordaad Street in Tehran (Figure 1). This is a pedestrian site and most visited public space in Iran. A pedestrian street with old bazar Tehran, one palace of Pahlavi era, two historic plaza and old restaurants of Tehran along with all on the edges. This project is one of the most important pedestrianisation projects in Iran. Firstly, this site attracts a wide range of citizens regardless of their socioeconomic background, as a result, our participants cover virtually all socioeconomic groups of citizens. This site is also historically, economically and spatially important due to its location and history. There are many motivations on this site that attract different groups of people to this space on daily/weekly or monthly basis. The old and traditional bazaar of Tehran, which

Figure 1. 15 Khordaad pedestrian location in Tehran and Famous side spaces.



is two hundred years old, along with the traditional architecture of the city, along with the existence of historical squares and also the best restaurants in this site all around the pedestrian site in which cars are not allowed in, has made this space the most attractive public spaces for citizens.

5. Results

Our qualitative Findings support that the main areas of urban planning intervention in public spaces to improve the level of social interaction include three main areas. These three areas are intervention in the place characteristics (built environment), urban management and citizens' tendencies, respectively. Each of these includes the three tasks of an urban planner. Urban planning in this approach is no longer just a tool in the hands of urban authorities to legitimize the policies, but on the other hand, urban planner is more of a lawyer for the people who pursues democratic demands by mediating and negotiating with policy makers to maximize the public benefit from public projects. While another task of the urban planner is to raise the level of awareness of citizens about citizenship rights. Finally, the interventions of the city planner and designer through small and large urban projects cause better communication between citizens and the urban space.

As a result, the historical and social values of the urban spaces are identified, and people have the opportunity to recognize their historical memories, and more democratic spaces are formed. Consequently, increased urban vitality and social interaction within the research area is closely dependent on three main themes: place characteristics, urban management, and citizen approach.

For coding, the whole interview was written line by line. A semantic code was then assigned to each sentence or word that could potentially have a specific meaning. Semantic units were divided into sub-categories based on similarity, and finally sub-categories form the main categories (place characteristics, urban management and citizen tendencies). An example of coding is shown in the Table 1.

Sub-categories of place characteristics are sense of place, service provided on the site, functions within the place, environmental aspects, and identity of the place. Urban management includes six sub-categories which are: participation, space organization, services, sustainability, and control and traffic management. Finally User characteristic. This theme has three sub-categories which are: sense of user toward space, user's functional preferences, and user's collaborative preferences. Place characteristic invites and attracts citizens to come and stay in urban spaces. A place with appropriate environmental features such as shade, maintenance against harsh sunlight, and heavy rain has the minimum requirements for hosting citizens however these qualities are not enough. Each place has a specific identity. Identity is in close relation to the background and history of space. Our

Table 1. Example of coding in qualitative phase.

Part of interview	Semantic coding	Sub-categories	Main categories
Urban space planning should be such that citizens can recognize their collective memories in space. I mean these memories of the historical values that our urban spaces have in Tehran.	Revive collective memories through space planning	Sense of place	Place characteristics
Promoting social interactions in our public spaces requires not only design interventions but also a shift in urban management approach toward public spaces. Urban management should increase the level of public participation in those decisions that affects citizen's lives.	Increasing level of public participation in decisions that affects the built environment	Participation	Urban management
The formation of social interactions and democratic urban spaces requires the promotion of public awareness of citizenship rights. One of the tasks I envisage for urban planners is to be present in cyberspace and raise public awareness about it, which leads to a desire to participate in decision-making among the people.	Increasing citizen's intention for participation in urban management decisions	Collaborative preferences	Citizens

case is a historic and cultural one. Historic sites are places that hold memories and identity of a nation within themselves, therefore planners should advertise them within such public spaces. If we build a new modern shopping center in a historic site, in fact, we destroy all citizens' memories and their belongings to space.

One of our interviewees says:

"This traditional bazaar brings my childhood memories back to me, I always came here with old friends to relive my childhood memories" (I19).

Expressing the importance of the environmental features of the space, one of the participants says:

"If you pay attention, all the people are sitting under the trees in front of which the street theater is running" (I34).

Finally, every space should provide the required services for users. These services include restaurants, outdoor fast foods, edges for sitting, places for photo taking, and other innovative and creative services that seem interesting for users. If we want to invite people to public space, we should have a plan for them. Here is where we see the importance of place organization. Space should be organized. An unorganized space is not suitable for time spending.in our case, many interviewees believed that the presence of vendors decreases the quality of space and it is crystal clear that people don't like to spend time and have interaction in such places. A planned space gives the citizen the opportunity to get to know the sense of place and to identify with it. A historical space takes the citizen to history, while spaces designed with natural elements give the citizen the opportunity to experience naturalistic feelings. The identity of a place, sense of a place, functions, environmental features, and services of a place are all sub-categories of urban management. The importance of urban management is that the space is shaped through authorities decisions and later shape the citizens. Urban management approach toward space determines where to be active, where to be safe, where to be appropriate for the criminals, were to be attractive for couples and were to be inviting and this happens through land use planning and environmental planning. Accordingly, security is the product of the existence of active uses in a public space. Security, which is the basis for the presence and interaction of citizens, while many active spaces such as restaurants and cafes are not allowed to operate in the late hours of the night in Tehran. Now, to test the accuracy and generalizability of our qualitative findings, we will test them though questionnaire.

At the end of the qualitative section, we identified areas in which urban planners and designers can increase the level of social interaction in public spaces. This identification is based on interviews with experts, so our approach in the qualitative sector has been an elitist one. Now we want to see if these identified areas meet people's expectations. And whether there is a correlation between elite views and public expectations. As a result, each main-category and sub-category identified in the qualitative section is provided to the public in the form of a questionnaire. All participants had a history of using the public space we were looking for and visited it at least once a week. At first, all of them were explained that this is a scientific questionnaire and they expressed their desire to participate in this research. In designing the questions, an attempt was made to make the questions

Table 2. Reliability and validity of study structures.

Research Structure	No. of questions	Cronbach's alpha	CR index	AVE
Place characteristics	1-25	0.799	0.797	0.8203
Sense of place	1-5	0.787	0.782	0.5992
Physical features	7-10	0.793	0.790	0.8022
Environmental features	11-15	0.788	0.784	0.7866
Identity of place	16-19	0.859	0.853	0.8021
Functional features	20-24	0.821	0.829	0.8199
Urban management	25-54	0.833	0.839	0.5759
Participation	25-29	0.834	0.839	0.8022
Space organization	30-34	0.715	0.713	0.7846
Services	35-39	0.712	0.715	0.8420
Sustainability	40-44	0.805	0.809	0.5703
Control	45-49	0.899	0.898	0.8428
Traffic management	50-54	0.845	0.843	0.5807
User characteristics	55-69	0.788	0.789	0.5990
Collaborative preferences	55-59	0.875	0.878	0.6109
Functional preferences	60-64	0.885	0.884	0.6744
Sense of user	65-69	0.823	0.825	0.6630

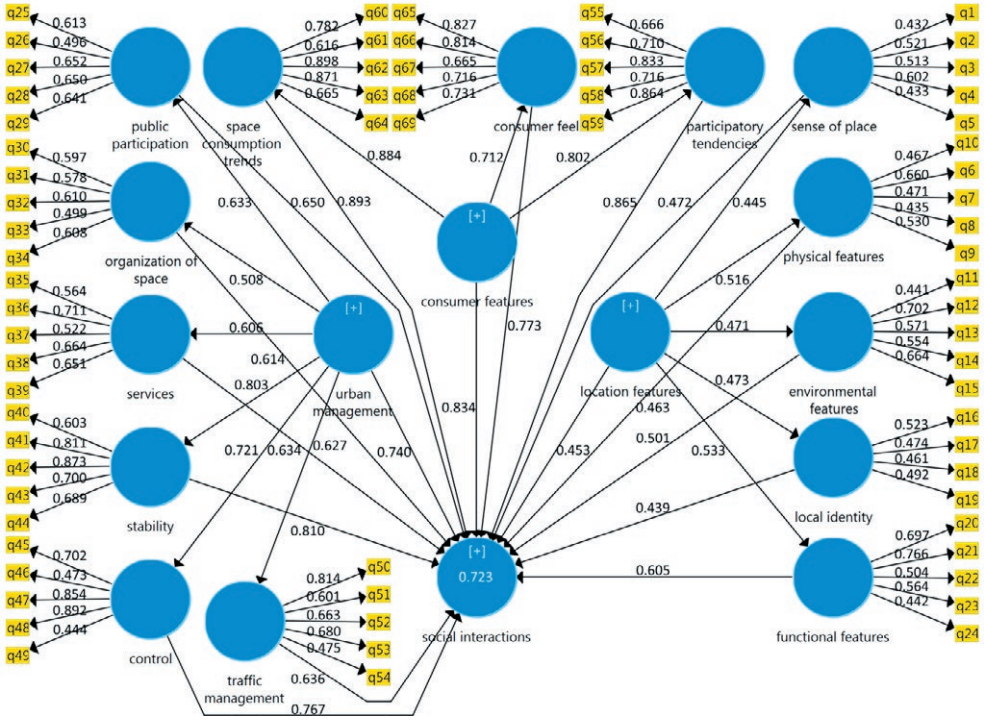
as simple and understandable as possible, and no specialized sentences were used that were incomprehensible to the general public. At the beginning of each questionnaire, while explaining the purpose of the study, participants' demographic information such as age, sex and education were asked.

Totally, 390 questionnaire are distributed in our sample from which 47.9% of respondents (184) were male and 52.1% (200) were female. In Partial Least Square (PLS), we test reliability of structures first. The most used index for establishing reliability is Cronbach's alpha and acceptable value for this index is at least 0.7 (Wong, 2013). According to Table 2, Cronbach's alpha is more than 0.7 for all structures which is favorable moreover, we also used average variance extracted (AVE) for estimating convergent validity. Minimal value for this index should be 0.5 for each structure (Ringle et al., 2014).

As it is shown in Table 2, all values for AVE are between 0.5703 and 0.8428. This shows that convergent validity for all structures are acceptable. As follows to assess the accuracy of model produced in qualitative phase, confirmatory factor analysis (CFA) is used. In CFA, it is necessary to connect all latent variables together.

In the standard estimation mode, the factor loads are shown. The larger the factor load is and the closer to one, that is, the better the observed variable (ques-

Figure 2. Factor loads of study constructs in standard mode.



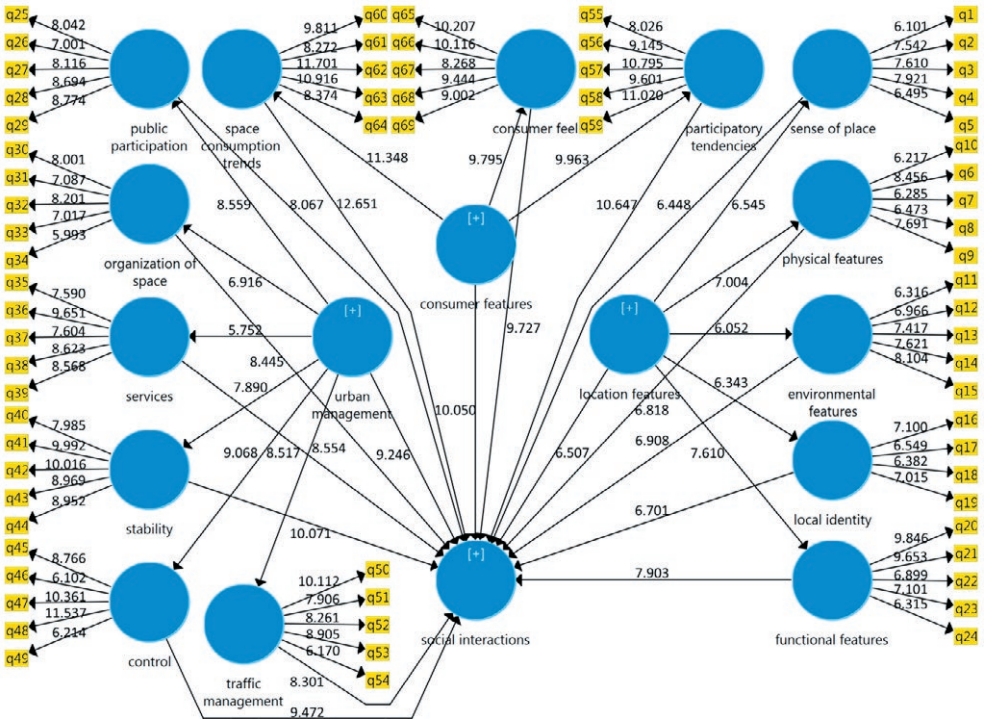
tion) can explain the latent or hidden variable. If the factor load is less than 0.3, a weak relationship is considered and ignored. A factor load between 0.3 and 0.6 is acceptable and if it is more than 0.6 it is very desirable. As shown in the Figure. 2, all factor loads are of accaptable value

The p-value associated with a 95% confidence level is 0.05. If T-value is between -1.96 and +1.96, p-value will be larger than 0.05, and we cannot reject our null hypothesis. In Figure 3, we see that the T-value for all of our structure are higher than 1.96. This confirms the accuracy of our model.

Now, for measuring the difference between the discrepancy between observed values and the values expected under the model, we used goodness of fit (GOF) index. GOF shows how much the model designed by the researcher is supported based on real data (Jung and Schindler, 2017). In other words, it shows the compatibility of the experimental findings with the theoretical findings. The theoretical finding in this study is what we obtained in qualitative phase while experimental findings refer to what we implemented based on data collected in quantitative phase. We calculated GOF through following formula:

$$GOF = \sqrt{\overline{Communalities} \times \overline{R^2}} \quad (1)$$

Figure 3. T-values for study structure.



In this formula, $\overline{Communalities}$ show shared values average for each structure and $\overline{R^2}$ shows average value of variance for endogens structures of model. In PLS three values i.e. 0.01, 0.25 and 0.36 are defined as weak, average, powerful for GOF respectively. In Table 3, GOF values are shown.

GOF value for this model is calculated as 0.36 which shows high goodness of fit. In the standard estimation mode, the factor loads are shown. The larger the factor load and the closer to one, that is, the better the observed variable (question) can explain the hidden variable. If the factor load is less than 0.3, a weak relationship is considered and ignored. A factor load between 0.3 and 0.6 is acceptable and if it is more than 0.6 it is very desirable.

In the case of significance, the Value must be greater than 1.96 or less than -1.96 in order for the relationship between each question and the desired variable to be significant (Wong, 2013). If the T Value for all questions is greater than 1.96, then the relationship between the questions and the variable is significant and therefore the questions are a good explanation for the variable (Sarstedt and Cheah, 2019). As follows, we According to Tables 4 and 5 construct T value and factor loads are also acceptable for our hypotheses. Moreover Correlation coefficient (R) is a statistical tool for determining the type and degree of relationship of one quantitative variable with another quantitative variable (Li and Deng, 2019). Cor-

Table 3. Assessment of GOF index.

Variable	Confirmed variance	Shared value	GOF
Sense of place	0.81	0.812	0.36
Physical features	0.82	0.820	
Environmental features	0.56	0.587	
Identity of place	0.74	0.805	
Functional features	0.78	0.788	
Urban management	0.81	0.797	
Participation	0.82	0.849	
Services	0.85	0.829	
Sustainability	0.53	0.550	
Control	0.74	0.800	
Traffic management	0.79	0.785	
Collaborative preferences	0.81	0.797	
Functional preferences	0.82	0.899	
Sense of user	0.84	0.820	

relation coefficient is one of the criteria used to determine the correlation between two variables. The correlation coefficient indicates the intensity of the relationship as well as the type of relationship (direct or inverse). This coefficient is between 1 and -1 and if there is no relationship between the two variables, it is equal to zero. These indexes measure the equality of our model.

Finally, in order to check the accuracy of our quantitative analysis, we use composite reliability and Cross validated redundancy along with average variance extracted. Composite reliability (sometimes called construct reliability) is a measure of internal consistency in scale items, much like Cronbach's alpha (Ringle et al., 2014). It can be thought of as being equal to the total amount of true score variance relative to the total scale score variance. Cross validated redundancy is the indirect prediction of the omitted data points of indicators of the dependent latent variables by the constructs that are predictor of the latent variables (Wong, 2013). It is a measure of the predictive relevance of the model in regard to the dependent latent variables. While AVE is a measure of the amount of variance that is captured by a construct in relation to the amount of variance due to measurement error (Chung et al., 2020). According to Table 5 all of these values are acceptable in our study.

6. Discussion

Public spaces in today's world have a special role in meeting the social needs of citizens. These spaces, due to the opportunities they provide to the citizens,

Table 4. Hypotheses testing in SEM.

Relation between variables	T Value	R	Factor load	Result
place characteristics and SI	6.507	0.453	0.453	Supported
Sense of place and SI	7.448	0.472	0.472	Supported
Physical features and SI	0.618	0.463	0.463	Supported
Environmental features and SI	6.908	0.501	0.501	Supported
Identity of place and SI	6.701	0.439	0.439	Supported
Functional features and SI	7.903	0.605	0.605	Supported
Urban management and SI	9.246	0.740	0.740	Supported
Participation and SI	8.067	0.750	0.650	Supported
Space organization and SI	8.445	0.614	0.614	Supported
services and SI	8.517	0.734	0.634	Supported
sustainability and SI	10.071	0.810	0.810	Supported
control and SI	9.472	0.767	0.767	Supported
Traffic management and SI	8.301	0.636	0.636	Supported
User characteristics and SI	10.050	0.834	0.834	Supported
Functional preferences and SI	12.651	0.893	0.893	Supported
Sense of user and SI	9.727	0.773	0.773	Supported
Collaborative preferences and SI	10.647	0.865	0.865	Supported

Table 5. Model quality criterions and the level of acceptance in PLS.

Study variables	Model quality Criterion		
	Cross validated redundancy (0 =<)	Composite Reliability (0.7 <)	Average Variances Extracted (0.5 <)
Place characteristics and Social interaction	0.003	0,825	0.631
	0.000	0.870	0.645
Urban management and social interaction	0.005	0.843	0.585
	0.001	0.822	0.573

meet the needs that the home and work environment are unable to meet. As a result, a public space is an important part of a city's social life that ensures its social sustainability. Such an environment, given the capabilities and opportunities

it provides to citizens, increases social solidarity and social capital and creates a strong belt against the damage of metropolitan life.

This research was an attempt to recognize the role of urban planners in production of urban spaces and the role that planners can play in improving the level of social interaction. This study investigates the components and characteristics that urban planners and designers should pay special attention to in city plans for public spaces in order to contribute to the social sustainability of cities. In the first place, this research sought to expand the existing theoretical literature in the field of public spaces and social interactions and to increase the boundaries of knowledge. As we have shown in our research background, the question of what realms planners can use to intervene to improve the level of social interaction has not been studied in a comprehensive manner. As a result, the findings of this study can be useful for both designers and urban planners as well as managers and practitioners.

Here, however, it is necessary to pay special attention to some limitations. In Iranian context and with the limitation of laws and principles, we know that an urban planner or designer has a lot of problems when planning a public space. For example, in the case of the 15 Khordaad pedestrian space, as we know, the domination of the government over the space production institutions makes the task of planners difficult to shape the urban space toward the desired form. Urban plans are usually regulated by a lot of manipulation of managers and upstream institutions and expert considerations form a small part of the space.

The domination of political powers on all space production manners results in a monopoly of space in which space turns into an area for advertising government values rather than a platform to observe the will of public. Many of the rights mentioned under the planned interventions in this study are not officially recognized by the governing body, including the rights of gender heterosexuality and any demand that runs counter to government values may not be available in public. Accordingly, one can claim that the majority of public spaces within such limitations are not democratic and a nondemocratic space can never be public.

In addition, issues such as nightlife that contradicts government law cannot be put on the agenda by planners. Government policy on space is so strict and firm; "space is a powerful stream to advertise my value". Such attitudes clearly show that the publicity of public spaces in Iran is still far from its ideal definition, and public spaces are still point of contention between people and governments. This conflict and contradiction makes public spaces an arena for expressing political protests which we witnessed in previous years.

It seems that in such tensional situation, the task of urban planners should be to stay away from government institutions and play a facilitating and mediating role between the people and the government. Moving towards more participatory practices and planning based on public will and needs is actually what this study sought to support. Our aim in using a mixed-method was to show that elitist ideas and theories cannot work without public approval, and that the basis of any idea about space is illegitimate until it is approved by the public court. According to our findings, our suggestion to other researchers is to research the following topics:

1. Identify the challenges of promoting spatial democracies in public spaces due to the conflict between government values and beliefs of social groups and develop operational strategies.
2. Evaluate the role of urban planners in resolving the conflict between the nation and the government at the urban level and turning the urban space into an arena for public activities.

7. Conclusion

The purpose of this article was to identify areas where urban planners and designers can improve the level of social interaction in urban spaces through intervention. Our findings, if the qualitative and quantitative phases in this study were examined in detail, show that these areas include spatial characteristics, urban management and citizenship tendencies. As a result, we know that these three areas involve changes that affect the role of the urban planner.

First of all, the city planner role is now in the hands of the city principles as an employee. They design the space according to the demands of the city managers and authorities. In other words, an urban planner or designer tries to put a scientifically and legitimately cover on the demands of city managers. Such an approach is not able to meet the social and civic needs of residents, and the result of this approach is nothing but the continuation of the status quo. However, our findings more than anything else confirm the fact that the urban planners should change the direction and work in a new format and play the role of advisor and mediator between people and managers. In this new paradigm, an urban planner must be able to notify citizens and make them aware of their rights and benefits from urban life.

Planners must negotiate and mediate with city managers to change their approach to the issue of space production and make them support the idea that the social values of urban space are no less than economic values. Unfortunately, what we have witnessed in recent years regarding the production processes of space in Iran is that space has become a commodity more than ever, and as a result, the decisions that are made about it have an economic flavor. It is also necessary for urban planners to recognize such importance in designing process to shape the spaces in a way to increase social interaction. They should focus in designing place to preserve the historical and traditional values of the space, and to recognize the identity values in order to improve the involvement of citizens in the urban space.

Our findings in this study are similar to those Fusco Girard and Nijkamp (1997) and Cerreta et al. (2010) and confirm their findings. Our proposal is to change the roles that city planners have to play, and to move the role of the planner out of a legitimate tool for urban management decisions and to turn them into a mediator and negotiator. Our research shows that in order to foster social interaction through urban planning, planners must take on new roles at different levels. These three levels include citizenship level, physical level and managerial level. At the managerial level, the planner should be able to encourage city au-

thorities to be more participatory, sustainable and accountable through mediation and advocacy planning. The urban planner should ask for more participatory and responsive methods on the municipal agenda through negotiation with managers and raising citizens' awareness. This is in fact an attempt to move from urban management to urban governance, where city managers make more participatory decisions, are more accountable, and are more transparent. This idea brings the city closer to what the citizens want. The second level of intervention of urban planners is related to the built environment. In this study, we used the term place characteristics because we believe that every built space has unique features and the task of the urban planner is to introduce these features to the citizens. Public spaces actually contain historic values that has been passed down from previous generations to the present day. As a result, social interactions in an urban space require proper identification and communication with space, and without recognizing these values, citizens in urban spaces feel alienated. The third area in which an urban planner must change role is related to citizens. Undoubtedly, social interactions require more interactive citizens who are aware of their citizenship rights and intend to participate and play a role in urban projects. Urban planners must come out of their offices and keep citizens aware of their forgotten rights through different Information networks.

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Circular economy and cultural heritage conservation: a proposal for integrating Level(s) evaluation tool

The paradigm shift towards a more humanistic and ecological paradigm evoked by United Nations and the Green Deal is increasingly required in this period of growing unsustainability, especially during ongoing COVID-19 pandemic. The challenge today is to reduce poverty and inequalities, while preserving the vitality of natural ecosystems and ensuring inclusive economic growth and wellbeing, both now and in the future, thus including future generations. To this end, new models for city development and new tools for operationalizing them are necessary. This paper is focused on the circular economy model and, in particular, on the functional reuse of cultural heritage as the entry point for triggering circular processes in the cities. The attention is focused on the evaluation tools and a methodological proposal is presented starting from the Level(s) tool (developed by European Commission) for assessing the multidimensional impacts of cultural heritage functional reuse projects in the circular economy perspective.

1. Introduction

The paradigm shift towards a more humanistic and ecological paradigm evoked by United Nations (§§ 15, 24, 25 of the New Urban Agenda) (United Nations, 2016) and by the European Commission (in the Green Deal) (European Commission, 2019c) is increasingly required in this period of growing unsustainability. Furthermore, the health emergency due to the COVID-19 confirmed (and is still confirming) the need to move towards this new paradigm, requiring a new balance between natural and man-made ecosystems. It has highlighted that "people and nature are interlinked" and thus the necessity to "resew" the "humanity's broken relationship with nature" (World Wide Fund for Nature WWF, 2020).

The humanistic dimension, in particular, is related to human wellbeing, health and living conditions, issues that in this period of health emergency due to COVID-19 are even more at the centre of international debates.

The crisis due to the pandemic has also demonstrated that the ecological, economic and social dimensions are interconnected and dividing them has been a great mistake. This leads us to rethink the processes of the current economy, linking them more closely to those of ecology and society. People's health has to be also interrelated with the health of the ecosystem and the "health" of the economy (that is an economy characterized by a positive evolutionary dynamic able to generate and/or regenerate, and conserve value over time).

The pandemic due to COVID-19 has produced negative impacts not only in terms of disease and illness but, as highlighted by the General Director of WHO,

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it has revealed today's inequalities, injustices and contradictions, highlighting strengths and vulnerabilities of our society (World Health Organization WHO, 2020b). The health and wellbeing of people depends also on factors and actions taken in sectors other than health (World Health Organization - WHO, 2018). In particular, the WHO recognizes many factors as "health determinants", including both natural biological factors (age, gender and ethnicity), and also behaviours and lifestyles, the physical and social environment, and access to health care and services (World Health Organization - WHO, 2019). So, there are different factors impacting the human health.

Cities cover 3% of the earth's surface and are home to more than half of the world's population (www.metabolic.nl), consume 78% of the world's energy, produce more than 60% of greenhouse gas emissions and 50% of global waste (UN-Habitat). Considering these data, it is clear that cities play a key role in achieving (or not) sustainable development and in fighting the challenges of our time (climate change, social inequality, environmental crisis, economic crisis). Many researches and studies are demonstrating that human activities are producing polluting substances (Coker et al., 2020; Ripple et al., 2019; Watts, 2019) that are contributing to climate changes with negative impacts on the air, land, sea, weakening also the immune system and making people prone to diseases (as that due to COVID-19 pandemic) (Wu et al., 2020). This necessary requires a new equilibrium (Zeleny, 2021) and a change of the way in which the human being lives, produces and consumes.

According to the documents of the United Nations (2015b, 2016), if well-planned and managed, the cities can contribute to achieve sustainable development. So, the urban organization and transformation model are recently increasingly investigated and questioned. Furthermore, cities today have also to be "reviewed" in the light of all the needs and changes in lifestyles arising from the COVID-19 pandemic.

The urban development strategies should place the human being at the centre of its processes, and thus his health and wellbeing, considering that the human right to the highest attainable standard of health is recognized by the Charter of the United Nations (United Nations, 1948).

The challenge today is to reduce poverty and inequalities, while preserving the vitality of natural ecosystems and ensuring inclusive economic growth and wellbeing, both now and in the future, thus including future generations. Considering the changes and challenges that cities are facing today, we are called and "forced" to transform and plan cities in a different way than we have done so far. So, new urban development models are required in order to implement the above paradigm shift and to move towards a more sustainable world.

Furthermore, some international organizations, such as UNESCO and ICOMOS, emphasize the crucial role that culture can play in the achievement of sustainable development (Hosagrahar et al., 2016; ICOMOS Climate Change and Heritage Working Group, 2019; Potts, 2016). The economic, social, cultural and environmental systems are not isolated, but they are "interconnected" (principle of interconnectedness (Throsby, 2008) and cultural heritage can represent the "glue"

among these different dimensions of sustainable development (Srakar and Vecco, 2016). Furthermore, the intersection between cultural heritage and climate change is recognized as an "urgent need" by ICOMOS, which highlights that cultural heritage is able to contribute to many Sustainable Development Goals and climate goals (ICOMOS Climate Change and Heritage Working Group, 2019). It recognizes that while the impacts of climate change on heritage are clear, the value of cultural heritage as an asset in the response is not.

The debate on urbanization and that on culture are intertwined, as also the UNESCO Recommendations highlighted (UNESCO, 2011). Furthermore, unlike the 2030 Agenda in which cultural heritage plays a marginal role, in the New Urban Agenda (NUA) cultural heritage is recognized in many points (i.e. points 10. 26, 38, 45, 60, 124) as an important factor for urban sustainable development. Culture is recognized as "a priority component of urban plans and strategies in the adoption of planning instruments, including master plans, zoning guidelines, building codes, coastal management policies, and strategic development policies that safeguard a diverse range of tangible and intangible cultural heritage and landscapes" (point 124). This makes it necessary to protect it from potential disruptive impacts of urban development. Culture "provide an important contribution to the sustainable development of cities, human settlements and citizens, empowering them to play an active and unique role in development initiatives" (point 10). It is considered as a key element in the humanization of cities and human settlements (point 26), playing an important role in "rehabilitating and revitalizing urban areas, and in strengthening social participation and the exercise of citizenship" (point 38). Furthermore, the role of cultural heritage in developing vibrant, sustainable, and inclusive urban economies is highlighted (point 45 and 60).

In the aforementioned paradigm shift and implementation of more sustainable urban development strategies, the circular economy can play a key role. In fact, it is the economy in which nature co-evolves with the city. At the same time, it is the economy of relationships: it helps generate and regenerate the relationships between human-beings and nature and between people, contributing to the creation of community. This relational dimension of the circular economy means that it contributes to the humanization of cities.

This paper is focused on the circular economy model and, in particular, on the functional reuse of cultural heritage as the entry point for triggering circular processes in the cities. In particular, here the attention is focused on the evaluation tools, which are essential to understand the effectiveness and efficiency of these new model and thus to assess the multidimensional impacts it produces. After an overview of the official documents by European Union about the above issues (§1.1), the circular economy model is introduced (§2) and cultural heritage is proposed as key element for triggering urban circular processes (§§2.1; 2.2). The attention is focused, in particular, on the evaluation tools (§3) and, starting from the Level(s) tool (by European Commission) (§3.1), a methodological proposal is presented for assessing the multidimensional impacts of cultural heritage functional reuse projects in the circular economy perspective (§§4, 5, 6).

1.1 How Europe is moving towards a more sustainable future

As a response to the challenges linked to climate changes, environmental degradation and socio-economic crisis, the European Union (EU) has approved a number of documents to promote measures to make our country more sustainable.

In particular, the EU recognizes the role that cities played in achieving a more sustainable future, as already highlighted by the United Nations in the 2030 Agenda and in the New Urban Agenda (United Nations, 2015b, 2016)

In 2016, the EU has adopted the principles, the commitments and the actions of the New Urban Agenda approving the Pact of Amsterdam (European Union, 2016). This document identifies 12 challenges which our cities are called to face. These challenges are linked to the following themes: inclusion, air quality, urban poverty, housing, circular economy, employment, adaptation to climate change, energy transition, sustainable land use and nature-based solutions, urban mobility, digital transition, innovative and responsible public procurement. Therefore, the Pact of Amsterdam considers, among its priorities, the "circular economy" and the "sustainable use of land and nature-based solutions" as two important themes that will guide actions of the EU Urban Agenda for a smart, sustainable and inclusive growth.

In December 2019, the European Commission (EC) approved the European Green Deal (European Commission, 2019c). It is a "new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use. It also aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. At the same time, this transition must be just and inclusive. It must put people first, and pay attention to the regions, industries and workers who will face the greatest challenges" (European Commission, 2019c).

In the context of contemporary cities, that are characterised by high density and increasing unsustainability, we are called to face many problems related to the redevelopment of the existing asset. In particular, in our cities, facing the challenges of our time (that is the ecological, social and economic crisis) is an issue more related to the sustainable use, management and transformation of the existing asset than to the planning of the new one. These are issues related to the energy efficiency, the efficient use of water and of construction materials. The redevelopment of the existing asset is also related to the use of biomass - natural capital, green roofs, urban greenery, etc.

In the Green Deal there is an explicit reference to the built heritage. In fact, the need to start a "wave of renovations" of existing public and private buildings is highlighted to face the double challenge of energy efficiency and affordability of energy (currently the annual renovation rate in the Member States varies only from 0.4% to 1.2%). Indeed, the construction, use and renovation of buildings absorb significant amount of energy and mineral resources (such as sand, gravel, concrete). Buildings are also responsible for 40% of energy consumption. In March

2020, the European Commission adopted a new Circular Economy Action Plan (European Commission, 2020) as one of the main building blocks of the European Green Deal. It provides "a future-oriented agenda for achieving a cleaner and more competitive Europe in co-creation with economic actors, consumers, citizens and civil society organisations". In this Communication

the construction sector is among the key product value chains highlighting the necessity to promote circularity principles throughout the lifecycle of buildings in order to reduce climate impacts. To this end, the Commission is launching a new comprehensive "Strategy for a Sustainable Built Environment" (European Parliament, 2021).

Efficient building renovation would reduce the amount of energy bills, as well as boosting the building sector, thus providing an opportunity to support small and medium-sized enterprises and employment at local level. The EC with the Green Deal is committed to strictly enforce the legislation on energy performance in the building sector. In addition, it is committed to reviewing the Construction Products Regulation which should ensure that all phases of the design of new and renovated buildings are in line with the needs of the circular economy and lead to an increasingly climate resilient asset.

The EC also plans to set up a platform that brings together different "players" in the construction sector to collaborate and jointly tackle the obstacles to restructuring. In addition, forms of financing are envisaged for interventions aimed at energy improvement of buildings and specific actions for the removal of regulatory constraints in the matter.

Among the built asset, there is a specific asset characterized by particular values (historic, aesthetic, intrinsic, etc.), that is cultural heritage. This unique subset of the building sector is "expression of the ways of living, developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values" (ICOMOS International Cultural Tourism Committee, 2002, p. 21). It assumes a key role in sustainable development of the city, in achieving simultaneously economic, ecological and social goals, in the circular economy perspective.

2. The circular economy and circular city models

The circular economy model, based on the principle that nothing in nature is waste and everything can become a resource (Ellen MacArthur Foundation, 2015), aims to make the principles of sustainable development operational. The circular economy can be defined as "the restructuring the industrial systems to support ecosystems through the adoption of methods to maximize the efficient use of resources by recycling and minimizing emissions and waste" (Preston, 2012). Reference is made to how resource flows can be closed (Chertow, 2000).

To date there are 114 definitions of circular economy existing in literature (Kirchherr et al., 2017). The United Nations have introduced in the Goal 12 of the 2030 Agenda (United Nations, 2015b) and in paragraphs 71-74 of the New Urban

Agenda (United Nations, 2016), the final document of the Habitat III conference (October 2016), the notion of circular economy as a general development model that produces impacts on natural and social systems, while generating economic wealth. This stimulates an indefinite extension of the life of the resources and their use values and promotes cooperation circuits between the different actors.

The circular economy model, not intended in a limited sense (that is strictly linked to waste management or the use of renewable energy sources) and therefore by expanding its field of action, can contribute to reduce the trade-off between environmental health, community health and economic "health". The circular economy model can be assumed as a way for re-integrating the economy into ecology (Fusco Girard, 2020). Therefore, among the measures to make the country more sustainable, the circular economy offers a great potential also thanks to this capacity.

In this perspective, the EC has adopted in 2015 a first package to support the EU transition towards the circular economy, including legislative proposals aimed at stimulating the European path towards this new model (European Commission, 2015). This is an essential contribution of the EU's efforts to develop a "sustainable, low-carbon, resource-efficient and competitive" economy. The aim of this package is to stimulate economic growth, making it more sustainable and competitive in the long term. It considers the circular economy as a mean for contributing to innovation, growth and job creation (European Commission, 2015).

In March 2019, the EC published a Communication on the implementation of the Action Plan for the circular economy adopted in 2015 (European Commission, 2019a). It presents the main results of the implementation of the Action Plan and outlines the open challenges for the implementation of the circular economy model. This Communication shows some results of the 54 actions (implemented or in progress) envisaged by the 2015 Action Plan. From 2012 to 2016 there was, for example, a 6% increase in workers employed in the circular economy (four million workers in 2016). As highlighted by the Communication, the circular model has also opened up new job opportunities, gave rise to new business models and developed new markets, both inside and outside the EU. In 2016, circular activities such as repair, reuse or recycling generated nearly 147 billion euros in added value, while investments amounted to around 17.5 billion euros.

As emerges from international documents on the topic of the circular economy and especially from some good practices at different scales in which the implementation of circular processes has produced benefits, the circular economy offers a great opportunity to make our country sustainable and increase urban productivity. There are several cities that are moving in this direction linked to the circular economy as development model. Some of these cities explicitly define themselves as "circular cities" and are elaborating reports in which they define and systematize their action plan for the transition towards this new model of city (Agenda Stad, 2015; Circle Economy, 2019; Gemeente Rotterdam, 2016; LWARB, 2017; Mairie de Paris, 2017). In Europe, the circular city model is more widespread than in Italy: London, Amsterdam, Rotterdam, Brussels, Paris are just a few examples (Fusco Girard and Nocca, 2019).

These cities recognize the importance of organizing the city system in analogy with natural systems and are undertaking a series of strategic actions aimed at transforming the processes that characterize cities from linear to circular. These actions concern various sectors, from construction to agri-food, to textiles, etc. However, the closure of cycles should not only refer to technical issues (as emerges from most of the good practices of circular cities), but should refer to a systemic change of the city, its organization, its economy, its community, its governance (Fusco Girard and Nocca, 2018).

Most of the circular processes can be implemented in the urban space through urban planning. The latter can promote the conditions of spatial proximity between resource flows, encourage multi-function and flexibility of buildings and spaces, support the greenery of the spaces, etc. representing the institutional tool able to change the organization of the city in a new one based on circular flows.

2.1 The circular economy model and cultural heritage

The entry points for the implementation of the circular economy model in cities can be various. As emerges from the case studies of circular cities, these are mainly linked to those production chains that include greater flows of resources in cities: food chain, construction sector, energy, etc. (Circle Economy, 2016a, 2016b; Gemeente Rotterdam, 2016; LWARB, 2017; Mairie de Paris, 2017). In fact, one of the first steps for the implementation of the circular city is the definition of its urban metabolism and the identification of resource flows.

However, one entry point that is not considered in any circular city and that can play a key role in the implementation of this model is cultural heritage, that can be a significant "cyclifier" (Fusco Girard et al., 2014) in triggering circular processes.

Although not formally expressed, many principles that characterize the circular economy model are also evoked in the UNESCO Recommendations of the Historic Urban Landscape (HUL). In fact, in the paragraph no.11 of the Recommendations the need for a productive and sustainable use of space resources is stressed. In the paragraph no.19 reference is made in particular to the efficient use of the environmental resources represented by water and energy and the second paragraph calls for a strategic vision that goes beyond the short term: it stresses the importance of a long-term vision, which is typical of the circular economy. In addition, HUL stresses (in the paragraph 24/d) the need for self-financing, i.e. self-regeneration of financial resources in order to preserve the regenerated heritage over time. Furthermore, paragraph no. 22 insists on the need for "harmonious" cooperation between different private and public actors. These are two typical characteristics of the circular economy model.

Today there are many abandoned and underused cultural heritage buildings because public administrations do not have enough resources to maintain them "alive", although cultural heritage is recognized as a driver of sustainable development (European Commission, 2014). Heritage buildings play a crucial role in

transferring cultural identity to future generations: conserving cultural heritage can be helpful to future generations to understand where they are coming from (Fusco Girard and Vecco, 2021; Mısırlısoy and Gunce, 2016).

City buildings can have a life span of up to hundreds of years. When a cultural building can no longer have its original function, it has to be adapted to new needs and identifying a new function is inevitable to preserve it. However, cultural heritage that no longer has its original use still has its historical, social and cultural values. Functional reuse is a strategy for preserving those values while adapting the function to the new community needs. According to the Leeuwarden Declaration, "new functions are thus brought together with heritage values in an active and meaningful dialogue" (Architects' Council of Europe - ACE, 2018). An appropriate new use for an abandoned or underutilized historic building needs to simultaneously both respect its intrinsic value and meet the needs of the local community, helping to improve its quality of life (Aigwi et al., 2020; Fusco Girard et al., 2019).

So, when heritage buildings are adopted to new functions, it is important preserve as much as possible the originality and architectural feature of the building (Mısırlısoy and Gunce, 2016), that is to identify the limit in the management of change. This new use has to be appropriate in terms of preserving its cultural significance, its intrinsic value (Fusco Girard, 1987; Fusco Girard and Vecco, 2019).

The restoration, rehabilitation and functional reuse of cultural heritage and cultural landscape are part of the circular economy processes. Here the attention is focused in particular on the functional reuse.

In the perspective of the circular economy, functional reuse is different from the one in the linear model, both in terms of design and in operational and management terms (Fusco Girard, 2020). The organization/management of a reused cultural asset should be interpreted in a way similar to the organizational structure of the nature and requires a particular attention to all dimensions and values included in cultural heritage. The issue of cultural heritage functional reuse in urban environment requires a transdisciplinary approach as it raises issues that cut across many disciplines (restoration, sociology, technology, etc.) (Foster and Saleh, 2021).

Both circular economy and the functional reuse of cultural heritage aim to prolong the lifetime of resources, that is the use values in an indefinite time. The functional reuse allows to extend the use values of cultural heritage, preserving its integrity and authenticity, so that it can continue to be enjoyed by both present and future generations. So, it can represent an important contribution in "decoupling growth from resource consumption"; cultural capital is preserved, regenerating values for many stakeholders.

The functional reuse has to be interpreted in a systemic logic: each spatial and functional transformation produces multidimensional impacts in environmental (link with the European Green Deal), economic, social and cultural terms. In addition, there are different values to keep at stake when dealing with cultural heritage. Functional reuse allow to bring back to life a dead heritage. It can be interpreted considering the centrality of the ecological dimension and thus considering this activity as source of environmental values (Fusco Girard, 2020). It represents

a valid alternative to the demolition and replacement or to the new construction, reducing energy consumption and waste production and, at the same time, also provides social benefits thanks to the revitalization of traditional landmarks and giving them new life (Conejos et al., 2011; Foster and Kreinin, 2020; Mısırlısoy and Gunce, 2016).

Furthermore, through the functional reuse of cultural heritage, a symbol of community is conserved "alive" (cultural benefits) and the construction of new assets – and the consequent use of other resources – is reduced (environmental benefits). Moreover, the functional reuse is able also to produce economic benefits (in terms of increase of productivity, touristic attractiveness, real estate values, etc.) and social benefits (in terms of employment, social relationships, etc.) (Conejos et al., 2011; Foster and Kreinin, 2020; Nocca, 2017; Sowinska-Heim, 2020). Therefore, it can produce multidimensional benefits in the perspective of the circular economy. It allows conserving all values of the cultural heritage, among which the use values and the intrinsic value. The multiple benefits of re-using built heritage (economic, environmental, social and cultural benefits) are highlighted also in the Leeuwarden Declaration (Architects' Council of Europe - ACE, 2018).

2.2 The multidimensional benefits of reuse of cultural heritage

In literature there are some authors that are highlighting the benefits from the reuse of cultural heritage. Circular economy in built environment is mainly still related to waste recycling and minimization. However, there are many researches highlighting the environmental benefits, although they are not widespread (Assefa and Ambler, 2017; Bullen and Love, 2010; Foster, 2020; Foster and Kreinin, 2020; Mahpour, 2018; Munarim and Ghisi, 2016; Pereira Roders and Van Oers, 2011).

One of the most recognized environmental benefits is that related to the "embodied energy", which is the "cumulative energy inputs that were required to construct the building initially" (Hammond and Jones, 2008) and "process/operational energy consumed during the building's use" (Cabeza et al., 2013). Historic buildings have a significant amount of embodied energy. It is strictly linked to environmental impacts as it is referred to the "energy expenditure associated with the extraction, transportation, processing, on-site assembly, and performance of materials, over their expected life cycle" (Gaspar and Santos, 2015).

By making buildings more energy efficient, there are avoided costs that can be invested in other ways, such as supporting creative activities related to heritage reuse.

Functional reuse of historic buildings promotes sustainable communities because it significantly reduces the use of building materials, energy consumption, and pollution (in terms of carbon dioxide emissions) produced from the construction process (Itard and Klunder, 2007); at the same time, it preserves the unique heritage features and cultural identity of the building (Boarin, 2016).

As previously mentioned, historic buildings have a great amount of embodied energy and thus reusing them helps conserve this energy. As also Foster and

Kreinin (2020) underline, although water and energy are common circular economy indicators, they emerge few times by the analysis they conducted on the literature review (168 journal articles from 2008 to 2017) of environmental impact indicators of cultural heritage buildings (from a circular economy perspective).

Functional reuse of a building could also contribute to changes in the amount of water used, such as increased demand due to increased occupancy or plumbing system upgrades. Although indicators related to water quantity are easier to measure, more emphasis in the literature is given to indicators related to water quality and eutrophication (Moraga et al., 2019). The emphasis on water efficiency related to the reuse of a building is little highlighted when dealing with environmental aspects, despite the global importance of the water issue. The low awareness that emerges related to water and rainwater recycling implies the need to undertake actions to increase awareness and culture related to water. Water saving programs linked for example to optimization and modification of consumption models are necessary.

In addition, functional reuse is also a way to reduce negative soil impacts from dust when compared to new construction activities (Aigwi et al., 2018; Bullen and Love, 2010).

Cultural heritage can represent an opportunity to face climate change and thus contributing to limit global warming to below 2 degrees, preferably to 1.5 degrees Celsius, compared to pre-industrial levels, as recommended in the Paris Agreement (ICOMOS Climate Change and Heritage Working Group, 2019; IPCC, 2019; United Nations, 2015a).

Although there are many studies highlighting the environmental benefits of the reuse of cultural heritage, many of them deal with the environmental impacts only from a narrative point of view, lacking in operational perspective, that is without identifying specific indicators and quantitative data. Even though often not addressed in operational terms, it is important to highlight a certain awareness among researchers regarding the link between the environmental issue and cultural heritage.

However, from an environmental perspective, heritage buildings extend the lifespan of buildings while preserving cultural values, reduce and avoid demolition waste, prevent the extraction of new materials, and provide opportunities to improve environmental quality through, for example, improving energy efficiency, expanding green spaces, and shifting from fossil fuels to renewable energy sources.

Sometimes regulatory requirements can limit the environmental performance of reused buildings (for example, in terms of acoustic and thermal insulation), resulting in lower performance than new buildings (Wilkinson et al., 2009). However, other benefits from reuse, such as social benefits, can balance these disadvantages (Aigwi et al., 2020; O'Donnell, 2004).

In addition, as most historic buildings usually do not promote passive environmental systems, functional reuse could represent an opportunity to test innovative technologies and new solutions for promoting sustainable development models.

Furthermore, the new use to be attributed to an abandoned or underutilized historic building should be able to stimulate a vibrant economy for the community

and produce a "profit" capable of self-sustaining it. This is a "circular process": the functional reuse is able to produce impacts that partially "come back" to cultural heritage itself (Fusco Girard and Nocca, 2019).

From an economic point of view, in most cases the reuse of heritage buildings can result cheaper and faster if compared to demolition and rebuild (Aigwi et al., 2018; Bullen and Love, 2011a; Douglas, 2006), except in cases in which total structural reconstruction of the building is required (Shipley et al., 2006).

In addition, redeveloping a heritage building rather than demolishing and rebuilding it often takes much less time, and this reduction in time can also means lower costs (Highfield and Gorse, 2009). The latter are also reduced because most of the structural components of the building that serve as raw materials are already on site and this reduces the duration of the work (Shipley et al., 2006).

Some studies also recognize that reusing cultural heritage produces positive impacts in terms of property values, both of the building itself and of the buildings in the surrounding area (Aigwi et al., 2020; Nocca, 2017). However, this increase in value sometimes can turn in an increase in housing cost and gentrification.

Sometimes regulatory requirements and structural complexities can reduce the economic and financial benefits of heritage reuse compared to new construction. Furthermore, in reuse, labor and material costs can often be higher (Bullen, 2007; Kohler and Yang, 2007).

If on the one hand functional reuse reduces the amount of materials to be used compared to demolition and reconstruction, thus reducing embodied energy and carbon dioxide emissions, on the other hand it should also be taken into account that existing buildings have more difficulty in achieving energy standards than new buildings (Baker et al., 2017; Ball, 2002; Bullen and Love, 2011b). Existing buildings could still be brought to a similar energy level as new buildings, for example compared to zero-emission buildings. However, this would result in a significant increase in costs.

However, this increase in costs can be balanced if, in addition to the economic dimension, also the dimensions related to other heritage values, such as social and cultural values, are taken into account. In fact, although reuse can sometimes be more expensive than demolition and reconstruction, it is "winner" from a cultural (Fusco Girard, 2020) and environmental (Foster, 2020) point of view. For example, Baker et al. (2017) explain how decision makers chose to implement a project to adapt and reuse the Fort Dunlop (United Kingdom) despite the fact that it was technically complex due to the physical condition of the building that it did not comply with certain regulations (such as fire safety). However, this choice of conservation was linked to the awareness that this heritage has a high importance for the local community that finds in it a symbol of its identity.

Furthermore, Aigwi et al. (2020) underline the importance to consider the multidimensional impacts of functional reuse projects. They elaborate a holistic performance-based framework to prioritise underutilised or abandoned cultural heritage buildings for functional reuse intervention. It is based on five main priority aspects: economic sustainability, built-heritage preservation, socio-cultural aspects, building usability, and regulatory.

3. Evaluation tools for the circular economy model

The implementation tools play a fundamental role in making the circular economy/city model operational. The focus here is in particular on the evaluation tools to assess and monitor the efficiency and effectiveness of the circular model, that is, to assess the impacts (positive and/or negative) of the projects and initiatives of the circular agenda.

Although interest in the circular economy model is growing, the debate around it remains more on a theoretical level, while the tools to implement it is still a fertile field of research (de Jesus and Mendonça, 2018; Foster, 2020; Fusco Girard and Nocca, 2019). Knowledge about how to implement this new model is still confusing and lacking. There are some studies on circular economy indicators in literature, but they are rather sectoral and do not include simultaneously all the key principles of the model.

In Europe, the sustainability of cultural buildings is driven by indicators mainly related to Life Cycle Analysis-based standards; environmental impact assessment; and green building certifications (Foster et al., 2020). However, a commonly recognized system of indicators for evaluating cultural heritage from a circular economy perspective, including simultaneously all the impacts related to environmental, social, economic, and cultural dimensions does not yet exist to date.

The decision-making process of cultural heritage reuse cannot be focused only on financial issue (on the basis of which reuse can often be more expensive than demolition and reconstruction). Given the particularity of the object of evaluation, other impacts (i.e. social, cultural, environmental), in addition to financial ones, need to be necessarily considered in the evaluation framework.

Less importance is often given to the socio-cultural impacts of reuse during decision-making processes (Aigwi et al., 2020; Bullen and Love, 2011b). Instead, to fully understand the convenience of a reuse project, its multidimensional impacts have to be considered.

The challenge is to identify the functional reuse solutions able to integrate the economy with the ecology and the human dimension. To do it, tools are necessary, from management to financial, to business, to evaluation tools.

The evaluation framework for circular economy projects should be based on two levels. On the one hand, it has to be able to capture the level of circularity of the project itself, while on the other hand it has to be able to capture the impacts that the implementation of such a project produces on the city.

An integrated evaluation framework for assessing new uses is fundamental to identify the satisfactory compromise solution (Simon, 1976) between conservation and transformation, that is between the logic of change and of permanence.

Foster et al. (2020) elaborate a Circular Environmental Impact Indicator Framework for assessing the reuse of cultural heritage, but focussing this framework only in the environmental dimension. This framework identifies environmental indicators that could be used for any "circular" renovation of existing buildings.

Baker et al. (2017), comparing five case studies, argue the decision-making process for choosing the demolition or adaptation of buildings. They analyze the

advantages and disadvantages of adaptation versus demolition. Benefits of adaptation include saving embodied energy and preserving heritage values. They state that demolition may be encouraged if the building is in poor physical condition or if there are difficulties in complying with building regulations, as this can increase the financial risk and overall cost of the project.

Foster (2020) develops a new comprehensive circular economy framework for the reuse of historic buildings to reduce environmental impacts. The framework, starting from the relevant literature about this issue, integrates methods and techniques from the construction literature that aim to reduce the environmental impacts of the life cycle of buildings based on a circular approach. This framework aims to be flexible and easy to understand in order to provide a guide both for technical and non-technical stakeholders. However, this rich and interesting framework is focused only on the environmental impacts.

Della Spina (2020) proposes an integrated evaluation model to assess and compare different scenarios of the potential reuse of some historical fortifications in Sicily (Southern Italy). Starting from focus groups with expert actors, she identifies a matrix of criteria and multidimensional impact indicators (3 criteria and 11 indicators) according to the systemic perspective of the landscape proposed in the HUL Recommendation by UNESCO (2011). A limited number of criteria and indicators has to be chosen otherwise the evaluation process becomes overly complex and less effective.

Sheata et al. (2015) propose a comprehensive assessment framework for evaluating the reuse projects of cultural heritage in Cairo, starting from the awareness that many of them did not report success also because they have been analysed from a singular perspective. The interdisciplinary nature of functional reuse of cultural heritage instead requires an integrated evaluation framework. They, in particular, identify many criteria divided into three main themes: building preservation, success of the new function and local community development. However, they have not associated specific indicators to these criteria.

As Aigwi et al. (2020) highlight, there are many indicators to assess the economic impacts of the projects of heritage building reuse. For example, they identify indicators related to employment (in terms of the creation of new businesses and new jobs), increased property values of surrounding buildings, and increased revenue from tourism activities related to the building under reuse.

The increase in economic value of reused buildings is also transferred over time to the surrounding buildings as an indirect spillover effect. In addition, among the indirect effects related to the reuse of cultural heritage there is also the potential increase in income from the growth of cultural tourism due to a greater attractiveness of the area (Gravagnuolo et al., 2017). Other economic benefits arising from the functional reuse of cultural heritage are related to new job opportunities related to the new function attributed to the asset, savings arising from the reuse of construction materials (Aigwi et al., 2018; Bullen and Love, 2010; Conejos et al., 2011) and savings due to the shorter working period because the structural elements are already existing (Douglas, 2006).

The historic environment and the economic activity are strictly linked considering the many economic activities that depend on it, take place within it and it

attracts (Historic England, 2019). Tangible cultural heritage secures thousands of jobs (European Spatial Planning Observation Network - ESPON, 2020). The historic rehabilitation is the activities producing more jobs for each $1 million of activity compared to other ones, as automobile manufacturing, computer manufacturing, air transportation, poultry processing, new construction (Rypkema and Hin, 2019).

The study conducted by Foster and Krenin (2020) highlights that the most widely used circular environmental impact indicators in the reuse of historic buildings are the embodied energy of building materials and CO2 emissions, both during the construction and the operation phase. The assessment of energy and greenhouse gas emissions is crucial to face the climate change that represents one of the main goals of decision-making processes related to construction sector. The assessment field of historic buildings today is strongly influenced by a number of both international and national evaluation and certification schemes, such as BREEAM and LEED certifications.

An evaluation tool that integrates the "traditional tools" – born and used in the field of linear economy – with tools characterized by a matrix linked to the circular economy model is certainly necessary. The role of evaluation is critical to show the differential benefits between the circular model and the linear model, that is to demonstrate that the benefits of the circular model overcome the costs. In fact, the benefits that the circular model produces are both tangible and intangible. Although implementing the circular economy model can have additional financial costs, these would be balanced by the benefits produced (throughout the life cycle of the building), considering these not only in economic terms, but also environmental, social and cultural.

The evaluation framework should be characterized by an iterative learning process through three stages: evaluation, monitoring and adaptation. In fact, considering that cities, and therefore its elements (as cultural assets), evolve and transform over time, a "dynamic" evaluation framework is necessary to be able to grasp the impacts in changing conditions in the short, medium and long term and to continuously monitor to understand if you are moving in the right direction. In this way, if the results are not as expected, interventions can be reviewed and adapted to better address the challenges. This could lead to several feedback loops over time (dynamic aspect of evaluation). The discipline of evaluations helps not only to compare the alternatives already given, but also to produce new solutions by aiming at a positive sum game in which all subjects obtain benefits (Fusco Girard et al., 1989).

The starting point for the proposed evaluation framework is the Level(s) as it is the only officially recognized evaluation tool to date. However, it needs to be revised and adapted to be used for cultural buildings.

3.1 Level(s) tool

In 2018, the European Commission has identified a first framework for assessing the circular economy by identifying a series of indicators divided into four cat-

egories: production and consumption, waste management, secondary raw materials, competitiveness and innovation (European Commission, 2018). These indicators certainly represent a starting point, but not a sufficient framework to evaluate and monitor the complex framework of the circular economy that involves different sectors, different actors and different "flows".

The only more detailed and specific official evaluation tool adopted by the European Commission (in collaboration with various stakeholders, including different producers, associations and organizations) in the context of the circular economy is the Level(s), a tool referring only to the construction sector. Level(s) provides a set of indicators to assess the environmental performance of office and residential buildings, considering impacts throughout its life cycle. It is not currently mandatory, but can be adopted on a voluntary basis.

The construction sector is one of the sectors that consumes the largest amount of resources: it represents half of all extracted materials, half of total energy consumption, one third of water consumption and one third of waste production (European Commission, 2017a). It therefore represents a key objective for the European Commission's policies on sustainability and circular economy.

Since the testing phase began (2018), the Level(s) tool has been applied to 136 construction projects (of which 74 residential and 62 non-residential) (European Commission, 2019b).

The purpose of the Level(s) tool is to standardize the assessment framework of environmental sustainability in Europe by means of a system of indicators to assess the sustainability of buildings during their life cycle, both with reference to residential and office buildings, refurbished or newly built. Each indicator is developed to link the impact of the individual building with the sustainability priorities at European level.

The sustainable buildings use less energy and materials, and are healthier and more comfortable spaces for occupants. Together with the lower environmental impact, they require lower management costs. Level(s) encourages operators both to implement the Life Cycle Assessment (LCA) and the Life Cycle Cost Assessment (LCCA), or the assessment of life cycle costs.

The Level(s) tool, currently still in the testing phase, promotes a holistic logic based on life cycle assessment as a tool for assessing sustainability, promoting an overall view of the building rather than a compartmentalized vision of individual performances.

Level(s) allows to evaluate various aspects: environmental aspects, performance related to issues such as health and wellbeing, life cycle costs and potential future risks of performances.

The Level(s) framework is based on six macro-objectives that correspond to three following different thematic areas:

- environmental performances of life cycle;
- health and comfort;
- cost, value and risk.

Each of the above thematic area includes some macro-objective, for a total of six macro-objectives, shown in Table 1.

Table 1. Thematic areas and macro-objectives of the Level(s) tool (European Commission, 2017b).

	Temathic area 1	Macro-objectives
1	Environmental performances of life cycle	greenhouse gas emissions along a building life cycle
		resource efficient and circular material life cycles
		efficient use of water resources
2	Health and comfort	healthy and comfortable spaces
3	Cost, value and risk	adaptation and resilience to climate change
		optimised life cycle cost

The achievement of these macro-objectives is the desired result, so that buildings can contribute to the achievement of European environmental policies (European Commission, 2017b).

Level(s) is structured in different phases ranging from the collection, estimation, evaluation and analysis of data regarding the performances of the building under study. Furthermore, as the name suggests, this tool is made up of three levels of increasing depth of performance evaluation (European Commission, 2017b, 2017c).

- common performance assessment; the simplest level, a common reference guide for building evaluation;
- comparative performance assessment; the level that allows the comparison between two or more equivalent buildings from the functional point of view;
- optimized performance assessment; the more complex level, which allows to perform a more detailed analysis and calculation models aimed at optimizing performances.

The levels show how to reduce the environmental impacts and can prepare operators for more challenging performance evaluation schemes and tools.

The assessment of the impacts of circular economy projects on health represents an added value to the decision-making process, considering that human health is significantly influenced by policies and actions in many other fields (including those involved in the transition to a circular economy) that go beyond the health sector and influencing health through different pathways. Health conditions represent a fundamental aspect in the circular model of the city because they reduce costs which, in the perspective of human-centered development, are linked to morbidity, malaise, etc.

From the perspective of the circular economy, the reference to the construction sector is certainly fundamental as this sector is the greatest producer of interdependencies. This, in addition to contributing to economic productivity and environmental sustainability, at the same time also contributes to "social" productivity, producing employment.

Therefore, the construction sector certainly represents an excellent entry point for the implementation of a model that can simultaneously satisfy economic, environmental and social sustainability, reducing the trade-off between the green economy and the social economy.

The Level(s) tool, although quite comprehensive, does not explicitly mention cultural heritage. However, considering also that the European Union itself recognizes the key role of cultural heritage as one of the drivers in sustainable development, it is necessary that the EU specifically addresses the issue related to implementation tool for the functional reuse of cultural heritage, providing a comprehensive and adequate list of indicators (economic, environmental, social, and cultural).

4. An integrated evaluation tool for assessing cultural heritage functional reuse projects

4.1 The contribution of cultural heritage to the macro-objectives identified by the Level(s) tool

Among the built asset, there is cultural heritage, that is an asset characterized by particular values and historical, cultural and aesthetic characteristics. Since, as mentioned above, there is not yet an evaluation framework for assessing cultural heritage conservation and regeneration projects from a circular perspective, in this research study it is intended to move in the direction to fill that gap. The idea is to move towards the creation of a common language for the evaluation framework of cultural heritage conservation and regeneration projects.

A framework for this integrated evaluation is here proposed starting from the tool adopted by the European Commission (Level(s) tool). The integrated evaluation (Lichfield, 1989; Lichfield and Lichfield, 1986) is here interpreted integrating the humanistic dimension, with the ecological, economic, technological and social dimensions. The functional reuse is considered not only in a green perspective, but in an integrated logic that includes all the different dimensions and values.

The Level(s) tool can be adopted, with the appropriate modifications and integrations, to cultural heritage, as a particular type of built asset. Unlike Level(s) that is used for both new construction and rehabilitation projects, in the case of cultural heritage, this tool is clearly only used for existing assets.

As emerged from previous researches and as highlighted in the previous paragraphs, cultural heritage functional reuse projects produce multidimensional impacts, covering both the environmental and the economic/financial, social and cultural dimensions (CHCfE Consortium, 2015; Nocca, 2017). Furthermore, cultural heritage cannot be considered separate from its context (UNESCO, 2011) and thus its evaluation framework has to include both impacts of the projects on the asset itself, but also the impacts that it is able to produce on its context, that is on the city.

Indeed, cultural heritage is able to contribute to the achievement of almost all the macro-objectives identified by the Level(s) tool, as shown in the following paragraphs.

4.1.1 The contribution of cultural heritage to the macro-objective "Greenhouse gas emissions along a buildings life cycle"

The aim of this objective (included in the thematic area "Life cycle environmental assessment") is "to minimise the total greenhouse gas emissions along a buildings life cycle, from cradle to cradle, with a focus on emissions from building operational energy use and embodied energy" (European Commission, 2017c).

Cultural buildings have a long lifespan; so, assessing their environmental impacts is important to achieving a sustainable, low-carbon economy. Functional reuse of cultural heritage contributes to reduce greenhouse emissions because it avoids new construction and the resulting emissions of polluting gases and resources consumption. Furthermore, contrary to the construction process which requires high energy expenditure (linked to the different phases, from extraction to assembly), in the functional reuse the materials are maintained and reused and, consequently, less emissions are produced (Gravagnuolo et al., 2017; Rayman et al., 2017).

In the functional reuse, conserving the tangible asset means also preserving its embodied energy (CHCfE Consortium, 2015; Foster, 2020; Itard and Klunder, 2007). The built environment has great potential for energy savings and the investments made pay back throughout the life cycle of the asset. Energy savings can be achieved both through investments in technology (i.e. using renewable or high energy efficiency energy systems) and through management systems and lifestyle change (Nocca and Fusco Girard, 2017). Through the protection and revitalisation of the huge embedded energy in the historic building stock, cultural heritage can contribute to facing climate change challenges (CHCfE Consortium, 2015; Foster, 2020; ICOMOS Climate Change and Heritage Working Group, 2019; Itard and Klunder, 2007).

4.1.2 The contribution of cultural heritage to the macro-objective "Resource efficient and circular material life cycles"

This objective (included in the thematic area "Life cycle environmental assessment") is related "to optimise the building design, engineering and form in order to support lean and circular flows, extend long-term material utility and reduce significant environmental impacts" (European Commission, 2017c).

Considering that the purpose of cultural heritage functional reuse is to preserve the integrity and authenticity of the asset, it prevents the use of new raw materials trying to use materials already extracted during the past. Furthermore, considering the aforementioned purpose, also demolition waste are minimized. The parts that inevitably have to be demolished to adapt the building to its new use can be reused, in a circular economy perspective, as "raw material" for the construction of other parts.

Furthermore, as underlined in the previous paragraphs of this paper, functional reuse prolongs the values of the resources extending, at the same time, the life cycle of materials because materials are maintained and preserved to allow joining

the asset. In addition to saving materials, functional reuse also reduces land consumption that would be caused if a new building were to be built.

4.1.3 The contribution of cultural heritage to the macro-objective "Efficient use of water resources"

This objective (included in the thematic area "Life cycle environmental assessment") is related "to make efficient use of water resources, particularly in areas of identified long-term or projected water stress" (European Commission, 2017c).

Considering the reduction in demolition works (but also during the construction phase) compared to new construction, functional reuse contributes significantly to reduce water consumption. Furthermore, as water is considered as a precious resource that cannot be wasted, water self-sufficiency should be the characteristic of every re-use project (Fusco Girard, 2020). Specific water-saving strategies (from optimization to changing consumption models) can be included in reuse projects to reduce the amount of water used during the life cycle of the building compared to before the reuse project was implemented.

4.1.4 The contribution of cultural heritage to the macro-objective "Healthy and comfortable spaces"

This objective (included in the thematic area "Health and comfort") is related "to create buildings that are comfortable, attractive and productive to live and work in and which protect human health" (European Commission, 2017c).

In this thematic area, references to the health conditions and to comfort (as concept related to wellbeing) are considered.

Here the definitions of health and wellbeing provided by the Italian National Institute of Statistics (ISTAT, 2019) are assumed. In particular, the health dimension is principally associated to the medicine and has always the same parameters; the wellbeing dimension, instead, is a multidimensional concept related both to the economic wealth but also to happiness, quality of life, to ensure social cohesion, human rights and needs fulfilment, etc. However, health and wellbeing are interconnected. In fact, a good health contributes to the perception of greater wellbeing and, on the contrary, a feeling of malaise can lead to a worsening of health.

Historical buildings can contribute to a good health also thanks to their wise features. An effective orientation and the physical characteristics, for example the walling's gauge, contribute to guarantee lesser temperature inside and outside the buildings, improving the general microclimatic condition. This contributes to health and wellbeing of the occupants. Furthermore, there is a relationship between quality landscape variation and wellbeing variation (Nocca and Fusco Girard, 2017). The landscape is important for our wellbeing and this link is intuitive. In fact, we tend, even unconsciously, to be more attracted by places that communicate harmony, balance and serenity while, on the contrary, we move away from those that communicate disorder, imbalance and insecurity. To this end, it is im-

portant to consider that the BES Report by the Italian National Institute of Statistic (ISTAT, 2015, 2019), among the 12 dimensions of wellbeing, make an explicitly reference to "landscape and cultural heritage", recognizing its contribution to the achievement of a state of wellbeing and a better quality of life. Furthermore, the ISTAT recognizes the health as a domain of the wellbeing, highlighting once again their close relationship. Finally, cultural heritage contributes to improving the quality of life in different ways by providing, for example, new job opportunities, new spaces for living or doing activities through reuse.

4.1.5 The contribution of cultural heritage to the macro-objective "Adaptation and resilience to climate change"

This objective (included in the thematic area "Cost, value and risk") is related "to futureproof building performance against projected future changes in the climate, in order to protect occupier health and comfort and to sustain and minimise risks to property values" (European Commission, 2017c).

The World Bank has recognized the role that cultural heritage can play in the fight against climate change, identifying investment in cultural heritage as one of the solutions for CO_2 reduction. Activities that are related to cultural heritage represent a model of land use, consumption and production that is intrinsically more sustainable, as it has developed over time through continuous adaptation between community and environment. Cultural heritage can help face the challenges of our time, such as climate change, for example, "through the protection and revitalization of the huge amount of embedded energy in the historic building stock", aspect already highlighted many times in this paper (CHCfE Consortium, 2015).

The reduction of greenhouse emissions, of waste production and the efficiency use of resources related to cultural heritage functional reuse contribute to reduce negative environmental impacts and thus to face climate change. Also in the 19GA 2017/30 Resolutions, ICOMOS recognizes the relationships between cultural heritage and climate change engaging to strengthen the efforts for supporting the implementation of the Paris Agreement emphasizing the contribution of cultural heritage and landscape-based solutions for reducing the global average temperature to well below 2°C. ICOMOS emphasizes the role of cultural heritage community to help meet the challenge of climate change (ICOMOS, 2017; ICOMOS Climate Change and Heritage Working Group, 2019).

4.1.6 The contribution of cultural heritage to the macro-objective "Adaptation and resilience to climate change"

This objective (included in the thematic area "Cost, value and risk") is related to "optimise the life cycle cost and value of buildings to reflect the potential for long term performance improvement, inclusive of acquisition, operation, maintenance, refurbishment, disposal and end of life" (European Commission, 2017c). This objective refers to the Life Cycle Costing (LCC), that is "particularly relevant

to achieving an improved environmental performance as higher initial capital costs may be required to achieve lower life-cycle running costs, higher residual property values and improved workforce productivity. It therefore represents a method for making effective, long-term investment decisions" (European Commission, 2017c). It refers to the cost over the life cycle of the asset, also including "the 'intangible' benefits, which may include factors that influence the users' comfort and productivity" (European Commission, 2017c). This objective is also related to the impacts that the enhancement of environmental performances can have on the real estate market. In the case of the functional reuse, the re-functionalization of the building and the regeneration of its values contribute to the increase of the real estate values, both of the regenerated building itself and of the surrounding buildings, producing economic benefits for the city. The impact on the real estate dimension is one of the most immediate impacts of such projects (Nocca, 2017). Furthermore, attention to consumption models such as energy and water in reuse projects certainly contributes to reducing costs over the life cycle of the building.

4.2 The macro-objectives of cultural heritage functional reuse projects: the evaluation framework

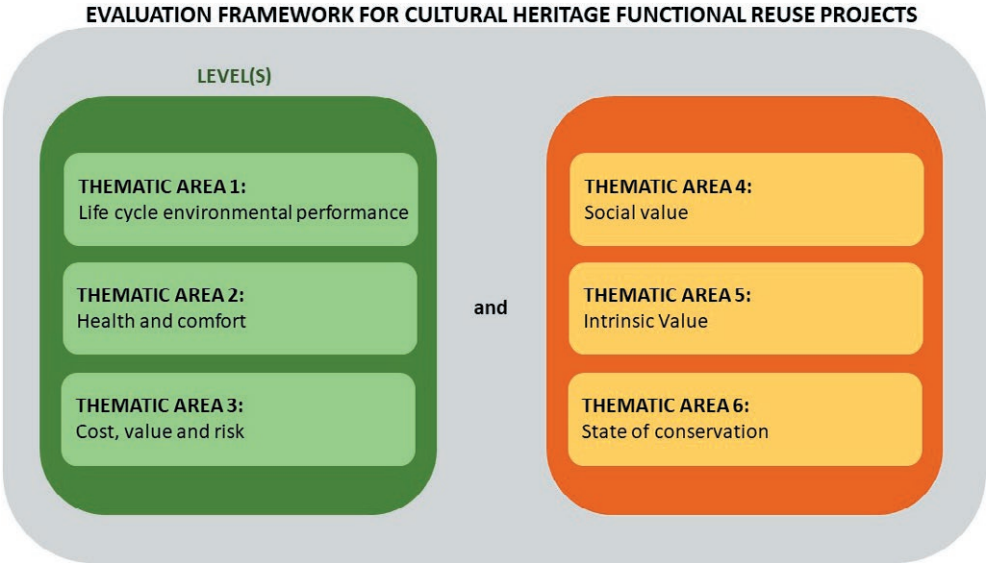
As the table 1 shows, the functional reuse of cultural heritage is able to contribute to the achievement of all objectives identified by European Commission in the evaluation framework for building construction (that is the Level(s) tool).

However, the Level(s) framework is more focused on environmental and economic dimensions, resulting weak from the human and social point of view, except for the thematic area on "health and comfort". The health dimension is fundamental in this period of great unsustainability, of sanitary emergency due to COVID-19 and in which the aforementioned paradigm shift (towards a more humanistic and environmental paradigm) is required.

The human dimension should be integrated in the evaluation framework putting the human-beings at the centre of the objectives. The three thematic areas proposed by European Commission are maintained and other three thematic areas are added (more specific to cultural heritage values). The "Health and comfort" thematic area identified by Level(s) is here modified in "Health, comfort and wellbeing" considering health and wellbeing as two different (but linked) concepts (according to ISTAT definition) and that cultural heritage conservation and regeneration projects can contribute to achieve better conditions for both of them.

Furthermore, starting from the three thematic areas of the Level(s) tool, other three thematic areas have been included in the evaluation framework in order to enrich it and to consider all the aspects and different values related to cultural heritage projects. Therefore, the proposed evaluation framework includes both the three thematic areas (no.1,2,3) identified by the European Commission (that are still relevant also for the evaluation of the functional reuse of cultural heritage and for which the contribution of cultural heritage has been highlighted in paragraph

Figure 1. The thematic area of the evaluation framework proposed for cultural heritage functional reuse projects.



§2) and three thematic areas (no. 4,5,6) that capture also the social and cultural dimensions (closely linked to cultural heritage and that escapes in the Level(s) tool).

The proposed thematic areas are:

- social value;
- intrinsic value;
- state of conservation (and related use value).

The total of the six thematic areas intends to cover all dimensions (Fig. 1): environmental, social, cultural and economic dimensions. The environmental and the economic ones were already included in the Level(s) by European Commission and they are here declined in relation to cultural heritage. The social and cultural ones are lacking in the European Commission's framework, but they need to be included in the evaluation framework for cultural heritage, considering its particular characteristics and values.

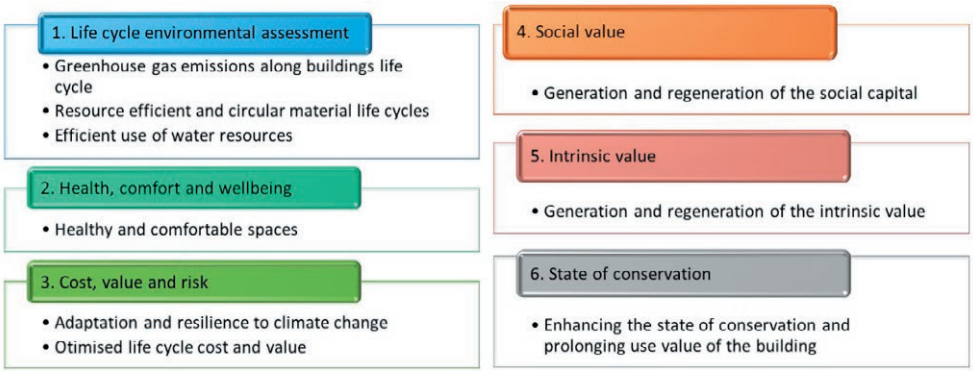
Furthermore, for each thematic area, related macro-objectives and specific indicators are identified.

Regarding the thematic areas already existing in the Level(s) tool, the corresponding macro-objectives identified by the European Commission have been considered. Instead, regarding the three proposed thematic areas, three new macro-objectives strictly related to cultural heritage have been identified.

The macro-objectives related to the new identified thematic areas are (Figure 2):

- generation and regeneration of the social capital (thematic area 4);
- generation and regeneration of the intrinsic value (thematic area 5);

Figure 2. Thematic areas and related macro-objectives of the evaluation framework proposed.



- enhancing the state of conservation and prolonging the use value of the building (thematic area 6).

The indicators are partly those identified by the European Commission in the Level(s) tool and partly those deduced starting from previous studies about cultural heritage conservation and regeneration projects. Here the following studies are considered: the research by Fusco Girard and Nocca (2019), about the contribution of cultural heritage in implementing the circular city; the research by Nocca (2017), about the multidimensional impacts of cultural heritage conservation and regeneration projects of 41 case studies, and the research by De Medici et al. (2020), about impacts of two projects of cultural heritage functional re-use. So, unlike the research analyzed in the literature review which mainly include indicators from other theoretical studies (paragraphs §§2,3), the indicators (that will be show in §6) included in the proposed evaluation framework are deduced and referred to concrete experiences. However, some of the indicators deduced from the case studies were also found to match those highlighted in the literature.

4.2.1 The thematic area "social value"

Since the 1970s there has been a strong emphasis on the social values of cultural heritage. There is a clear increase in awareness of the importance of the intangible values of cultural heritage and the need to take them into account alongside (with the same importance) the tangible values in a decision-making process of the reuse of the asset itself (Fusco Girard, 2020; Nocca, 2017; Sowinska-Heim, 2020).

When dealing with cultural heritage, it is inevitable to include the social dimension, considering that cultural heritage has positive impacts on social capital generating and regenerating synergies, bonds and collaborative relationships (the "glue value" of cultural heritage) (CHCfE Consortium, 2015; Department for Culture Media & Sport, 2016; Fusco Girard and Vecco, 2019).

In cultural heritage there is a potential as a "connective infrastructure" (Fusco Girard, 2018; Fusco Girard and Nocca, 2019), that is an infrastructure able of keeping society cohesive, which is today greatly fragmented especially in large urban agglomerations, generating and re-generating bonds and relationships. It is fundamental for social cohesion as it expresses the values and identity of the community and organizes the community itself and its relationships through its symbolic power and aesthetic dimension. These relationships generated and regenerated by functional reuse can represent an input for implementing other activities related to cultural heritage.

Cultural heritage contributes to build social capital and social cohesion (CHCfE Consortium, 2015; Hosagrahar et al., 2016; Throsby, 2010, 2016), providing a context for participation and engagement and also fostering integration (CHCfE Consortium, 2015; European Association of Historic Towns and Regions - EAHTR, 2007). Furthermore, it encourages associations, new forms of economy (i.e. crowdfunding, municipal bonds, etc.) that, in turn, contributes to local economy.

Cities are characterized by amount of waste related to industrial activities, to land use, to household, to building sector, etc., but also to "waste" of human and social capital. Circular economy related to cultural heritage contributes to minimize waste of different kinds of capital: natural capital, manmade capital but also human and social capital. The latter is referred to unemployed, marginal people, poor people, etc.

Circular economy is focused not only on flows and recycling, but it is also linked to the relational capital, thus incorporating the avoiding "waste" of human capital, of skills, knowledge, creative, entrepreneur capacity of human beings (Fusco Girard, 2019). In this perspective, a key aspect related to social capital is the employment. It represents a very significant indicator of social inclusion, considering that it not only contributes to make people "feel good", but also because it represents "the bridge" between the individual and society. Through the production of job opportunities, cultural heritage contributes to the improvement of wellbeing and quality of life. This aspect becomes, in a circular perspective, an input for economic productivity considering that a state of wellbeing makes people more productive (Zamagni et al., 2015), as also understood from some entrepreneurs, as Olivetti, Bata and Ferrero.

The indicators emerged from the study of concrete experiences of cultural heritage conservation and regeneration projects and that are proposed for this thematic category are (Fusco Girard and Nocca, 2019; Nocca, 2017):

- number of new jobs related to functional reuse projects (employment sub-category);
- number of associations, number of volunteers, number of cooperative enterprises related to functional reuse projects (social cohesion sub-category).

4.2.2 The thematic area "intrinsic value"

Cultural heritage is an integral part of community life and is expression of its culture, identity, religious beliefs, etc. It is involved in social, economic and en-

vironmental processes. It is the element in which the community can recognize itself, today and tomorrow, becoming crucial for transferring cultural identity to future generations (Mısırlısoy and Gunce, 2016). The reuse of cultural heritage is important to preserve the identity of a community, to strengthen it and to help future generations in "learning" where they came from.

Conservation and reuse aim not only at preserving material values, but also intangible values, the cultural significance that cultural heritage has for past, present and future generations, as values can change from individual to individual (and between different social groups).

This value-based approach requires careful reflection and investigation on what values are important to a community, its development and its quality of life. This investigation has to be carried out by experts (scientific knowledge) with the support of the community itself (communal knowledge).

Cultural heritage is characterized by an intrinsic value (Fusco Girard, 1987; Fusco Girard and Nijkamp, 1997). The notion of intrinsic value draws its foundation from ecological economics and in the recognition of the system's autopoietic capabilities (Costanza et al., 2014; Maturana and Varela, 2001; Turner, 1993; Zeleny and Hufford, 1992). In fact, John Ruskin and Williams Morris had already introduced this notion (Morris, 1889; Ruskin, 1989), later taken up by Riegel as a value of memory (Riegl, 1903). It was the Burra Charter (ICOMOS, 1979, 2013) that opened the perspective of intrinsic value in the field of conservation of cultural heritage.

The formulation of intrinsic value was recently taken up in the European Commission (2014) which considers the dual dimension of culture as a value "in and of itself", distinguishing it from the instrumental one (such as economic and social values).

This value reflects the specific and unique character, meaning, identity and beauty of a place, creating a sense of connection among people and between the community and cultural heritage. The intrinsic value reflects the way a community has lived, worked and organized itself over time.

The intrinsic value of cultural heritage, unlike that of the natural ecosystems, is produced by people over centuries of history and therefore also has a subjective aspect (Callicott, 1989; Elliot, 1992). Therefore, it does not exist in itself, but depends on the subjects who have recognized that value, that uniqueness, beauty, meaning in that cultural heritage. In this perspective, the subjective intrinsic value remains linked to an anthropocentric and not eco-biocentric approach, eliminating the dichotomy between anthropocentric and eco-biocentric values.

Cultural heritage expresses the values and traditions of a city and its community, linking present, past and future. However, its meaning may differ among diverse communities and even among different members within the same community. In fact, different social groups can have different values and perceptions, thus attributing different values to heritage.

Cultural heritage is a source of local identity, integration and cohesion. In a period of rapid transformation and urbanization like the one we are living, it expresses the memory of a community, its roots, and represents the "means" by

which each generation can communicate with the others. While serving as shared memory, a successfully adapted historical building will help to link residents to their roots. Furthermore, reusing cultural heritage allows preserving the sense of place (Aigwi et al., 2020).

Functional reuse allows cultural heritage to continue "to live" both for present and for future generations, prolonging its use values and preserving the intrinsic one. It contributes to keep alive a symbol of the community identity.

The intrinsic value helps to identify a direction for the use and management of the assets. In this sense, by offering a perspective to new strategies of local regeneration, the intrinsic value is the foundation on which to articulate any new use value (or combination of several use values) connected to a new project/strategy. In this way, the new project is in continuity with a territorial urban history and offers the "energy" for a creative synthesis, for processes of hybridization between memory and innovation. The intrinsic value offers the "insuperable" limit in the management of change (Fusco Girard et al., 2019).

Therefore, also this important value should be considered in the evaluation framework of cultural heritage functional reuse projects. In this perspective, some indicators can be proposed starting from the analysis of concrete experiences of cultural heritage conservation and regenerations (Fusco Girard and Nocca, 2019):

- place attachment and local identity (following the implementation of projects related to cultural heritage);
- sense of place in sites/area.

4.2.3 The thematic area "state of conservation"

When a cultural building is no longer able to fulfil its functions, but needs to be adapted to different functions, it is necessary that the interventions do not alter the originality and architectural character of the building "in order to not give wrong or missing information for the further generations" (Mısırlısoy and Gunce, 2016).

Considering the role of cultural heritage at different level (economic, environmental, social and cultural), indicators about the state of conservation of landscape values are fundamental in the proposed evaluation framework. They are related to the physical conditions of the asset and thus, indirectly, also to its use value.

The state of conservation is linked to the building usability that, in turn, is linked to three factors, that is effectiveness, efficiency, satisfaction related to the new use (Aigwi et al., 2020). In the perspective of the circular economy, the functional reuse projects contribute to prolong the use values of the asset and thus to preserve its state of conservation from the state of degradation due to abandonment. Functional reuse allows functionally obsolete or underutilized historic buildings to adapt to new needs and serve new functions (Douglas, 2006), while retaining their original features and existing building structure (Aigwi et al., 2020; Bullen and Love, 2010).

By preserving the cultural heritage, we build the memory of ourselves and therefore identity. So, through the cultural heritage that has been handed down to us, we can react to the risk of loss of identity in a period of strong globalization

like this one we are experiencing today and, at the same time, we can pass it on to future generations.

Cultural heritage is subject to continuous adaptation to changes that occur throughout history. It is subject to continuous processes of hybridization and each "graft" represents new lifestyles, new styles, etc. It is able, thanks to functional reuse, to adapt to changing context, as it happens in living organisms.

A place where historical and cultural values are preserved for longer is characterized by a greater sense of belonging. In such places, the attractiveness of the place will also be greater (increasing also the tourist flows that in turn feed the local economic productivity) and the civic and individual attention to the preservation.

The use value of the cultural heritage depends also on the state of preservation. Cultural heritage has to be conserved also for future generations that have the right to enjoy that particular asset.

Cultural heritage can be preserved by maintaining its function, or by identifying a new function that meets the needs and requirements of a society in continuous transformation. The use value can therefore change and it is linked to the type of heritage (public building, private building, castle, church, etc.), its location and the type of ownership and management. The threshold within which a new use value is admissible, therefore the threshold of change, is given by the intrinsic value of the assets itself (Fusco Girard et al., 2019).

In this perspective, the approach proposed by HUL implies the ability to identify the limits (the threshold) within which the change is admissible. The "change management" (UNESCO, 2011) has to ensure consistency (continuity) with the past, with identity, with memory, that is with the intrinsic value. It is necessary to identify the structural and cultural constraints to re-functionalization.

Through the conservation and regeneration of cultural heritage, new use values are attributed to adapt it to the dynamism and changing needs of the community. These use values are consistent with the value independent of use and therefore do not produce loss of identity of the heritage. The functional reuse of cultural heritage is considered here as a way to enhance the identity of the territory as it is based on its history, its values, etc. It is an entry point to regenerate cultural, community and collaborative values, in the awareness that the challenge to development can only be faced together.

In this perspective, some indicators, starting from concrete experiences of cultural heritage conservation and regeneration, can be identified:

- state of conservation of the building (Nocca, 2017);
- conservation of the geometric features (De Medici et al., 2020; Pinto et al., 2017);
- recognizability and acceptability of the transformations (De Medici et al., 2020; Pinto et al., 2017).

Furthermore, the enhancement of the state of conservation of a cultural asset can contribute to increase the real estate values in the surrounding area. So, an indicator related to the positive impact produced by functional reuse not directly on the asset itself, but on the asset placed close to it can be:

- real estate value in the surrounding area (Fusco Girard and Nocca, 2019).

5. The indicators for assessing cultural heritage functional reuse projects

The proposed evaluation framework, including thematic areas, macro-objectives and indicators, covers the economic, environmental and socio-cultural dimensions, highlighting the multidimensional impacts that cultural heritage conservation and regeneration projects are able to produce. It has been elaborated considering all values characterizing cultural heritage and thus it considers indicators related to environmental and economic dimensions (as the Level(s) tool), but also social and cultural ones.

For each thematic areas and related macro-objectives, key indicators have been identified (already anticipated in the previous paragraphs). The starting point are the indicators identified by Level(s) tool that have been modified to better adapt to cultural heritage which is not a new asset like the object of the tool proposed by the European Commission.

Some indicators are those of the Level(s) tool (that provide indicators, scenarios and LCA tool); the others are those identified and explained in the previous paragraphs (§4) deduced from previous researches on the issue (De Medici et al., 2020; Nocca, 2017; Fusco Girard and Vecco, 2019; Pinto et al., 2017). The indicators included in the proposed evaluation framework are deduced from concrete case studies. However, it was found that some of these indicators are assonant with those identified by the literature review (discussed in §§2,3).

The Level(s) tool has a micro and not territorial approach. Its scale of reference should be broadened by considering that the cultural asset itself cannot be considered independent from the context it belongs to, with which it interacts. The indicators, referred to the life cycle of the building, are here identified considering three reference scale: micro-scale (Mi) related to building level, citizens level; meso-scale (Me) related to neighbourhood level, city level; macro-level (Ma) related to regional level, national level, international level.

The indicators are listed in the table below, identifying the related unit of measure, reference scale and source (Table 2).

The proposed assessment framework is thus structured into six thematic areas (Figure 1) nine macro-objectives (Figure 2) and twenty performance indicators (Table 2) for measuring the achievement of the objectives.

The above identified indicators cover all the impact dimensions of cultural heritage functional reuse projects. The proposed tool includes also the community perspective, since it is the addressee of the project. In fact, in the proposed evaluation framework there are some indicators (perception indicators) that allow to bring into the evaluation process also the community point of view.

It could be useful to compare some of these indicators (i.e. construction and demolition waste and materials) between the scenario of the functional reuse and the scenario of new construction in order to demonstrate the major benefits of the first scenario, that is that reuse is better rather than demolish and of construct a new building.

These indicators are multidimensional and concern both short and medium- and long-term impacts. They are both quantitative and qualitative, including objective and subjective indicators (related to the perception of stakeholders).

Table 2. Indicators for cultural heritage functional reuse.

1.THEMATIC AREA 1 – Life cycle environmental assessment

Indicator	Unit of measure	Territorial scale	Source
Greenhouse gas emissions along a buildings life cycle			
Use stage energy performance	kWh/m^2/yr	Mi	(European Commission, 2017b)
Life cycle Global Warming Potential	CO_2e/m^2/yr	Mi	(European Commission, 2017b)
Resource efficient and circular material life cycles			
Indicator	Unit of measure		Source
Construction and demolition waste and materials	kg waste and materials per m^2 of total useful floor area	Mi	(European Commission, 2017b)
Reuse of materials in projects related to cultural heritage	% of total waste reused in the project	Mi	(Fusco Girard and Nocca, 2019)
Efficient use of water resources			
Use stage water consumption	m^3/occupant/yr	Mi	(European Commission, 2017b)

THEMATIC AREA 2 – Health and comfort and wellbeing

Indicator	Unit of measure	Territorial scale	Source
Healthy and comfortable spaces			
Indoor air quality a. Ventilation rate (air flow) b. CO_2 c. Particulates d. Relative humidity	a. Litres per second per square metre (l/s per m^2) b. Parts per million (ppm) c. μg/m^3 d. % ratio of partial to equilibrium vapour pressure	Mi	(European Commission, 2017b)
Time out of thermal comfort range	% of the time out of range of defined maximum and minimum temperatures during the heating and cooling seasons	Mi	(European Commission, 2017b)
Lighting and visual comfort	Useful Daylight Illuminance (UDI)	Mi	(European Commission, 2017b)
Acoustics and protection against noise	Yes or not	Mi	(European Commission, 2017b)
Perception of wellbeing	% Percentage of people feeling in a wellbeing condition inside the building	Mi	(Nocca, 2017)

THEMATIC AREA 3 – Cost, value and risk			
Indicator	Unit of measure	Territorial scale	Source
Adaptation and resilience to climate change			
Life cycle tools: Scenarios for projected future climatic conditions	Protection of occupier health and thermal comfort. Simulation of the building's projected time out of thermal comfort range for the years 2030 and 2050.	Mi	(European Commission, 2017b)
Optimised life cycle cost and value			
Indicator	Unit of measure		Source
Life cycle costs	€/m²/yr	Mi	(European Commission, 2017b)
Real estate value of surrounding buildings	€/sqm	Me	(Nocca, 2017; Fusco Girard and Nocca, 2019)

THEMATIC AREA 4 – Social value			
Indicator	Unit of measure	Territorial scale	Source
Generation and regeneration of the social capital			
Number of new jobs related to functional reuse projects (employment sub-category)	N./project	Me	(Fusco Girard and Nocca, 2019; Nocca, 2017;)
Number of associations, number of volunteers, number of cooperative enterprises related to functional reuse projects (social cohesion sub-category)	N./project	Me	(Fusco Girard and Nocca, 2019; Nocca, 2017)
THEMATIC AREA 5 – intrinsic value			
Indicator	Unit of measure	Territorial scale	Source
Generation and regeneration of the intrinsic value			
Place attachment and local identity (following the implementation of projects related to cultural heritage)	Qualitative (scale 1–5)	Me	(Fusco Girard and Nocca, 2019)
Sense of place in sites	Qualitative (scale 1–5)	Me	(Fusco Girard and Nocca, 2019)

THEMATIC AREA 6 – State of conservation

Indicator	Unit of measure	Territorial scale	Source
Enhancing the state of conservation and prolonging use value of the building			
Overall state of preservation of the building	Qualitative (very low, low, moderate, high, very high)	Mi	(Nocca, 2017)
Conservation of the geometric features	Qualitative (Yes or Not)	Mi	(De Medici, De Toro and Nocca, 2020; Pinto et al., 2017)
Recognizability and acceptability of the transformations	Qualitative (high-medium-low)	Mi	(De Medici, De Toro and Nocca, 2020; Pinto et al., 2017)

This evaluation framework can be used both ex-ante (in forecasting terms during the design phase) and ex post as a monitoring of results in order to check the impacts that the project is producing and, if necessary, make changes or additions.

6. Discussions and conclusions

The pandemic due to COVID-19 has highlighted the close relationship existing among social, natural and economic systems. It has confirmed the relationship between people and nature and thus how human activities negatively impact nature. "We do not need to choose between life and livelihood, or between health and economy. It is a false choice. On the contrary, the pandemic reminds us that health and economy are inseparable" (World Health Organization WHO, 2020a).

Post-COVID recovery plans need to go beyond the health sector, that is seeking to reduce the risk of disease at source by reducing, for example, the impacts of human activities on the environment. In this perspective, new models of city development play a key role.

As also the World Health Organization (2018) recognized, the circular economy is able to produce benefits on health and to contribute to the achievement of Sustainable Development Goals (United Nations, 2015b). It offers "an avenue to sustainable growth, good health and decent jobs, while protecting the environment and its natural resources" (World Health Organization - WHO, 2018).

Most urban areas today are saturated in terms of the built environment. Therefore, in the development of cities, greater attention is given to the recovery of the existing building stock (abandoned or underused) and disused areas, rather than to further urban expansion (De Toro et al., 2021). This also includes the reuse of cultural heritage buildings.

The functional reuse of cultural heritage can play a key role in the achievement of sustainable development of cities, contributing to its economic growth,

social and ecological wellbeing (European Commission, 2014; CHCfE Consortium, 2015). Interpreted through the lens of ecology (re-integrating economy into ecology) (Fusco Girard, 2020), it is consistent with the principles of the Green Deal (European Commission, 2019c) and the WHO approach (Watts, 2019; World Health Organization - WHO, 2020c).

Current approaches to the evaluation of cultural heritage are mostly sectoral, focusing on individual dimensions (economic, social, environmental) and, to a lesser extent, on their interrelationships (de la Torre and Mason, 1998; Gravagnuolo et al., 2017; Historic England, 2016).

This methodological proposal wants to represent a first step for the elaboration of a general evaluation framework for assessing cultural heritage conservation and regeneration projects in the circular economy perspective and going beyond the sectoral approaches. It integrates the Level(s) tool by European Commission, elaborated for built environment in general, with specific studies on cultural heritage.

The aim is to create a common language by using a common framework of indicators for dealing with sustainable conservation and valorisation of cultural heritage, going beyond the mere economic aspects and considering all values and impacts involved in the process. In this way, it is allowed a greater understanding of the whole process of conservation and regeneration of cultural heritage by giving better support to the decision-making process and making the comparable impacts between projects related to different buildings, geographical areas or between alternative scenarios for the same cultural building.

A decision-making process for functional reuse of cultural heritage based only on economic/financial aspects would give a "distorted and narrow" assessment. Certainly, financial return is a benefit commonly linked to reuse; however, some significant issues related to the environmental, social and cultural values of such activity are taking an increasingly important role in the evaluation of reuse projects related to urban regeneration. Quantitative and qualitative data are both relevant in the evaluation process for the functional reuse of cultural heritage and an integrated evaluation method/methodology allows to manage the complexity of the entire assessment process.

The recipients of this evaluation framework are different actors who intervene in different phases of the project: from the owners of the property to the technicians involved in the design, to construction companies, managing bodies, government institutions, community, etc. It has to be understandable, comparable among different experiences, and, at least in part, accessible not only to the experts, but to all stakeholders involved in the process.

Due to the multiplicity of actors and stakeholders involved, a common and officially recognized language is even more necessary. The development of guidelines for the use of this evaluation framework (as developed for the Level(s) tool) is therefore necessary. In addition, it is appropriate to invest in staff training so that the various subjects can acquire the right mastery and awareness of these tools.

Moreover, it is necessary to consider that cultural heritage is not only consisting of built heritage, but there are also many natural assets that have a cultural-historical, aesthetic, symbolic value (www.clicproject.it). The evaluation framework to date does not include this type of heritage, which often also has an intrinsic value. As far as possible, evaluation of reuse projects should also include those of natural heritage (public parks, historic gardens, etc.), as the two heritages are often in synergy (i.e. gardens pertaining to asset). Furthermore, the assessment framework requires some reflections and adjustments (for example for the aspect related to intrinsic value) to assess also heritage that, although recognized as valuable cultural heritage, is not recognized as "exceptional" (that is it is not outstanding universal value - OUV).

Furthermore, it should be considered that in implementing reuse projects, there are often some "barriers" due also to external factors. Regulatory aspects (as governance restrictions, seismic retrofit, building code, etc.) play an important role in the prioritization for the new use of heritage building. However, they could represent a barrier in the functional reuse implementation. Moreover, also the physical conditions of the building itself, its internal organization and layout (which often does not meet/differ from that which meets the current tastes and needs of the community/demand) can represent an obstacle.

Another barrier can be the lack of financial resources to implement the project, that is public financial resources, incentives and/or private investment. This is often compounded by high retrofit costs.

The proposed evaluation framework although complete, is not exhaustive and will need to be expanded to include other aspects related to circularity. Further research step is to test the proposed framework on a concrete functional reuse project of cultural heritage in order to verify its efficiency and any possible limit to be corrected.

Author contributions

The paper is the result of a joint effort by all authors. In particular, conceptualization: Francesca Nocca, Pasquale De Toro; methodology: Francesca Nocca, Pasquale De Toro, Viktoriya Voysekhovska; writing-draft, Francesca Nocca, Pasquale De Toro, Viktoriya Voysekhovska; writing-review and editing, Francesca Nocca, Viktoriya Voysekhovska. All authors have read and agreed to the published version of the manuscript.

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Rassegna giurisprudenziale

(a cura di Nicola Lucifero)

AGRICOLTURA

T.A.R. Lazio Roma, Sez. I bis, 06/05/2021, n. 5298
Terreno demaniale – pascolo – concessione – preferenza imprenditoria giovanile
Inizio modulo
Fine modulo
In un procedura per l'assegnazione di una concessione su un terreno demaniale per il pascolo e lo sfalcio dell'erba deve essere data prevalenza al soggetto che vanti un diritto di preferenza in favore c.d. giovane imprenditore agricolo ai sensi dell'art. 6, comma 4-bis, d. lgs. 18 maggio 2001, n. 228, piuttosto che al soggetto che intenda esercitare un diritto di prelazione agraria ex all'art. 4-bis della legge 3 maggio 1982, n. 203.

CGUE, 08/07/2021, C-830/19, *C.J. contro Région wallonne*
Rinvio pregiudiziale – Agricoltura – Fondo europeo agricolo per lo sviluppo rurale (FEASR) – Regolamento (UE) n. 1305/2013 – Regolamento delegato (UE) n. 807/2014 – Insediamento dei giovani agricoltori – Sviluppo delle aziende agricole – Aiuti all'avviamento d'impresa per giovani agricoltori – Condizioni d'accesso – Equivalenza – Insediamento in qualità di capo non unico dell'azienda – Massimali – Fissazione – Criteri – Produzione standard dell'azienda agricola
Gli articoli 2, 5 e 19 del regolamento (UE) n. 1305/2013 del Parlamento europeo e del Consiglio, del 17 dicembre 2013, sul sostegno allo sviluppo rurale da parte del Fondo europeo agricolo per lo sviluppo rurale (FEASR) e che abroga il regolamento (CE) n. 1698/2005 del Consiglio, in combinato disposto con gli articoli 2 e 5 del regolamento delegato (UE) n. 807/2014 della Commissione, dell'11 marzo 2014, che integra talune disposizioni del regolamento (UE) n. 1305/2013 del Parlamento europeo e del Consiglio sul sostegno allo sviluppo rurale da parte del Fondo europeo agricolo per lo sviluppo rurale (FEASR) e che introduce disposizioni transitorie, devono essere interpretati nel senso che non ostano a una normativa nazionale in forza della quale il criterio di determinazione del massimale che consente ad un giovane agricoltore, che si insedia in qualità di capo non unico dell'azienda, di accedere agli aiuti all'avviamento d'impresa, è quello della produzione lorda standard dell'intera azienda agricola, e non soltanto della quota di tale giovane agricoltore in tale azienda.

CGUE, 15/04/2021, C-736/19, *ZS "Plaukti"*
Rinvio pregiudiziale – Agricoltura – Fondo europeo agricolo per lo sviluppo rurale (FEASR) – Regolamento (CE) n. 1698/2005 – Regolamento (UE) n. 65/2011 – Articolo 16, paragrafo 5, terzo comma – Regolamento (CE) n. 73/2009 – Articoli 4

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e 6 – Regolamento (CE) n. 1122/2009 – Sostegno dello sviluppo rurale – Pagamenti agroambientali – Sostegno per il mantenimento della biodiversità nelle praterie – Inosservanza dei presupposti per la concessione di tali pagamenti – Sfalcio prematuro – Riduzione ed esclusione di detti pagamenti – Norme obbligatorie – Criteri di gestione obbligatori – Requisiti minimi per le buone condizioni agronomiche e ambientali – Impegni che vanno al di là delle norme obbligatorie, dei requisiti minimi e di altre specifiche norme obbligatorie prescritte dalla legislazione nazionale

1) L'articolo 16, paragrafo 5, terzo comma, del regolamento (UE) n. 65/2011 della Commissione, del 27 gennaio 2011, che stabilisce modalità di applicazione del regolamento (CE) n. 1698/2005 del Consiglio per quanto riguarda l'attuazione delle procedure di controllo e della condizionalità per le misure di sostegno dello sviluppo rurale, dev'essere interpretato nel senso che non è applicabile nel caso in cui il richiedente il sostegno non abbia rispettato gli impegni agroambientali relativi ai requisiti riguardanti lo sfalcio, senza che sia stata constatata alcuna modifica del gruppo di colture interessato.

2) Gli articoli 4 e 6 del regolamento (CE) n. 73/2009 del Consiglio, del 19 gennaio 2009, che stabilisce norme comuni relative ai regimi di sostegno diretto agli agricoltori nell'ambito della politica agricola comune e istituisce taluni regimi di sostegno a favore degli agricoltori, e che modifica i regolamenti (CE) n. 1290/2005, (CE) n. 247/2006, (CE) n. 378/2007 e abroga il regolamento (CE) n. 1782/2003, in combinato disposto con l'articolo 39, paragrafo 3, del regolamento (CE) n. 1698/2005 del Consiglio, del 20 settembre 2005, sul sostegno allo sviluppo rurale da parte del Fondo europeo agricolo per lo sviluppo rurale (FEASR), devono essere interpretati nel senso che essi ostano a una normativa nazionale secondo la quale un medesimo requisito può al contempo costituire un requisito minimo in materia di buone condizioni agronomiche e ambientali e un requisito che va al di là di tali requisiti minimi, ossia un presupposto per la concessione di pagamenti agroambientali.

CGUE, 10/03/2021, C-365/19, *FD contro Staatliches Amt für Landwirtschaft und Umwelt Mittleres Mecklenburg*

Rinvio pregiudiziale – Politica agricola comune – Pagamenti diretti – Regolamento (UE) n. 1307/2013 – Articolo 24 – Giovane agricoltore che ha beneficiato di una prima assegnazione di diritti all'aiuto – Articolo 30, paragrafo 6 – Regolamento delegato (UE) n. 639/2014 – Articolo 28, paragrafo 2 – Assegnazione supplementare di diritti all'aiuto a partire dalla riserva nazionale

L'articolo 30, paragrafo 6, del regolamento (UE) n. 1307/2013 del Parlamento europeo e del Consiglio, del 17 dicembre 2013, recante norme sui pagamenti diretti agli agricoltori nell'ambito dei regimi di sostegno previsti dalla politica agricola comune e che abroga il regolamento (CE) n. 637/2008 del Consiglio e il regolamento (CE) n. 73/2009 del Consiglio, in combinato disposto con l'articolo 28, paragrafo 2, del regolamento delegato (UE) n. 639/2014 della Commissione, dell'11 marzo 2014, che integra il regolamento n. 1307/2013 e che modifica l'allegato X di tale regolamento, deve essere interpretato nel senso che un giovane agricoltore, ai sensi dell'articolo 30, paragrafo 11, lettera a), del regolamento n. 1307/2013, in combinato disposto con l'articolo 50, paragrafo 2, di detto regolamento, che abbia già beneficiato, ai sensi dell'articolo 24 del medesimo regolamento, di una prima assegnazione di diritti all'aiuto pari al massimo al numero degli ettari ammissibili

che ha dichiarato al momento della sua domanda, ha diritto a ricevere, successivamente, un'assegnazione supplementare di diritti all'aiuto a partire dalla riserva nazionale pari al numero aggiuntivo di ettari ammissibili che detiene in quel momento e per i quali non detiene alcun diritto all'aiuto. Tale diritto è subordinato all'esistenza di fondi disponibili in misura sufficiente nelle riserve nazionale o regionali. In caso contrario, l'assegnazione dovrà avvenire in modo da assicurare la parità di trattamento tra gli agricoltori ammissibili ai diritti ai sensi dell'articolo 30, paragrafo 6, del regolamento n. 1307/2013 e da evitare distorsioni del mercato e della concorrenza.

CGUE, 4/02/2021, C-640/19
Rinvio pregiudiziale – Agricoltura – Organizzazione comune dei mercati – Regolamento (CE) n. 1234/2007 – Quote latte – Prelievi sulle eccedenze – Latte rivolto alla produzione di formaggi che beneficiano di una denominazione d'origine protetta (DOP) e sono destinati all'esportazione verso paesi terzi – Esclusione – Articolo 32, lettera a), articolo 39, paragrafi 1 e 2, lettera a), articolo 40, paragrafo 2, e articolo 41, lettera b), TFUE – Principi di proporzionalità e di non discriminazione – Validità
1) Gli articoli 55, 65 e 78 del regolamento (CE) n. 1234/2007 del Consiglio, del 22 ottobre 2007, recante organizzazione comune dei mercati agricoli e disposizioni specifiche per taluni prodotti agricoli, come modificato dal regolamento (CE) n. 248/2008 del Consiglio, del 17 marzo 2008, devono essere interpretati nel senso che essi non escludono dal calcolo delle quote nazionali per la produzione di latte e di altri prodotti lattiero-caseari, nonché dal calcolo dei prelievi sulle eccedenze, i quantitativi di latte rivolti alla produzione di formaggi che beneficiano di una denominazione d'origine protetta e sono destinati ad essere esportati verso paesi terzi.
2) L'esame della terza questione pregiudiziale non ha rivelato alcun elemento idoneo ad inficiare la validità degli articoli 55, 65 e 78 del regolamento n. 1234/2007, come modificato dal regolamento n. 248/2008.

CGUE, 27 gennaio 2021, C-361/19, *De Ruiter vof contro Minister van Landbouw, Natuur en Voedselkwaliteit*
Rinvio pregiudiziale – Politica agricola comune – Regime di sostegno agli agricoltori – Regolamento (UE) n. 1306/2013 – Articolo 97, paragrafo 1, e articolo 99, paragrafo 1 – Pagamenti diretti – Riduzioni ed esclusioni in caso di inosservanza delle regole di condizionalità – Determinazione dell'anno da prendere in considerazione ai fini del calcolo della percentuale di riduzione – Sanzioni proporzionate, effettive e dissuasive – Regolamento di esecuzione (UE) n. 809/2014 – Articolo 73, paragrafo 4, primo comma, lettera a)
L'articolo 97, paragrafo 1, primo comma, e l'articolo 99, paragrafo 1, primo comma, del regolamento (UE) n. 1306/2013 del Parlamento europeo e del Consiglio, del 17 dicembre 2013, sul finanziamento, sulla gestione e sul monitoraggio della politica agricola comune e che abroga i regolamenti del Consiglio (CEE) n. 352/78, (CE) n. 165/94, (CE) n. 2799/98, (CE) n. 814/2000, (CE) n. 1290/2005 e (CE) n. 485/2008, nonché l'articolo 73, paragrafo 4, primo comma, lettera a), del regolamento di esecuzione (UE) n. 809/2014 della Commissione, del 17 luglio 2014, recante modalità di applicazione del regolamento n. 1306/2013

per quanto riguarda il sistema integrato di gestione e di controllo, le misure di sviluppo rurale e la condizionalità, devono essere interpretati nel senso che le riduzioni dei pagamenti diretti per inosservanza delle regole di condizionalità devono essere calcolate sulla base dei pagamenti corrisposti o da corrispondere per l'anno in cui si è verificata tale inosservanza.

ALIMENTI

CGUE, 15/04/2021, C-53/20, Hengstenberg GmbH & Co. KG contro Spreewaldverein eV

Rinvio pregiudiziale – Protezione delle indicazioni geografiche e delle denominazioni d'origine dei prodotti agricoli ed alimentari – Regolamento (UE) n. 1151/2012 – Articolo 49, paragrafo 3, primo comma e paragrafo 4, secondo comma – Articolo 53, paragrafo 2, primo comma – Modifica del disciplinare di un prodotto – Cetriolini della Foresta della Sprea (Germania) "Spreewälder Gurken (IGP)" – Modifiche non minori – Opposizione – Dichiarazione di opposizione alla domanda di modifica – Ricorso contro la decisione che accoglie tale domanda – Nozione di "interesse legittimo"

L'articolo 49, paragrafo 3, primo comma, e paragrafo 4, secondo comma, del regolamento (UE) n. 1151/2012, del Parlamento europeo e del Consiglio, del 21 novembre 2012, sui regimi di qualità dei prodotti agricoli e alimentari, in combinato disposto con l'articolo 53, paragrafo 2, primo comma, di quest'ultimo, deve essere interpretato nel senso che, nell'ambito della procedura applicabile alle domande di modifica non minore del disciplinare di un prodotto che beneficia di un'indicazione geografica protetta, ogni persona fisica o giuridica che subisca un pregiudizio economico, reale o potenziale, però non del tutto inverosimile, dalle modifiche richieste può vantare l'«interesse legittimo» richiesto per dichiarare un'opposizione alla domanda di modifica presentata o per proporre ricorso contro la decisione che accoglie detta domanda, qualora il rischio di pregiudizio agli interessi di tale persona non sia puramente improbabile o ipotetico, circostanza che spetta al giudice del rinvio verificare.

Corte cost., 09/03/2021, n. 31

Alimenti - Definizione e promozione dell'utilizzo, nelle mense scolastiche, dei prodotti a chilometro zero e da filiera corta selezionati in base al collegamento con il territorio regionale - Violazione della competenza esclusiva statale in materia di tutela della concorrenza e della libera circolazione dei prodotti nel territorio nazionale - Illegittimità costituzionale

Sono dichiarati costituzionalmente illegittimi - per violazione degli artt. 117, secondo comma, lett. e), e 120 Cost. - gli artt. 2, 3 e 4 della legge reg. Toscana n. 75 del 2019, che definiscono e promuovono l'utilizzo, nelle mense scolastiche, dei prodotti a chilometro zero e da filiera corta selezionati in base al collegamento con il territorio regionale. Le norme impugnate dal Governo, pur perseguendo il fine di valorizzare i prodotti del territorio - di per sé non illegittimo - realizzano siffatto obiettivo favorendo i prodotti e i produttori regionali, con una evidente discriminazione per chi faccia uso di prodotti di diversa provenienza. Infatti, in difformità da quanto previsto dalla normativa statale, le definizioni dei prodotti a

chilometro zero e da filiera corta non si collegano, in quanto tali, a un criterio di prossimità tra produzione e vendita, né a un trasporto delle merci breve o con una bassa emissione di sostanze inquinanti, ma fanno una selezione in base al collegamento con il territorio regionale. In tal modo le disposizioni impugnate non solo non favoriscono la concorrenza, ma chiaramente la alterano; il che si risolve altresì in un ostacolo alla libera circolazione delle merci. La declaratoria d'illegittimità costituzionale deve estendersi anche all'art. 2, comma 3 - che si limita a far rientrare i prodotti a denominazione protetta o a marchio tutelato (oggetto, tra l'altro, di specifiche disposizioni di diritto europeo), ove ne rispettino i requisiti, nelle definizioni di chilometro zero e filiera corta - che, in virtù del rapporto di stretta concatenazione oggettiva e funzionale con le censurate disposizioni resta privo di autonoma portata normativa. Le procedure di selezione dei concorrenti e i criteri di aggiudicazione degli appalti pubblici sono ascrivibili alla materia della tutela della concorrenza di cui all'art. 117, secondo comma, lett. e), Cost. - che riflette la definizione operante in ambito comunitario - nella specie alla concorrenza «per il mercato»

AMBIENTE

CGUE, 12/05/2021, C-87/20, *Hauptzollamt B contro XY*

Protezione di specie della flora e della fauna selvatiche mediante il controllo del loro commercio – Regolamenti (CE) nn. 338/97 e 865/2006 – Caviale delle specie di storione – Introduzione nel territorio doganale dell'Unione europea a titolo di oggetti personali o domestici – Licenza di importazione – Deroga – Quantitativo massimo di 125 grammi per persona – Superamento – Intenzione di donare a terzi

1) L'articolo 7, paragrafo 3, del regolamento (CE) n. 338/97 del Consiglio, del 9 dicembre 1996, relativo alla protezione di specie della flora e della fauna selvatiche mediante il controllo del loro commercio, come modificato dal regolamento (UE) n. 1320/2014 della Commissione, del 1° dicembre 2014, deve essere interpretato nel senso che il caviale delle specie di storione, al momento della sua introduzione nel territorio doganale dell'Unione europea, può essere considerato un «oggetto personale o domestico» ai sensi di tale disposizione, qualora sia destinato a essere regalato a terzi, purché da nessun elemento emerga una finalità commerciale, e può pertanto beneficiare della deroga, prevista da detta disposizione, all'obbligo per il suo importatore di presentare una licenza di importazione.

2) L'articolo 57, paragrafo 5, lettera a), del regolamento (CE) n. 865/2006 della Commissione, del 4 maggio 2006, recante modalità di applicazione del regolamento n. 338/97, come modificato dal regolamento (UE) 2015/870 della Commissione, del 5 giugno 2015, deve essere interpretato nel senso che, ove il quantitativo di caviale delle specie di storione introdotto nel territorio doganale dell'Unione europea superi il quantitativo massimo di 125 grammi per persona e l'importatore non sia in possesso di una licenza rilasciata ai fini dell'importazione effettuata, l'intero quantitativo di caviale delle specie di storione in tal modo importato dovrà essere confiscato dall'autorità doganale competente.

CGUE, 29/04/2021, C-617/19, *Granarolo SpA contro Ministero dell'Ambiente e della Tutela del Territorio e del Mare e a.*

Rinvio pregiudiziale – Ambiente – Direttiva 2003/87/CE – Sistema per lo scambio di quote di emissioni dei gas a effetto serra – Articolo 3, lettera e) – Nozione di "impianto" – Articolo 3, lettera f) – Nozione di "gestore" – Allegato I, punti 2 e 3 – Regola dell'aggregazione – Somma delle capacità delle attività di un impianto – Cessione di un'unità di cogenerazione di energia elettrica e calore da parte del proprietario di uno stabilimento industriale – Contratto di fornitura di energia tra le imprese cedente e cessionaria – Aggiornamento dell'autorizzazione ad emettere gas a effetto serra

L'articolo 3, lettere e) e f), della direttiva 2003/87/CE del Parlamento europeo e del Consiglio, del 13 ottobre 2003, che istituisce un sistema per lo scambio di quote di emissioni dei gas a effetto serra nella Comunità e che modifica la direttiva 96/61/CE del Consiglio, come modificata dalla direttiva 2009/29/CE del Parlamento europeo e del Consiglio, del 23 aprile 2009, in combinato disposto con i punti 2 e 3 dell'allegato I della stessa, deve essere interpretato nel senso che esso non osta a che il proprietario di uno stabilimento produttivo dotato di una centrale termica la cui attività rientra nell'ambito di applicazione di tale allegato I possa ottenere un aggiornamento della sua autorizzazione ad emettere gas a effetto serra, ai sensi dell'articolo 7 di tale direttiva, se ha ceduto un'unità di cogenerazione situata nello stesso sito industriale di tale stabilimento ed esercente un'attività con una capacità inferiore alla soglia stabilita in detto allegato I ad un'impresa specializzata nel settore dell'energia, concludendo con tale impresa un contratto che prevede, in particolare, la fornitura a detto stabilimento dell'energia prodotta da tale unità di cogenerazione, sempre che la centrale termica e l'unità di cogenerazione non costituiscano un solo ed unico impianto, ai sensi dell'articolo 3, lettera e), di detta direttiva, e che, in ogni caso, il proprietario dello stabilimento produttivo non sia più il gestore dell'unità di cogenerazione, ai sensi dell'articolo 3, lettera f), della medesima direttiva

CGUE, 04/03/2021, C-473-474/19, *Föreningen Skydda Skogen e a. contro Länsstyrelsen i Västra Götalands län e a.*

Rinvio pregiudiziale – Ambiente – Direttiva 92/43/CEE – Conservazione degli habitat naturali e della flora e della fauna selvatiche – Articolo 12, paragrafo 1 – Direttiva 2009/147/CE – Conservazione degli uccelli selvatici – Articolo 5 – Silvicoltura – Divieti diretti a garantire la conservazione delle specie protette – Progetto di disboscamento definitivo – Sito ospitante specie protette

1) L'articolo 5 della direttiva 2009/147/CE del Parlamento europeo e del Consiglio, del 30 novembre 2009, concernente la conservazione degli uccelli selvatici, dev'essere interpretato nel senso che osta ad una prassi nazionale in base alla quale i divieti previsti da tale disposizione riguardino unicamente le specie elencate nell'allegato I di tale direttiva, quelle minacciate ad un certo livello o la cui popolazione presenti una tendenza alla diminuzione a lungo termine.

2) L'articolo 12, paragrafo 1, lettere da a) a c), della direttiva 92/43/CEE del Consiglio, del 21 maggio 1992, relativa alla conservazione degli habitat naturali e seminaturali e della flora e della fauna selvatiche, dev'essere interpretato nel senso che, da un lato, osta ad una prassi nazionale secondo la quale, laddove l'oggetto di un'attività umana, quale la silvicoltura o l'utilizzazione del territorio, sia manifestamente diverso dall'uccisione o dalla perturbazione di specie animali, i divieti previsti da tale disposizione si applichino unicamente

a condizione che sussista un rischio di impatto negativo sullo stato di conservazione delle specie interessate e, dall'altro, la protezione offerta da tale disposizione non cessa di applicarsi alle specie che hanno raggiunto uno stato di conservazione soddisfacente.
3) L'articolo 12, paragrafo 1, lettera d), della direttiva 92/43 dev'essere interpretato nel senso che osta ad una prassi nazionale secondo la quale, nel caso in cui la permanenza della funzionalità ecologica dell'habitat naturale della specie interessata in una determinata zona sia, nonostante le precauzioni prese, perduto per deterioramento, distruzione o degradazione, direttamente o indirettamente, per effetto dell'attività in questione considerata isolatamente o cumulativamente con altre, il divieto previsto dalla disposizione suddetta non operi fino a quando lo stato di conservazione della specie in questione rischi di deteriorarsi.

CGUE, 15 aprile 2021, C-470/19, *Friends of the Irish Environment Ltd contro Commissioner for Environmental Information*
Rinvio pregiudiziale – Convenzione di Aarhus – Direttiva 2003/4/CE – Diritto di accesso alle informazioni ambientali detenute dalle autorità pubbliche – Articolo 2, punto 2 – Nozione di "autorità pubblica" – Organi o istituzioni che agiscono nell'esercizio del potere giudiziario – Informazioni contenute nel fascicolo di un procedimento giurisdizionale chiuso
L'articolo 2, punto 2, della direttiva 2003/4/CE del Parlamento europeo e del Consiglio, del 28 gennaio 2003, sull'accesso del pubblico all'informazione ambientale e che abroga la direttiva 90/313/CEE del Consiglio, deve essere interpretato nel senso che esso non disciplina l'accesso alle informazioni ambientali contenute nei fascicoli giudiziari, nei limiti in cui gli organi giurisdizionali o le istituzioni poste sotto il loro controllo, e che presentano quindi stretti legami con questi ultimi, non costituiscono «autorità pubbliche» ai sensi di tale disposizione e non rientrano dunque nell'ambito di applicazione di tale direttiva.

CGUE, 14 gennaio 2021, C-826/18, *LB e a. contro College van burgemeester en wethouders van de gemeente Echt-Susteren*
Rinvio pregiudiziale – Convenzione di Aarhus – Articolo 9, paragrafi 2 e 3 – Accesso alla giustizia – Mancato accesso alla giustizia per il pubblico diverso dal pubblico interessato – Ricevibilità del ricorso subordinata alla previa partecipazione al processo decisionale.
1) L'articolo 9, paragrafo 2, della convenzione sull'accesso alle informazioni, la partecipazione del pubblico ai processi decisionali e l'accesso alla giustizia in materia ambientale, firmata ad Aarhus (Danimarca) il 25 giugno 1998 e approvata a nome della Comunità europea con la decisione 2005/370/CE del Consiglio, del 17 febbraio 2005, deve essere interpretato nel senso che esso non osta a che i membri del «pubblico» di cui all'articolo 2, paragrafo 4, di tale convenzione non abbiano accesso in quanto tali alla giustizia, al fine di impugnare una decisione rientrante nell'ambito di applicazione dell'articolo 6 della medesima. Per contro, l'articolo 9, paragrafo 3, di detta convenzione osta a che tali persone non possano avere accesso alla giustizia per avvalersi di più ampi diritti di partecipazione al processo decisionale, che siano loro conferiti unicamente dal diritto ambientale nazionale di uno Stato membro.
2) L'articolo 9, paragrafo 2, della convenzione sull'accesso alle informazioni, la partecipazione del pubblico ai processi decisionali e l'accesso alla giustizia in materia ambientale, fir-

mata ad Aarhus il 25 giugno 1998 e approvata a nome della Comunità europea con la decisione 2005/370, deve essere interpretato nel senso che osta a che la ricevibilità dei ricorsi giurisdizionali a cui esso si riferisce, esperiti da organizzazioni non governative facenti parte del «pubblico interessato», di cui all'articolo 2, paragrafo 5, di tale convenzione, sia subordinata alla partecipazione di tali organizzazioni alla procedura di preparazione relativa alla decisione impugnata, anche se tale condizione non si applica qualora non possa essere loro ragionevolmente addebitato di non avervi partecipato. Per contro, l'articolo 9, paragrafo 3, di detta convenzione non osta a che la ricevibilità di un ricorso giurisdizionale a cui esso si riferisce sia subordinata alla partecipazione del ricorrente alla procedura di preparazione relativa alla decisione impugnata a meno che, tenuto conto delle circostanze del caso, il fatto di non essere intervenuto in tale procedura non gli possa essere ragionevolmente addebitato.

BOSCHI E FORESTE

Cass. pen., Sez. III, 3/03/2021, n. 8499
Bellezze naturali - Alberi - Abbattimento di alberi di alto fusto in area sottoposta a vincolo paesaggistico in assenza o in difformità della prescritta autorizzazione - Reato di deturpamento delle bellezze naturali di cui all'art. 734 c.p.
L'abbattimento di alberi in difetto della preventiva autorizzazione paesaggistica configura il reato di cui all'art. 181, d.lgs. n. 42 del 2004, in quanto attività idonea a compromettere i valori ambientali incidendo in modo apprezzabile sull'assetto del territorio. Commette il reato di deturpa-mento delle bellezze naturali di cui all'art. 734 c.p. chi effettui l'abbattimento di alberi di alto fusto in area sottoposta a vincolo paesaggistico in assenza o in difformità della prescritta autorizzazione

T.A.R. Puglia Bari, Sez. III, 06/04/2021, n. 577
Boschi e foreste – vincolo paesaggistico - recepimento in atti di pianificazione regionale
In tema di vincolo boschivo, lo stesso in quanto rilevante ex lege prescinde dal suo effettivo recepimento negli atti di pianificazione generale e/o dalla sua rappresentazione cartografica nella pianificazione paesaggistica, che al riguardo non interviene con effetti costituitivi limitandosi ad operare una mera ricognizione circa l'effettiva esistenza del bene tutelato in base alle sue qualità intrinseche.

BONIFICA

Cass. civ., Sez. Unite, 26/02/2021, n. 5422
Opere idrauliche – progettazione e realizzazione – affidamento a consorzi di bonifica – gestione dell'acqua – responsabilità ex art. 2051 c.c. - presupposti
Considerato che le funzioni di progettazione, realizzazione e gestione delle opere idrauliche, nonché i conseguenti poteri di custodia, possono essere dalle Regioni delegate ai consorzi di bonifica o ai concessionari delle relative opere, la cui posizione, quindi, deve essere valu-

tata di volta in volta sulla base delle singole legislazioni regionali (tenendo presente quanto stabilito a livello statale in tema di classificazione delle opere idrauliche e riparto dei relativi compiti di gestione e manutenzione, nonché di esecuzione delle opere di attuazione del piano generale di bonifica), occorre verificare se ed in quale misura il consorzio di bonifica sia, nel caso concreto, realmente investito di funzioni di manutenzione dei corsi d'acqua, con conseguente insorgenza di responsabilità a titolo di custodia, ai sensi dell'art. 2051 cod. civ. Ciò posto, l'inserimento espresso di un bacino (di cui fa parte l'alveo la cui esondazione, a causa di forti piogge, ha recato danni ad un provato) nel territorio del Consorzio, da un lato, esclude la necessità di un apposito atto di consegna da parte della Regione e, dall'altro, attribuisce all'ente compiti di manutenzione, restando irrilevante verificare se, in concreto, il Consorzio abbia o meno proceduto alla predisposizione di un piano di classifica e di contribuzione consortile, esigendone il pagamento.

CACCIA E PESCA

CGUE, Sez. I, 17/03/2021, n. 900/19

Rinvio pregiudiziale – Ambiente – Direttiva 2009/147/CE – Conservazione degli uccelli selvatici – Articoli 5 e 8 – Divieto di ricorrere a qualsiasi metodo di cattura degli uccelli – Articolo 9, paragrafo 1 – Autorizzazione a ricorrere in virtù di una deroga a un siffatto metodo consacrato dagli usi tradizionali – Presupposti – Assenza di altra soluzione soddisfacente – Giustificazione dell'assenza di "altra soluzione soddisfacente" con la sola preservazione di detto metodo tradizionale – Selettività delle catture – Normativa nazionale che autorizza la cattura di uccelli tramite l'impiego di vischio

1) L'articolo 9, paragrafi 1 e 2, della direttiva 2009/147/CE del Parlamento europeo e del Consiglio, del 30 novembre 2009, concernente la conservazione degli uccelli selvatici, deve essere interpretato nel senso che il carattere tradizionale di un metodo di cattura di uccelli non è sufficiente, di per sé, a dimostrare che un'altra soluzione soddisfacente, ai sensi di tale disposizione, non possa sostituirsi a detto metodo.

2) L'articolo 9, paragrafo 1, lettera c), della direttiva 2009/147 deve essere interpretato nel senso che esso osta a una normativa nazionale che autorizza, in deroga all'articolo 8 di tale direttiva, un metodo di cattura che comporta catture accessorie, qualora queste ultime, pur essendo di volume esiguo e di una durata limitata, siano idonee ad arrecare alle specie non bersaglio catturate danni che non siano trascurabili.

Inizio modulo

Fine modulo

Corte cost., 06/07/2021, n. 138

Caccia – appostamenti temporanei su fondi altrui – consenso implicito del proprietario – competenza statale

È fondata la questione di legittimità costituzionale sollevata in relazione all'art. 2, comma 1, 6 e 9 della legge della Regione Liguria 19 maggio 2020, n. 9 che ha aggiunto, nella parte finale dell'art. 29, comma 13, della legge della Regione Liguria 1° luglio 1994, n. 29 (Norme regionali per la protezione della fauna omeoterma e per il prelievo venatorio),

un ulteriore periodo ai sensi del quale "il consenso si intende validamente accordato nel caso in cui non esiste un formale diniego". La disposizione impugnata è ritenuta in contrasto con la riserva di competenza legislativa allo Stato in materia di «ordinamento civile» di cui all'art. 117, secondo comma, lett. l), Cost. in quanto, consentendo ai cacciatori di mantenere, se il proprietario non manifesta espressamente il suo dissenso, sul fondo altrui il materiale utilizzato per la costruzione degli appostamenti temporanei, inciderebbe sulle facoltà dominicali garantite dall'art. 832 c.c. Invero la disciplina del diritto di proprietà attiene alla competenza esclusiva dello Stato in materia di ordinamento civile e l'ordinamento del diritto privato si pone quale limite alla legislazione regionale, in quanto fondato sull'esigenza, sottesa al principio costituzionale di eguaglianza, di garantire sul territorio nazionale l'uniformità della disciplina dettata per i rapporti tra privati. Il limite dell'ordinamento civile, quindi, identifica un'area riservata alla competenza esclusiva della legislazione statale e comprende i rapporti tradizionalmente oggetto di codificazione. Nel caso in esame, la norma impugnata nell'aggiungere nella parte finale dell'art. 29, un ulteriore periodo, introduce una presunzione di consenso del proprietario del fondo al mantenimento su di esso del materiale usato per la costruzione degli appostamenti temporanei, che eccede i limiti del legittimo intervento del legislatore regionale, invadendo la competenza riservata allo Stato nella materia "ordinamento civile".

Corte cost., 03/06/2021, n. 116

Piani di abbattimento della fauna – partecipazione dei cacciatori - corsi di formazione – approvazione del ISPRA

È costituzionalmente illegittimo l'art. 1, comma 1, lettera a), della legge della Regione Sardegna 27 febbraio 2020, n. 5 (Modifiche all'articolo 6 della legge regionale n. 23 del 1998 in materia di piani di abbattimento), che sostituisce l'art. 6, comma 1, lettera f), della legge della Regione Sardegna 29 luglio 1998, n. 23 (Norme per la protezione della fauna selvatica e per l'esercizio della caccia in Sardegna), nella parte in cui non prevede che i corsi di formazione specifici, ai quali devono aver partecipato i meri cacciatori delegati dai proprietari e conduttori dei fondi su cui vanno attuati i piani di abbattimento della fauna selvatica, siano concordati con l'Istituto superiore per la protezione e la ricerca ambientale (ISPRA). Il controllo della fauna selvatica è demandato alle Regioni, ai sensi dell'art. 19 della legge n. 157 del 1992 e deve essere espletato mediante il ricorso a metodi ecologici e, solo allorché l'Istituto nazionale per la fauna selvatica (oggi Istituto superiore per la protezione e la ricerca ambientale – ISPRA) abbia verificato l'inefficacia di tali metodi ecologici, le Regioni possono autorizzare piani di abbattimento. Orbene, con riferimento alla delegabilità degli abbattimenti a soggetti diversi dai proprietari e conduttori (muniti solo di un'autorizzazione alla caccia), i corsi di cui alla norma censurata non risultano pienamente idonei a legittimare l'ampliamento dell'elenco dei soggetti autorizzati agli abbattimenti, di cui all'art. 19 della legge n. 157 del 1992, in quanto non è previsto che i corsi in questione siano concordati con l'Istituto superiore per la protezione e la ricerca ambientale, con conseguente illegittimità costituzionale della norma in parola.

Corte cost., 31/05/2021, n. 113

Caccia – controllo del prelievo venatorio – estensione del periodo per specie la cui presenza sul territorio sia divenuta eccessiva e critica – illegittimità

È *costituzionalmente illegittimo l'art. 12, comma 5, lett. a), della legge della Regione Molise 30 aprile 2020, n. 1 (Legge di stabilità regionale 2020), che aggiunge il comma 1-bis all'art. 27 della legge della Regione Molise 10 agosto 1993, n. 19 (Norme per la protezione della fauna selvatica omeoterma e per il prelievo venatorio). Il legislatore regionale, nell'esercizio della propria competenza legislativa residuale in materia di caccia, ha, infatti, violato l'art. 117, comma 2, lett. s), Cost., perché ha ridotto il livello di protezione della fauna selvatica stabilito – mediante la definizione della durata dei periodi venatori – dall'art. 18, commi 1 e 2, della legge n. 157 del 1992. Altresì, l'art. 27, comma 1-bis, della legge Reg. Molise n. 19 del 1993, introdotto dalla norma impugnata, attraverso l'indebita estensione dell'arco temporale del periodo del prelievo venatorio di determinate specie, la cui presenza sul territorio sia divenuta "eccessiva" e fonte di conseguenti "criticità", ha introdotto, nella sostanza, una surrettizia forma di controllo faunistico, svincolata però dai precisi limiti procedimentali previsti dal legislatore statale. Siffatta disciplina compromette pertanto il principio di gradualità e riduce lo standard minimo di tutela posto dal legislatore statale, così violando l'art. 117, secondo comma, lett. s), Cost., con conseguente declaratoria di incostituzionalità della norma censurata.*

Corte cost., 17/02/2021, n. 21

Caccia - Norme della Regione Toscana - Interventi di tutela della produzione agricola e zootecnica - Affiancamento del personale regionale - Soggetti che abbiano frequentato appositi corsi di preparazione regionali sulla base di programmi concordati con l'ISPRA - Denunciata violazione della competenza esclusiva statale in materia di tutela dell'ambiente - Insussistenza - Non fondatezza della questione

Sono dichiarate non fondate le questioni di legittimità costituzionale - sollevate dal TAR Toscana in riferimento all'art. 117, secondo comma, lett. s), Cost. - dell'art. 37, comma 4, della legge reg. Toscana n. 3 del 1994, secondo cui per interventi di tutela della produzione agricola e zootecnica, compresi i piani di abbattimento, la Regione può affiancare al proprio personale anche soggetti che abbiano frequentato appositi corsi di preparazione organizzati dalla Regione stessa sulla base di programmi concordati con l'ISPRA. La norma censurata, integrando l'elenco di cui all'art. 19, comma 2, della legge n. 157 del 1992, incrementa lo standard di tutela ambientale fissato dalla disposizione statale. Il coinvolgimento dei cacciatori nei piani di abbattimento è infatti subordinato all'acquisizione di una specifica formazione, concordata con l'ISPRA, nonché sottoposto al coordinamento della polizia provinciale.

T.A.R. Valle d'Aosta Aosta, Sez. Unica, 09/03/2021, n. 16

Caccia – individuazione delle specie cacciabili – temporanee limitazioni

L'indicazione generale delle specie cacciabili è rimessa al legislatore nazionale e per la Valle d'Aosta al legislatore regionale munito in materia di potestà esclusiva (si veda l'art. 30 della *L.R. n. 64 del 1994), ma ciò non esclude la possibilità di temporanee limitazioni al prelievo di alcune specie cacciabili adottabili con atto amministrativo, quale il calendario*

venatorio emesso con provvedimento regionale, il quale è un atto che ha un efficacia temporale limitata e che necessita di essere emanato ogni anno perché possono cambiare le circostanze concrete in cui è opportuno esercitare l'attività venatoria.

CONTRATTI AGRARI

Corte d'Appello Catanzaro, Sez. agraria, 18/03/2021

Contratti agrari – affitto - addizioni e miglioramenti – IAP – detrazione finanziamenti erogati

Ove rimanga accertata la qualifica di imprenditore agricolo a titolo principale dell'affittuario, a quest'ultimo non compete la detrazione dei finanziamenti erogati al fine della determinazione della misura dei miglioramenti, sul presupposto che la norma in discussione prevede che il suo computo è propriamente correlato alla configurazione di tale qualifica in capo alla parte affittuaria. Tanto viene spiegato dalla Corte territoriale sulla base di un'impostazione interpretativa, oltre che letterale, anche finalistica della controversa norma, siccome indirizzata, nel suo complesso, a favorire proprio chi esercita l'attività di impresa agricola a titolo principale.

IMPOSTE, TASSE E CONTRIBUTI

Cons. Stato, Sez. III, 12/07/2021, n. 5281

Debiti – Registro nazionale AGEA – iscrizione – equiparazione iscrizione a ruolo.

L'iscrizione nel Registro Nazionale dei debiti di cui all'art. 8 ter, 1° comma, della L. n. 33/2009, istituito presso AGEA, è equiparata all'iscrizione a ruolo delle somme dovute, ex art. 8 ter, 2° comma, L. n. 33/2009.

Cass. civ., Sez. V, Ordinanza, 10/06/2021, n. 16210

Piccola proprietà contadina – acquisto – agevolazioni fiscali – recupero imposte – prescrizione

In tema di agevolazioni fiscali previste per l'acquisto di terreni agricoli al fine della formazione della piccola proprietà contadina, il termine triennale di prescrizione previsto dall'art. 4, comma terzo, della l. n. 604 del 1954 per il recupero delle imposte ordinarie, decorrente dalla scadenza del termine concesso per la presentazione del certificato definitivo recante l'attestazione del possesso dei requisiti di cui al precedente art. 2, si applica tanto nel caso in cui l'acquirente sia già in possesso della certificazione definitiva al momento della registrazione dell'acquisto, quanto nel caso in cui tale certificazione sia conseguita successivamente.

Cass. civ., Sez. V, Ordinanza, 13/05/2021, n. 12852

Piccola proprietà contadina - Agevolazioni tributarie ici - Terreni edificabili destinati ad uso agricolo - Riduzione della base imponibile - Presupposti - Impre nditore agricolo professionale (iap) - Terreni ubicati in regione diversa da quella che ha riconosciuto la qualifica di iap

In tema di ICI, va esclusa l'agevolazione prevista dall'art. 2, comma 1, lett. b), d.lgs. n. 504 del 1992 per i terreni edificabili posseduti e condotti per l'esercizio di attività agricola da parte di imprenditore agricolo professionale, laddove i fondi siano ubicati in Regione diversa da quella che ha attribuito la qualifica di IAP, in quanto tale attribuzione tiene conto delle caratteristiche del singolo terreno regionale ai fini agricoli e, dunque, non può valere in modo generalizzato per l'intero territorio nazionale tenuto conto, altresì, che si è in presenza di norma di stretta interpretazione.

Cass. civ., Sez. V, Ordinanza, 12/02/2021, n. 3598

Piccola proprietà contadina - Agevolazioni tributarie - Agevolazioni fiscali in favore della piccola proprietà contadina ex art. 2 d.l. n. 194 del 2009 - Presupposti - Iscrizione alla gestione previdenziale ed assistenziale dei coltivatori diretti presso l'Inps - Necessità - Conseguenze - Perdita volontaria del requisito nel quinquennio dall'acquisto - Decadenza dal beneficio – Fattispecie

In tema di agevolazioni fiscali in favore della piccola proprietà contadina, il presupposto della iscrizione del coltivatore diretto o dell'imprenditore agricolo professionale nella relativa gestione previdenziale ed assistenziale, previsto dall'art. 2 del d.l. n. 194 del 2009 (conv., con modif., dalla l. n. 25 del 2010), ai fini della concessione delle agevolazioni per gli atti traslativi a titolo oneroso di terreni agricoli, non ha natura di requisito "istantaneo" (che deve ricorrere solo al momento dell'acquisto agevolato) ma - avuto riguardo al disposto dell'art. 1647 c.c. coordinato con quello delle disposizioni delle leggi speciali in materia (da cui si desume che l'obbligo di iscrizione nella gestione previdenziale dei coltivatori diretti è subordinato allo svolgimento di tale attività con abitualità e prevalenza rispetto ad altre eventuali attività lavorative) - deve essere caratterizzato dalla permanenza nel tempo, sicché la cancellazione dell'iscrizione per effetto di una condotta volontaria (nella specie, acquisizione dello "status" di pensionato, di per sé non incompatibile con la qualifica di coltivatore diretto) comporta la perdita dell'agevolazione ove si verifichi entro un quinquennio dall'acquisto, conformemente a quanto espressamente sancito dall'art. 2, comma 4 bis, del d.lgs. n. 99 del 2004, per il coltivatore diretto che sia socio o amministratore "qualificante" della società agricola.

Cass. civ., Sez. V, Ordinanza, 12/02/2021, n. 3597

Acquisto compendio agricolo – imposta di registro e ipotecaria – misura fissaInizio modulo

Fine modulo

L'atto di compravendita di un compendio agricolo costituito da terreni e fabbricati funzionali all'attività agricola compresi quelli destinati ad uso ufficio dell'azienda agricola e agrituristica ed i fabbricati abitativi rurali sconta l'imposta di registro e ipotecaria in misura fissa in quanto ciò che rileva è il rapporto di pertinenzialità che viene a configurarsi in funzione dell'attività di impresa.

Cass. civ., Sez. V, Ordinanza, 10/02/2021, n. 3260

Piccola proprietà contadina - Agevolazioni tributarie - Agevolazioni "ex lege" n. 604 del 1954 - Esercizio del diritto di riscatto agrario - Affitto del fondo rustico entro il quinquennio dal suo acquisto - Conseguenze - Decadenza dal beneficio – Fondamento

L'acquirente di un fondo rustico che abbia esercitato il diritto di riscatto agrario, avvalendosi delle agevolazioni fiscali relative all'acquisto della piccola proprietà contadina e che entro il quinquennio successivo affitti il bene a terzi, decade dal trattamento agevolativo, indipendentemente dal fatto che l'esercizio del diritto di riscatto comporti la sostituzione del riscattante nella posizione dell'originario acquirente con effetto retroattivo, essendo necessario, ai sensi dell'art. 7 della l. n. 604 del 1954, che egli provveda per cinque anni alla coltivazione diretta del fondo.

PRELAZIONE E RISCATTO

Cass. civ., Sez. III, 13/05/2021, n. 12894
Prelazione – denuntiatio – contenuto
In tema di prelazione agraria qualora la denuntiatio riguardi sia il fondo in affitto sia altri beni per i quali il diritto di prelazione non sussiste ed indichi, però, separatamente il prezzo dei cespiti, il titolare della prelazione può manifestare la volontà di acquistare soltanto il bene in affitto e non anche il bene estraneo, in tal modo rendendo effettiva la prelazione soltanto per il primo; e in questo caso si avrà una manifestazione idonea a determinare gli effetti del positivo esercizio della prelazione, con quanto ne consegue. Se, invece, com'è accaduto nel caso di specie, l'offerta non indica i prezzi diversificati per i beni assoggettati a prelazione rispetto agli altri, l'eventuale accettazione non potrà ritenersi come valida manifestazione di volontà all'interno dell'esercizio del diritto di prelazione.

Cass. civ., Sez. III, Ordinanza, 16/03/2021, n. 7292ì
Prelazione – concorso tra più prelazionari – individuazione.
In presenza di una pluralità di coltivatori diretti proprietari di terreni diversi, tutti confinanti con il fondo rustico posto in vendita, a ciascuno dei medesimi spetta il diritto di prelazione e riscatto di cui all'art. 7, comma 2, n. 2), della l. n. 817 del 1971, e, ove si verifichi una situazione di conflittualità, per effetto dell'esercizio della prelazione o riscatto da parte di due o più dei predetti confinanti, la scelta del soggetto preferito è compito riservato al giudice del merito, che dovrà accordare prevalenza ad uno piuttosto che agli altri aspiranti alla prelazione, alla stregua della maggiore o minore attitudine a concretare la finalità perseguita dalla citata norma ed in applicazione, inoltre, degli specifici criteri preferenziali dettati dall'art.7 del d.lgs. n.228 del 2001.

USI CIVICI

Cass. civ., Sez. Unite, Ordinanza, 26/03/2021, n. 8564
Usi civici - Giurisdizione del commissario regionale per la liquidazione degli usi civici - Contenuto - "qualitas soli" antecedente logico-giuridico della decisione - Impugnazione di atto amministrativo - Giurisdizione dell'a.g.a. - Configurabilità – Limiti
La giurisdizione del commissario per la liquidazione degli usi civici sussiste ogniqualvolta la valutazione o l'accertamento della natura ed estensione del diritto di uso civico - cioè, la

"qualitas soli" - si pongono come antecedente logico-giuridico della decisione; pertanto, in caso di impugnazione di atto amministrativo, la giurisdizione spetta al g.a. soltanto se le questioni dedotte sono dirette a censurare l'iter procedimentale, antecedentemente rispetto ad ogni indagine sulla qualità demaniale collettiva dei terreni.

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