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Urban Planning for Transit-Oriented Development: An application in the Naples metropolitan area

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Abstract

Transit-oriented development (TOD) is a planning strategy that aims to concentrate jobs, housing, and services around mass transit stations to make cities more sustainable, productive, and liveable. There is no one-size-fits-all strategy, and TOD principles cannot be uniformly applied across an entire city or transit network. This paper provides an innovative methodology to assess areas around transit nodes and supports decision-makers in identifying critical assets for investment. The developed methodology utilises Bertolini's node-place model (1996), classifying station nodes according to their transit characteristics (transit features) and the quality of the spaces (open areas) and the built environment (built development). The proposed methodology is applied to the Naples metropolitan area (Italy), which includes 92 municipalities and over 3 million inhabitants. The study identified significant transit corridors and urban hotspots within the study area, where integrated transport and urban strategies would effectively promote more sustainable development.

Keywords: Urban areas; Transit-Oriented Development; Naples.

1. Introduction

Transit-Oriented Development (TOD) is becoming a popular urban-planning strategy across the United States and Europe. It promotes urban revitalisation, smart growth, and sustainability (Tira, 2020) by densifying areas around mass transit nodes (both bus and rail-based), mixing land uses, and developing pedestrian-friendly environments. TOD is not new and dates back to earlier urban-planning theories, such as Garden and Linear cities (Ibraeva et al., 2020). TOD has become a key topic in urban and transport planning and has generated considerable interest in academic and professional circles (Bertolini, 2005; Cervero, 2004; Curtis, 2012).

TOD combines land-use and transport planning, urban design and regeneration, real estate development (Carpentieri et al., 2019), financing, land value capture, and infrastructure implementation to achieve more sustainable urban development. Hence, TOD assessment and implementation can be complex, also due to the fact that no single macro approach can be applied to different scales and territorial contexts. TOD is inherently context-specific and dependent on highly subjective sociocultural factors and local contingencies (Thomas et al., 2017; Liu et al., 2020; Su et al., 2021). A further challenge relates to implementing transit-oriented strategies and their integration into ordinary urban- and spatial-planning instruments. Since there is no one-size-fits-all strategy, preliminary assessments of transit nodes and their catchment areas are useful for suggesting integrated actions according to their characteristics. This is the objective of the node-place model promoted by Bertolini (1999) and subsequently adapted to different territorial contexts (Rausser et al., 2008; Vale, 2015; Papa E. and Bertolini, 2015; Caset et al., 2018). Since then, numerous scholars have worked to evolve the model.

The transformation of contemporary cities towards more sustainable models is a complex activity that involves, in its development, a multiplicity of actors and stakeholders with a plurality of skills and interests. Regional and urban planning involves a sequence of stages, in an iterative cycle, ranging from knowledge of the territory, through interpretation and modelling of data, to the design and monitor of ad hoc solutions to pursue objectives with a variable time horizon. The methodology we propose would be useful to provide policymakers a cognitive tool of the territory and its transit-oriented development, both in the state of the art and in forecasting project scenarios and in the monitoring phase. Hence, our work aims to develop an analytical method that allows the classification of station areas and suggests the scale and type of transit-oriented interventions. The methodology is suitable for use both in the knowledge phase prior to the design of urban areas, and for ex-post evaluations during the monitoring phase. It has been applied to the case study of a southern European city to enable sustainable development, which is a primary goal of urban policy (UN, 2019).

Cities are commercial, cultural, and intellectual centres as well as hubs for productivity, social development, and prosperity (del Hoyo et al., 2021). However, many challenges arise in urban environments that must be overcome to maintain thriving and productive workplaces and limit the use of non-renewable resources. These challenges include traffic congestion, lack of funds to provide equal access to basic living facilities, and the degradation of infrastructure and residential neighbourhoods (Baker, 2012). Innovative, sustainable approaches are necessary to facilitate the responsible growth and prosperity of urban areas, improve resource use, and limit pollution and social inequality (Porter and Van der Linde, 1995; Keirstead et al., 2008; Alawadi et al., 2021). Since transport is an essential part of cities' lives, many attempts have been made to foster sustainable development by promoting public transit.

Half the global population (3.5 billion people) lives in cities. This number is expected to increase to 60% by 2030. Urban environments represent only 3% of the world's land area, yet they account for 60–80% of energy consumption and more than 75% of greenhouse gas emissions (Sarkodie et al., 2020; Rosero et al., 2021). However, their high density of activity and infrastructure can enable efficiency and technological development, reducing the consumption of non-renewable resources and energy. Such reduction is essential for the TOD approach, which supports integrating urban- and transport-planning policies. The application of TOD principles to the existing urban environment is complex. However, the scientific literature widely recognises, in theory, the need to densify station areas with functional, high-quality mixed developments to foster sustainable transport use, including public transit (Fazio et al., 2020).

TOD presents a promising avenue of study. Although several applications were carried out in the early post-war years in Denmark and Sweden, the concept of TOD was not defined until the late 1980s, making it a relatively new concept in urban planning. TOD was born and primarily developed in US cities. Over the past 25–30 years, however, many interventions in European cities have adopted this approach in urban development and regeneration policies intended to improve accessibility and revitalise urban areas, yet most southern European cities lack a TOD approach. They consequently suffer problems deriving from a fragmentary approach to urban and transport planning. These cities initially evolved as compact, high-density cities, particularly in their centres. However, their urban structure has changed drastically over the last several decades due to rapid and often uncontrolled suburbanisation and urban dispersion. Despite the rich literature on TOD theories, examples of its application in these cities and practical strategies are lacking.

To address this gap, our work aims to develop a methodology to classify catchment areas of mass transit nodes in southern European cities, taking into account network attributes, open spaces, and the built environment around railway stations. Moreover, our research aims to develop a spatial analysis tool that can use the characteristics of the land-use transport subsystems to support decision-making processes of urban and territorial transformation governance.

The following section outlines the key issues of TOD methodology in the scientific literature. The third section introduces our methodology, after which we propose applying it to a significant case study: the Naples metropolitan area. Finally, the results and their potential applications to real-world practices are presented in the last section.

2. Literature review

The methodology we propose in our research is based on the well-known node-place model introduced by Bertolini (1996, 1999) to assess railway stations' performance by considering their transportation features (intensity and diversity of travel options) as well as their functional and territorial characteristics (intensity and diversity of activities within 700 m). In transport and land-use planning practices, the classification of railway stations is a necessary prior action to identify stations with comparable issues and to streamline their planning and management. Moreover, such preliminary assessment enables comparisons within different station classes, which identify successful benchmarks or highlight necessary interventions. In addition, classifications support the identification of general development potential and necessary future adaptations within classes and for entire classes.

From the perspective of urban planning, transport facilities (streets, stations, and transit stops) are considered as going beyond the status of functional elements that guarantee efficient mobility. Indeed, they can be considered as important components of a place. However, in the field of public transportation, the idea of transport infrastructure as urban places in all respects chiefly refers to major railway, metro, or intermodal stations. On the other hand, even if ordinary public transport stops are widespread through the city and physically integrated into the urban context, their role in shaping urban places is usually neglected. Technical variables, such as the time frequency of transport or infrastructural characteristics, are not sufficient to quantify the performance of station nodes as city places (Ceder, 2016; Kellermann, 2020).

Following Bertolini, several indexes were introduced to evaluate further issues of urban environments. Some scholars examined railway structures for their layout; the design and operation of their platforms; and their pathways, stairs, escalators, waiting areas, ticket booths, information, signage, buildings, shopping areas, parking spaces, and so on. Others introduced indexes to consider the functional mix of station catchment areas and their environments (organisation and dynamics of population, workplaces, shopping facilities, leisure and tourist attractions, public- and private-transport services, etc.). Since its initial applications to Utrecht and Amsterdam (Netherlands), the node-place model has been applied to various regional or national contexts (Reusser et al., 2008; Zemp et al., 2011; Vale and Pereira, 2016; Higgins and Kanaroglou, 2016; Caset et al., 2018; Lyu et al., 2016; Papa E. and Bertolini, 2015).

Assessment of transit-stop catchment areas supports the identification of key assets for public investment, development of land use, and realisation of transport-integrated solutions for metropolitan areas (Papa R. and Carpentieri, 2018). In a recent report (Salat & Olliver, 2017), the World Bank highlighted the capacity of transit-oriented urban transformations to create agglomeration effects proven to boost a city's competitiveness. Concentration around transit nodes creates vibrant communities with high-quality public areas and shorter commuting distances, thus making cities more liveable. Moreover, compact urban development and high-quality public transit mutually reinforce each other: mass transit can support the large passenger flows that come with high-density development. The concentration of jobs and housing around stations helps make public transport financially viable. Moreover, proximity to mass transit improves urban accessibility, boosting the attractiveness of cities and increasing real estate value. Cities can capture a part of these value increases and use it to finance additional transit improvements, affordable housing, and other initiatives that promote sustainable, inclusive growth. These considerations form the basis of the methodology are set out in this report, in which a third variable is added to the node and place variables: market-potential value, which refers to the unrealised market value of station areas. This is measured by combining the most significant variables able to influence the demand for land (current and future number of jobs in station proximity, number of jobs accessible by transit within 30 minutes, current and future housing densities) as well as supply (amount of developable land, possible changes in zoning policy, market vibrancy).

Our research aims to provide methodological advancements through an enhanced node-place model which will translate academic knowledge into solutions for urban-planning practice. We introduce variables to consider the transit features of nodes, open spaces, and the development of built environments within their catchment areas. Results show that stations and surrounding areas in the same transit and urban network with different functional orientations benefit from different development goals, which should be highlighted.

3. Methodology

Since the first application of Bertolini's model, several studies have introduced various indicators and methods to compute both node and place indexes.

In this research, we considered three main indicators for each railway station – T for transit features, O for open and green space development attributes, and D for variables related to the built environment – as the average of all standardised values of the same category (Bianconi et al., 2018).

Based on a systematic review of these studies, 19 indicators were selected from the literature and computed to assess the development of railway stations: seven refer to transit features, six to the presence of opportunities (jobs, green spaces, activities, etc.) within station catchment areas, and the remainder to the quality of the built environment (residential and territorial density, etc.). Only indicators that could be measured with publicly accessible data qualified for the list, allowing for transparency and applicability.

The selected indicators also met the following criteria: questionnaires distributed to 30 local experts (five urban researchers, five transport researchers, 10 urban planners, and 10 transport planners) and publicly accessible data (open data), in Italian, to calculate and contest the indicators. From the selection phase, we obtained the list of 19 indicators presented in Table 1.

After the selection of indicators and individuation of data required for the analysis, we defined a procedure of numerical and spatial analysis to calculate the three synthetic indicators of “transit”, “oriented”, and “development”. The steps of the methodology are displayed in Figure 1.

Table 1. The list of selected indicators for the TOD components.

	ID	*Description*	*Data source*
Transit	T1	Frequency	GTFS data and RFI
	T2	Intermodality	Google maps data and RFI
	T3	Interconnection	GTFS data
	T4	Infrastructure features	OSM
	T5	Number of stations within 20 min travel time	GTFS data
	T6	Closeness centrality	GTFS data
	T7	Transit travel time to major CBD	GTFS data
Oriented	O1	Walking topography	OSM
	O2	Urbanised area	Corine Land Cover
	O3	Mixed function	ISTAT
	O4	N° of interest points	OSM
	O5	Intersection density	OSM
	O6	Degree of attendance	Google maps data
Development	D1	Population density	ISTAT
	D2	Job density	ISTAT
	D3	Age mix	ISTAT
	D4	Job mix	ISTAT
	D5	Trips for studying	ISTAT
	D6	Trips for working	ISTAT

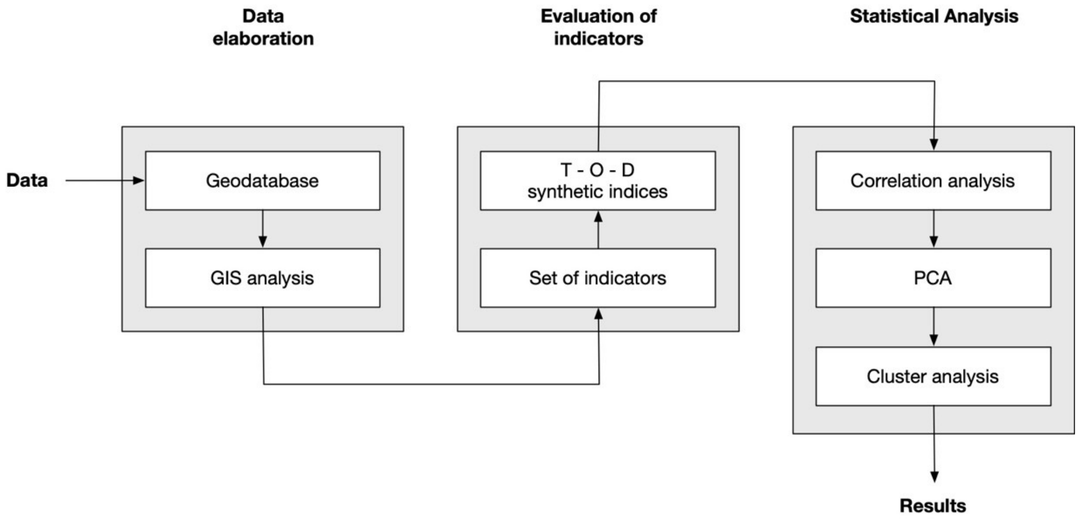

Figure 1: Methodology workflow.
Source: Authors' elaboration.

The first step of the methodology is the construction of a GIS (Geographical Information System) geodatabase to organise multiple sources of spatial and alphanumeric data on the study area and calculate the value of selected indicators. Then, for each station node, the analysis surface must be identified. In this case, it is the pedestrian catchment area of a station, defined by using the ESRI ArcGIS online network-analysis tool. For this analysis, we used the Open Street Map road network and a maximum of 10 minutes (800 m) walking distance from the station exits (Vale and Pereira, 2016; Rossetti et al., 2020). The third step involves calculating the values of indicators for each station. All indicators were standardised to have a minimum value of 0 and a maximum value of 1 (Reusser et al., 2008). In the fourth step, the three synthetic indexes (T, O, and D) are calculated as the average of all standardised values of the same indicator category. A correlation analysis is then carried out among the TOD indicators to explore their relationships prior to producing a categorisation of metro-station areas. Previous studies used the critical value 0.700 as the threshold to detect the dependence of measures (Dormann et al., 2013). A second statistical analysis is carried out in the sixth step to reduce collinearity among variables. The statistical literature provides several quantifications of collinearity, the most frequent being the correlation coefficient r (Douglass et al., 2003). Next, a cluster analysis is carried out to identify competitive transit corridors and potential development hotspots using the software package SPSS 20.00. Specifically, we apply a two-step clustering method that is frequently used in the node-place model application at the metro-regional scale. In addition, the optimal number of clusters for the analysis can be calculated through the Bayesian Information Criterion (BIC) (Reusser et al., 2008). Finally, numerical results are translated into maps and graphs for better usability.

The next step in our methodology concerns the identification of potential interventions to foster transit-oriented solutions in the station area. This step is missing in other research, but it could effectively support decision-making processes. Considering the domains of urban-planning transformation and their dimensions (which reflect the wide range of resources and actors involved), we identified three areas and four scales of actions.

The typologies of intervention derive from the three components used to assess the catchment areas of transit nodes and concern transit features, the quality of open and public spaces, and the development of the built environment. The scale of intervention depends on the features of stations within the whole network as well as on actors and stakeholders involved in transit-oriented transformation of urban areas. Metropolitan areas, transport corridors, stations areas, and station buildings have been identified as potential dimensions of action.

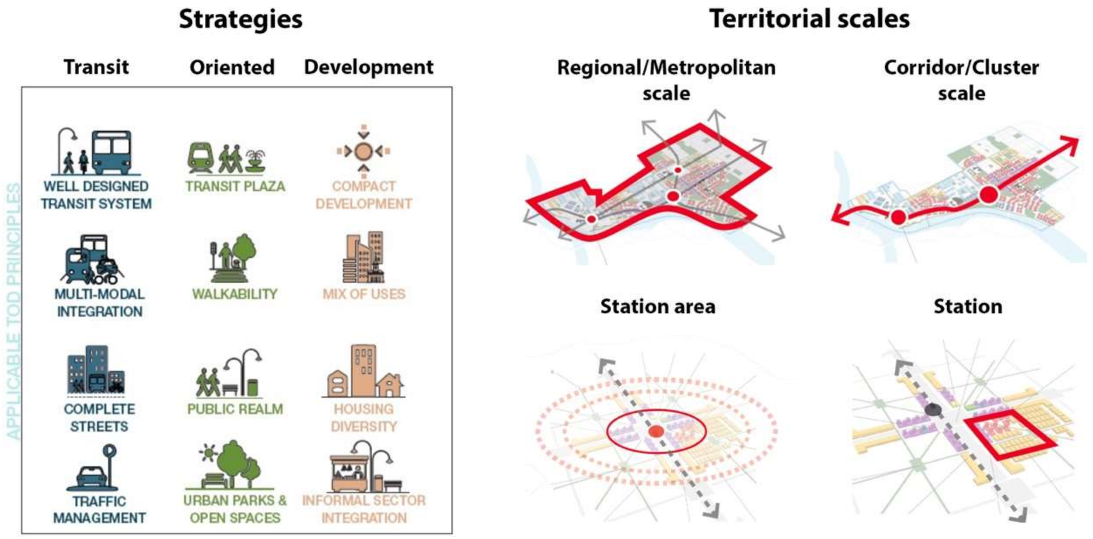

Figure 2: TOD strategies and territorial scales.
Source: Authors' elaboration from the "Transit-Oriented Development Implementation Resources and Tools" (World Bank, 2017).

The sample of interventions has been organised in a matrix and is based on the literature review. Figure 2 is the graphic synthesis of potential strategies and interventions, considering their territorial scale and main topic.
In the next section, the application of the methodology to a significant case study is discussed.

4. Naples metropolitan area

We selected the Naples metropolitan area as the study area to test the proposed methodology. It is one of 11 Italian metropolitan cities defined in 2014 by the Italian National Government (L. n. 56/2014). This metropolitan area includes 92 municipalities and with over 3 million inhabitants; it has one of the highest population-density values in the world. In the last two decades, this area has seen the implementation of several strategies for land use and transport-integrated development on an expanded scale, such as the "Piano delle 100 stazioni" (Plan of 100 Stations) for the municipality of Naples (Papa E. and Pagliara, 2011; Carpentieri, 2017) and regional and metropolitan strategies to integrate various railway lines and services into the urban-planning development (Cascetta and Pagliara, 2008; Papa R. and Carpentieri, 2018). The railway network of the Naples metropolitan area, shown in in Figure 3, is managed by three transport companies:

ANM (Azienda Napoletana Mobilità – Naples Mobility Company), which operates in Naples using Lines 1 and 6; EAV (Ente Autonomo Volturno – Volturno Indipendent Agency), which manages the following lines spread throughout the whole Naples metropolitan area: Cumana-Circumflegrea, Circumvesuviana, Alifana and Metro Nord-Est; and RFI (Rete Ferroviaria Italiana – Italian Railway Network), which manages Line 2 in the municipality of Naples and other regional lines.

There are 170 active stations in the Naples metropolitan railway network. The level of service and the main features of each station are very different, from the new metro-art stations in the Naples city centre to tiny and isolated stations in peripheral areas. Recently, the railway companies and local authorities have formed joint projects to improve the quality and safety of station buildings and their surrounding areas. In 2019, the Campania Region and EAV planned to renovate 52 stations with an investment of 28 million euros as a part of the Smart Station project. The amount of resources at stake to improve the service quality of Campania railway lines proves the liveliness and interest of the topic.

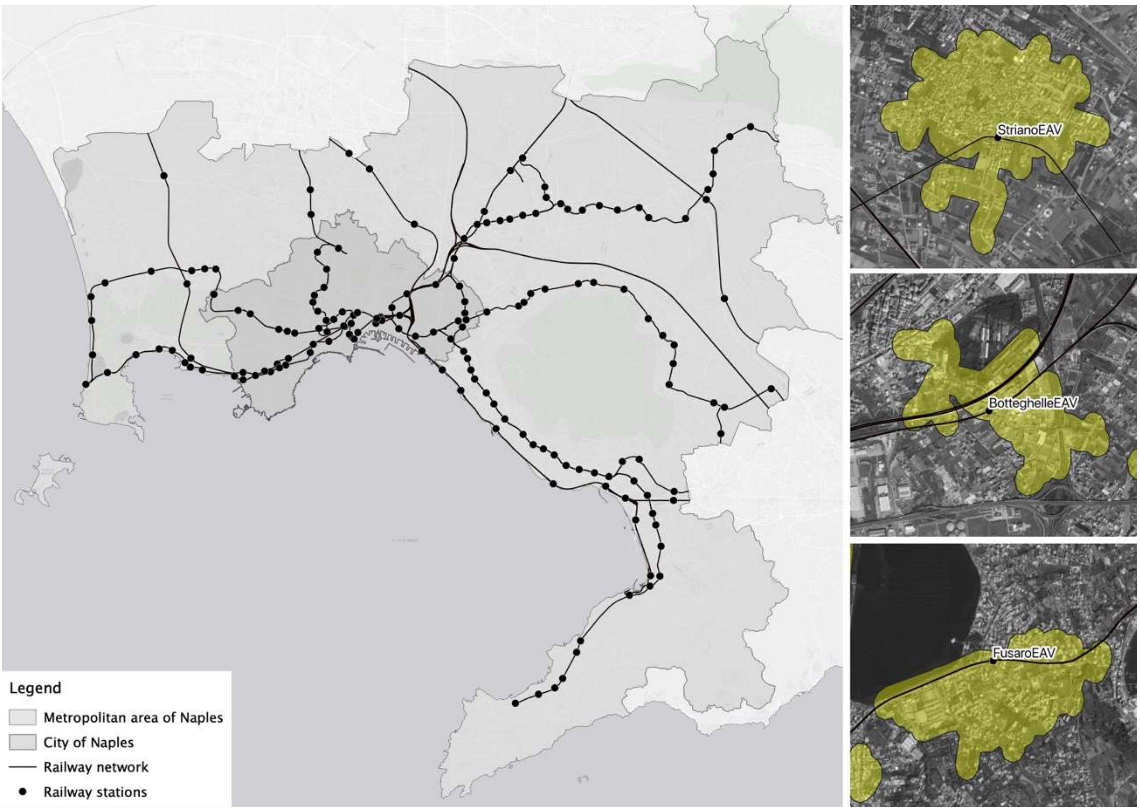

Figure 3: The stations and railway lines in the Naples metropolitan area.
Source: Authors' elaboration

5. Results

To apply the methodology to the Naples metropolitan area, we collected data for the calculation of the 19 selected indicators, which refer to the railway-station catchment areas, from different open-source databases (ISTAT, Open Street Maps, Google Maps, railway companies, and Copernicus). Once analyses were computed, the Pearson coefficient was evaluated to prove the mutual statistical significance of the T, O, and D indexes. Next, a correlation analysis was performed. It identified two indicators (D6 –

Trips for working – and O4 – N° of interest points) significantly related to others with a value higher than 0.700: in accordance with the scientific literature on the topic, we excluded variables exceeding 0.700 to ensure greater robustness to the model. Thus, the limited number of related indicators (two) did not require further statistical analysis. Hence, we performed a cluster two-step analysis, bypassing the application of PCA (Principal Component Analysis).

The BIC and the two-step cluster analysis divided the 170 stations located in the Naples metropolitan area into six clusters, thus identifying transit corridors and urban hot spots. The numerical results of the cluster two-step analysis are reported in Table 2 and Figure 3 and discussed below. The results obtained by two-step cluster analysis display the different characteristics of each group of stations in light of the three TOD components.

Cluster 1, "Station areas in the periphery T unbalanced", comprises 42 station areas located in the periphery of the Naples metropolitan area. This cluster includes the stations belonging to the Circumvesuviana railway network in the last sections of the lines towards Sorrento, Sarno, and Nola, and the stations included in the Phlegraean area west of the city of Naples. The stations belonging to this cluster have below-average values for most indicators of the transit component. The transit indicators T2, T3, T4, T6, and T7 show that the available transport is incommensurate with the urban and socioeconomic characteristics of the station areas belonging to this cluster. It would be necessary to implement the characteristics of the transport infrastructure and station services offered to support the territories potenatials and to realign the cluster.

Table 2. Cluster analysis results. For each cluster, the average value per T, O, and D indexes is reported. Red cells highlight a value lower than the average for the whole network; green cells show values higher than network averages.

ID	*Cluster 1*	*Cluster 2*	*Cluster 3*	*Cluster 4*	*Cluster 5*	*Cluster 6*	*Network*
	42	36	26	29	22	15	170
T1	0.221	0.223	0.843	0.333	0.504	0.157	0.367
T2	0.224	0.306	0.700	0.290	0.427	0.227	0.352
T3	0.159	0.250	0.365	0.339	0.182	0.167	0.244
T4	0.056	0.996	0.883	0.991	0.898	0.600	0.718
T5	0.361	0.344	0.470	0.809	0.373	0.405	0.456
T6	0.375	0.472	0.780	0.756	0.707	0.500	0.607
T7	0.299	0.530	0.810	0.668	0.545	0.320	0.523
O1	0.503	0.533	0.741	0.544	0.536	0.203	0.531
O2	0.715	0.808	0.925	0.762	0.900	0.391	0.770
O3	0.663	0.668	0.569	0.684	0.743	0.718	0.668
O5	0.126	0.123	0.558	0.206	0.330	0.059	0.226
O6	0.617	0.402	0.829	0.716	0.656	0.499	0.615
D1	0.220	0.239	0.728	0.303	0.434	0.075	0.331
D2	0.055	0.054	0.438	0.059	0.104	0.017	0.117
D3	0.807	0.732	0.799	0.855	0.763	0.635	0.777
D4	0.667	0.756	0.841	0.722	0.758	0.608	0.728
D5	0.269	0.166	0.436	0.360	0.225	0.178	0.275

Cluster 2, “Station areas along the regional corridors OD unbalanced”, includes 36 stations located along the Circumvesuviana lines for the city of Nola, the historical Naples-Salerno line, the line for Cancello, and the line for Formia. The characteristics of the railway infrastructure are among the best in the metropolitan transport network (double-track railway with electrification). For this cluster, the level of station use (O6), the job density (D2), and the trips for study (D5) are low. The indicator values suggest improving the oriented and development characteristics with the definition of a corridor strategy.

Cluster 3, “Station areas TOD stressed”, contains 26 stations located in the Naples city centre and the station areas of San Giorgio a Cremano, Campi Flegrei, and Volla. The values of almost all indicators are much higher than the average values of the network. The TOD characteristics and the spatial proximity of the station locations in this cluster provide evidence for the socioeconomic appeal of this urban area and its importance for the transport network.

Cluster 4, “Station areas with residential vocation on Vesuvian corridor”, includes 29 stations located in the Vesuvian territory along the Circumvesuviana lines and the section from San Giovanni a Teduccio to Pompei. The stations in this cluster have a lower value for job density (D2) and higher values for intrastation characteristics (T5), number of stations within 20 min travel time (T5), and age mix (D3). The characteristics of the cluster and the location of the stations require the development of corridor strategies oriented to improve some TOD components.

Cluster 5, “Station areas semi-central TOD oriented”, contains 22 stations located almost within the municipality of Naples, in the neighbourhoods of Fuorigrotta-Bagnoli and Soccavo-Chiaiano. These stations are situated along the main urban railway lines in the west part of Naples and have a high level of urbanisation (O2) and mixed function (O3).

Cluster 6, “Station areas TOD unbalanced”, includes 15 station areas with lower indicator values. These stations are located at random in different Naples metropolitan areas, and the general weakness of TOD components impacts this cluster. The stations in this cluster can be improved at the station level with integrated solutions tailored to the needs of each station.

Figure 4 represents the classification of station areas in the Naples metropolitan area based on the cluster analysis results.

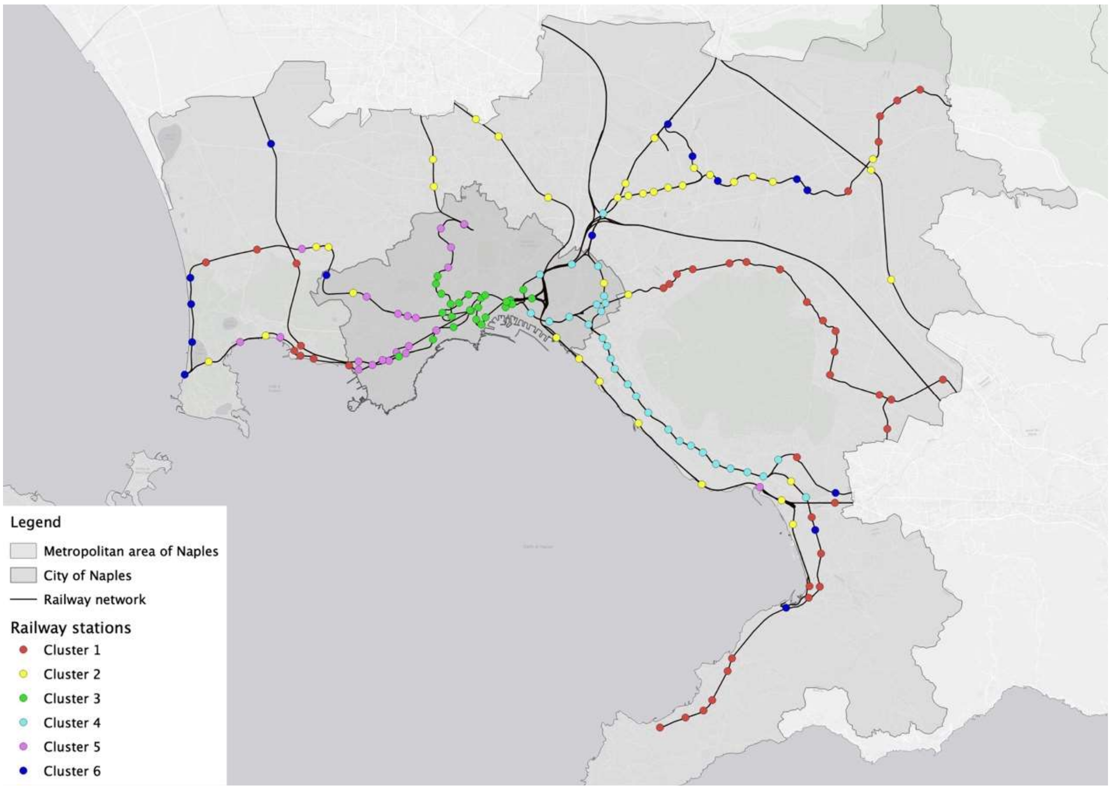

Figure 4: cluster classification of station catchment areas in the Naples metropolitan area and a focus for Naples municipality.
Source: Authors' elaboration

6. Conclusion

The transformation of contemporary urban areas towards more sustainable models is a complex activity that involves, in its development, a multiplicity of actors and stakeholders with a plurality of skills and interests. The challenges that 21st century cities face are manifold (climate change, availability of natural resources, ageing and growing populations in urban areas, new forms of mobility). An integrated and non-sectoral approach is needed to find solutions to these problems. Therefore, a cyclical and iterative process must be used to govern territorial and urban transformation (Figure 5). The governance cycle allows the management and control of the urban system as a whole and its orientation towards future states in order to face the challenges of urban and territorial systems, such as sustainability, social equity, accessibility. This theoretical planning approach for territorial development comprises four main steps (Knowledge, Decision, Action and Monitoring) (Papa R., 2009). Decision and Action steps fall within the control domain of public decision-makers, and stakeholders, while Knowledge and Monitoring require the engagement of urban technicians and the use of integrated planning tools.
It is necessary that spatial government strategies and visions are framed in urban planning tools that enable the realisation of plan forecasts. In the iterative cycle of territorial government, the methodology we propose in this research constitutes the skeleton of the phase of knowledge of the territory and its monitoring once the interventions have been decided and implemented.

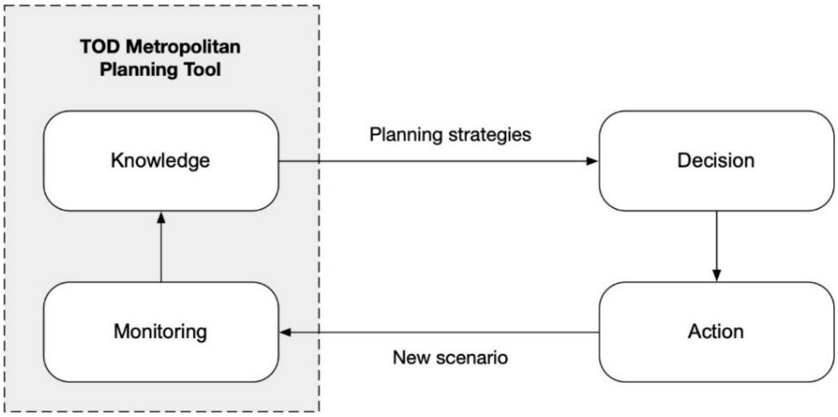

Figure 5: Cyclical and iterative process of urban and territorial transformation and interaction with developed TOD assessment methodology.
Source: Authors' elaboration

As a preliminary step in our research, this first application of the TOD model to the Naples metropolitan area attempted to define integrated land-use and transport guidelines to improve the transit orientation of station areas. The selected set of indicators (seven components for transit, six for oriented, and six for development) was improved with an in-depth study of the scientific literature on node-place applications as well as with expert knowledge and the availability of open data. The application of correlation and cluster analysis to the selected indicators of the 170 railway stations resulted in six station groups. Each cluster has specific features related to infrastructure, transport service, surrounding urban characteristics, socioeconomic conditions, and geographical location. The outcomes of the proposed procedure's application are useful for identifying stations or corridors which require further investigation in the transport- and land-use-planning process. The application of the methodology to the Naples metropolitan area shows that the outcomes of quantitative analysis to support urban-planning processes must be interpreted according to the spatial distribution of the elements of each cluster and their local characteristics. The results demonstrate that some groups of stations have a specific spatial localisation, such as Clusters 3 (west neighbourhoods of Naples) and 5 (city centre of Naples), while other clusters (1, 2, and 4) are mainly grouped along specific railway corridors. Other clusters do not have the same spatial localisation, but they require appropriate interventions that take into account the values of each TOD indicator. The concept of TOD ensures urban-transport sustainability by integrating transportation networks with the growth of the city. This objective is manifested through the centralisation of activities and developments around transit areas. The concentration of activities nearby mass transit nodes is among the essential principles of TOD. Therefore, a significant reduction of dependence on cars may be expected. To achieve this goal, urban-planning practices must account for transport and mobility issues (Su et al., 2021). Indeed, the application results show that implementing adequate solutions to balance the TOD components could be included both in traditional urban-planning tools (e.g. metropolitan plan, local urban plan, urban mobility plan, etc.) and in defining new, specialised tools to integrate land-use and transport planning, as in the case of "Piano delle 100 stazioni" developed for the municipality of Naples.

This study's limitations should be addressed in further research. The limitations were related either to the availability of data or the methodology. Data limitations include the absence of recent and detailed demographic data. Additional steps might include addressing these limitations and creating a detailed, small-scale (qualitative and quantitative) analysis for each station, as well as a definition of a set of strategies for each station.

In our opinion, further investigations might focus on increasing the number of selected indicators, applying a correlation analysis to choose the final set of indicators, defining a set of planning strategies for each group of stations, and proposing specific transport- and land-use-planning solutions to improve the balance of node and place components in the stations of each group.

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