



# Measuring retailers' perceptions of new metro stations inauguration

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## ABSTRACT

The choice of locating a retail store in a given area is among the most important decisions that retailers have to make for the long term success of their business. A good location allows for easy access, attracts customers and increases sales. This paper proposes an ex-ante analysis by measuring retailers' perceptions with respect to the inauguration of new metro stations. Main findings show that the increase of accessibility brought by new interventions in the transit system increases the attractiveness of the area for retailer's shops location choice. The evaluation of the attitudes of prospective retailers represents original insights into the dynamics of transit networks and the economic viability of local retailers.

## 1. Introduction

Retail store location can be considered as the most important determinant of the success or failure of a store (Vandell and Carter, 1993). Turhan et al. (2013) identified seven categories of criteria for choosing a store location. Among them, they proposed performance measures, which deal with the ability to predict performance goals that are often set in the form of sales. Population characteristics, such as income, gender, age, etc. are important to make the choice of good store locations. No variables are more important to retail manager than the demographic structure of the market in any potential location (Turhan et al., 2013). Economic factors, such as household income, income distribution, residents' willingness to spend, can affect store location. Competition, i.e. the competitive environment, is a factor determining store performance. Retailer analysts have traditionally used index of retail saturation to ascertain the attractiveness of a market. The index is quite useful in making decisions as to whether they will be able to achieve a higher profit in a market in which to locate. Among the store characteristics there is the easy access to them, the store-image attributes and costs. The role of transportation system is fundamental in retail store location. Indeed, Transit Oriented Development (TOD) can be defined as the development within one quarter mile to one half mile of a station characterized by a mix of land uses, high-density development, and pedestrian friendly environments (Cervero, 2004). With their mixed uses, urban furniture, pedestrian-friendly environment, bus transfer and biking facilities, TODs can foster retail development.

Moreover, the well-known dogma "no parking, no business" by

Mingardo and van Meerkerk (2012) should be cited to describe the importance of parking for the performance of shopping areas. Authors found that there is a positive relationship between parking tariffs and turnover and that no statistical relationship between parking capacity and turnover is present with the exception of regional shopping areas.

A good location allows immediate access, influences visibility and therefore attracts a large number of customers and increases the potential sales. The term location is used to indicate the location within the geographical space of a given store. The latter represents the junction point between the company and consumers, between the commercial product and its potential market, defining the quantity and quality of demand that can come into contact with the supply.

The literature reveals that the location of retail activities is the result of an analysis aimed at maximizing the benefits for individual companies, in which the decision is based on the forecast of future profits that are expected to be earned in that location (Holl, 2004). In an extremely competitive sales environment, even slight differences in location can have a significant impact on the market share and therefore on profitability (McLafferty and Ghosh, 1982). Unlike other elements belonging to the marketing mix - such as product, price, distribution and promotion - which can be easily modified according to changing environmental conditions, the store location can only be changed at considerable costs and for this reason it represents a long-term fixed investment for the retailer (McLafferty and Ghosh, 1982).

The purpose of this manuscript is to measure retailers' perceptions related to the opening of new metro stations. This aspect represents the originality of the paper since it is based on perceptions and not on the

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real effects of the inauguration of the metro stations. This is an ex-ante analysis and not an ex-post one. The area under study is the Chiaia borough of the city of Naples, which has an already developed transport system. Indeed, it is possible to reach it both by public transport (bus and metro) and by private transport with the availability of several private car parks. Two metro stations of Line 6, serving this area, will be inaugurated in the coming new year.

Five main variables have been considered in this manuscript and they are:

- **Attractiveness of the Zone (AZ):** representing the attractiveness that the area has in relation to the commercial activity location.
- **Benefits of the Transport System (BTS):** indicating all the benefits (in terms of accessibility, quality of transport, decrease in the use of car, etc.) that an efficient transportation system (in terms of services supply, in terms of high service frequencies, in terms of low service waiting times) brings to users travelling to and from the area.
- **Impacts deriving from the opening of New Metro Stations (NMS):** indicating the impacts that the opening of the new metro stations of Line 6 will have on the area.
- **Urban Renewal (UR):** the stations to be inaugurated will be part of the metro art stations of the city of Naples. This project has high standards of aesthetic quality, not only for the architectural elements and the presence of contemporary works of art, but also for the aesthetics of the terminals and for the improvement of the surrounding area (Cascetta and Carteni, 2014).
- **Costs for locating the store in the Zone (CZ):** representing all the costs (e.g. location and management) to which the stores located in this area are subject to. Management costs deal with the staff costs to be borne.

This paper is organized as follows. In Section 2 the literature review and the hypotheses made are reported; in Section 3 the case study is presented. Section 4 deals with the methodology. Results are described in Section 5 and finally in Section 6 conclusions and further perspectives are shown.

## 2. Literature review and research hypotheses

In this sections a literature review has been carried out in order to identify the main methodological approaches used to analyse store location choice and the main variables affecting this choice in order to define the hypotheses for the model specification. Since the 1920 s there has been a growing attention regarding the location of retail activities (Tinessa et al., 2020). Hotelling (1929) proposed a model according to which location decisions are not independent but are influenced by the actions of others. According to the model, a customer will choose a shop or another, not only on the basis of the price of the goods sold, but also on the basis of the transportation costs that he/she will have to bear to reach one or the other store. Camagni (1993) described the principle of urban economy according to which, since the value of a property depends not only on its characteristics but also on the accessibility and prestige of the area in which it is located, a competition is established between different economic activities to obtain the most advantageous location or the most accessible one. The proximity to public transport infrastructures is fundamental for the location choice of economic activities within a territory. As stated by Brown (1993), one of the major determinants of retail location is accessibility to transport. Retailers choose places with good accessibility to increase their exposure to potential customers. Biggiro et al. (2001), for the cities of Rome and Naples, demonstrated that the transport accessibility variables are significant for activity location choice. The study showed that the more accessible an area is for residents, the more attractive it becomes for retailers. Similar results were presented by Cascetta et al. (2001), who studied the location of economic activities in relation to accessibility measures, both active and passive, as well as the potential demand for

economic activities for the city of Naples. The results confirmed that the transport variables, such as the accessibility ones, together with the area characteristics, were significant. Transport accessibility is a very important concern for location assessment. Any recently launched transportation system that significantly improves accessibility increases exposure to potential customers and is beneficial to nearby businesses (Jen-Jia and Shu-Han, 2019).

The opening of new metro stations improves the efficiency of transport (Cervero, 1994) and also leads to a significant increase in the accessibility of the surrounding areas (Du and Mulley, 2006; Lewis-Workman and Brod, 1997; Martínez and Viegas, 2009), this leads non-local entrepreneurs to find opportunities to start commercial activities within the subway station areas. Tzouvadakis et al. (2007) analyzed the effect of seven metro stations in Athens on the surrounding commercial activities to test the relationship between commercial land use and rail transport. The results revealed that there was an increase in retail activity, within a radius of 100 m from the stations, and there was an increase in the pedestrian flows, an improvement in employee mobility conditions as well as a renewal of the urban environment. Dorantes et al. (2010, 2012) studied the influence that the construction of the new "MetroSur" line in Alcorcon, in the South-East of Madrid, had on promoting commercial activities around the stations. Specifically, the commercial activities located near the stations experienced significant advantages: on the one hand the increase in accessibility and, on the other hand, the increase in the number of residents passing through on their way to or from the stations. The study revealed that the number of commercial activities increased in the proximity of the new metro station and, in particular, the closer a commercial area was to the station, the more likely it was occupied by economic activities. Roukouni et al. (2012) examined the use of the existing territory around a metro station under construction in Thessaloniki, through Stated Preference surveys addressed to traders. The study showed that there was a very positive expectation. Indeed, more than half of the respondents believed that there would be an increase in sales following the opening of the new station.

Based on the above contributions to the literature, the following hypotheses were made:

- H1.** The Benefits of Transport System lead to an increase in the Attractiveness of the Zone (BTS → AZ).
- H2.** The opening of New Metro Stations leads to an increase in the Attractiveness of the Zone (NMS → AZ).
- H3.** The opening of New Metro Stations improves the Benefits of the Transport System (NMS → BTS).

Gibbons et al. (2019) investigated, not for rail investments but for UK road network improvements, the effects on productivity and employment in the served areas. The results stated that a 1% increase in accessibility led to a 0.3–0.5% increase in the number of plants and jobs. In addition, an increase in accessibility could lead to an increase in local wages and purchases of goods and services. The accessibility index specified was a weighted sum of the proximity of destinations, where proximity was a decreasing function of minimum journey times along the network.

Studies carried out on metro stations in the United States showed that properties close to stations had a higher value than properties further away (Bajic, 1983; Voith, 1991). Properties close to train stations benefit from the advantages of transport time and cost savings. Accessibility remains an important feature for urban properties. Commuter railways have a relatively large impact on property value (Cervero and Duncan, 2001; NEORail II, 2001; Cervero, 1984). Furthermore, railway stations are claimed to have a higher effect on commercial real estate than on residential properties (Cervero and Duncan, 2001), railway stations as gathering points attract commercial activities, which increase the value of real estate commercial. Xu et al. (2016), in a study conducted in the city of Wuhan, showed how the value of commercial

property grew within 400 m from the metro stations. Specifically, the authors identified two levels of growth, i.e. an increase of 16.7% for the area between 0 and 100 m from a metro station and an increase of about 8% for the area between 100 and 400 m from a metro station. Also the study of [Mohammad et al. \(2017\)](#), in Dubai, demonstrated how the value of the commercial property increased nearly of 40% within a 1000 m radius from a metro station. Rising prices lead to commercial gentrification, i.e. small, locally owned, local stores were replaced by expensive chain stores, boutiques or retailers, improving and revitalizing the living environment, ([Jen-Jia and Shu-Han, 2019](#)). Taking into account all this, the following hypotheses were made:

**H4.** The Benefit of the Transport System, due to an increase in the efficiency of the transport system leads to an increase in the Costs of the Zone served (BTS → CZ).

**H5.** The opening of New Metro Stations increases the Costs of the Zone served (NMS → CZ).

**H6.** The increase of the Costs of the Zone decreases the Attractiveness of the Zone itself (CZ → AZ).

As previously stated, the new metro stations, focus of this study, are part of the art metro stations project in the city of Naples. [Cascetta and Carteni \(2014\)](#) demonstrated that transit promotion policies, based on qualitative factors and high architectural standards, can have an impact on travelers' behavior, increasing the propensity of users to use rail services. Furthermore, it was shown that the catchment area of a station with high artistic and architectural standards can be 99% wider than a traditional station without particular attention to aesthetics.

TOD schemes develop station areas into dense, mixed-use, and pedestrian- and bicycle-friendly environments, thus revitalizing the neighborhood and increasing property values ([Transportation Research Board, 2004](#)). Urban renewal aims at improving the physical, socio-economic and ecological characteristics of urban areas through various actions including heritage redevelopment, rehabilitation and conservation ([Couch et al., 2011](#)). Urban renewal involves an improvement in environmental quality ([Adams and Hastings, 2001](#)), it allows for the achievement of several socio-economic objectives ([Lee and Chan, 2008](#)) and also strengthens existing social networks, improving the inclusion of vulnerable groups and modifying the negative impacts on the living environment ([Chan and Yung, 2004](#)). Specifically, public spaces function as useful components of urban regeneration strategies by improving the image of a city and therefore the attractiveness of an area. Open space contributes to a neighborhood's visual appeal, it also provides recreational spaces increasing foot traffic, leading to increased retail sales ([Choi and Shin, 2001](#); [Kang, 2016](#)). Consequently, the improvement of the pedestrian network leads to an increase of local accessibility and thus to a revitalization of the floating population which further affects the location of commercial structures sensitive to it ([Choi and Shin, 2001](#); [Lee and Jung, 2014](#); [Kim et al., 2015](#)). Urban regeneration schemes such as revitalization initiatives ([Thrash, 2001](#)), residential redevelopments ([Zukin, 2009](#)) and the restoration of open spaces ([Lim et al., 2013](#)), have been cited as the main reasons for commercial gentrification. Improved pedestrian access increases local rents ([Litman, 2014](#)), allowing only commercial establishments that can afford them or new high-end commercial structures ([Hon-Yip, 2014](#)) to stay in the area. Some studies have shown that a viable urban context is associated with a higher residential and commercial property value ([Pivo and Fisher, 2011](#); [Sohn et al., 2012](#)). These considerations support the following hypotheses:

**H7.** The opening of New Metro Stations brings the Urban Renewal of the zone (NMS → UR).

**H8.** Urban Renewal leads to a greater Attractiveness of the Zone (UR → AZ).

**H9.** Urban Renewal increases the Costs of the Zone (UR → CZ).

These hypotheses are strictly linked to the issue of the art metro station project above reported. Indeed, these stations, being real pieces of artwork, have made the area more prestigious, increasing the whole costs of the area itself, i.e. costs of living, house prices, rent prices etc.

Based on the above hypotheses, a model has been developed (see [Fig. 1](#)), which links the following five variables: Attractiveness of the Zone (AZ); Benefits of the Transport System (BTS); Impacts deriving from the opening of New Metro Stations (NMS); Urban Renewal (UR); Costs for locating the business in the Zone (CZ).

It is important at this stage to better highlight the added value of this manuscript with respect to previous studies above reported. These works have supported authors in the identification of the main variables to be chosen in the model, and to understand that the method shared is the hedonic pricing approach to carry out ex-post analyses. On the other hand, this paper applies consolidated statistical tools, such as SEM, to test an ex-ante analysis of the retailers' perceptions with respect to the opening of new metro stations in an urban area. The evaluation of the attitudes of prospective retailers represents original insights into the dynamics of transit networks and the economic viability of local retailers. Moreover, SEM, as far as the authors know, has been mainly applied to the retail sector for examining the influence of store and product attributes on patronage behaviour of shoppers, but not on evaluating the retailers' perceptions of store location.

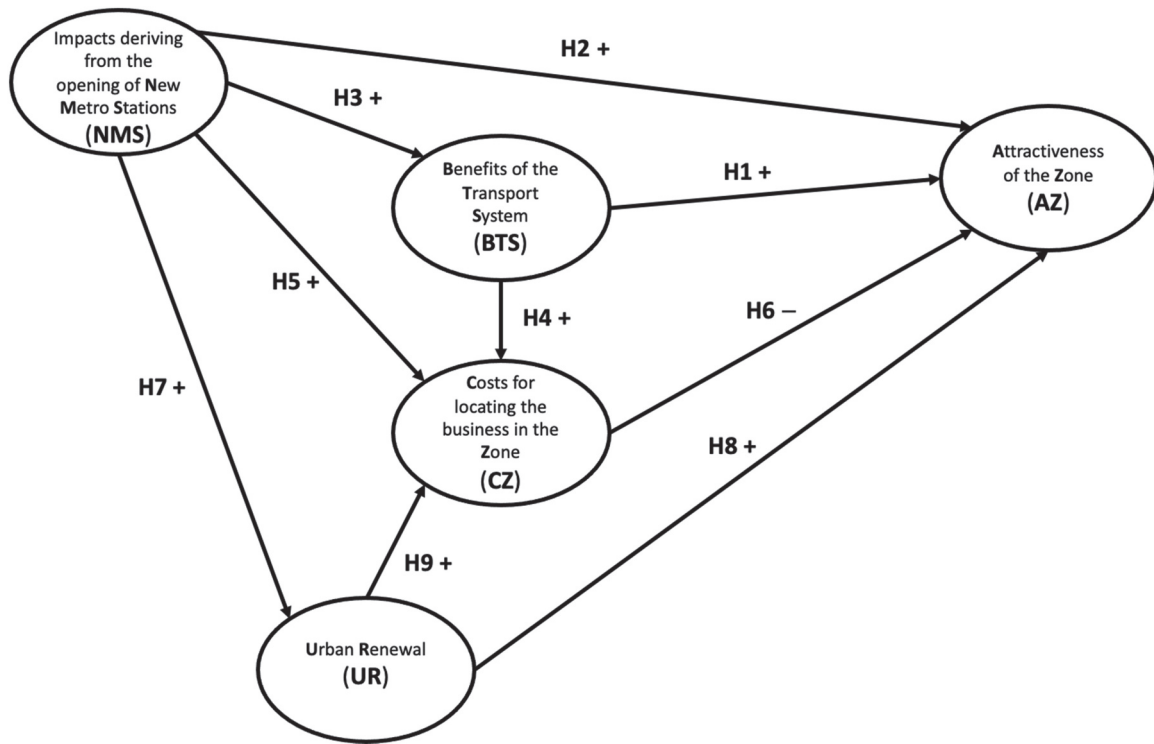
### 3. The case study

The city of Naples (in the South of Italy), with its almost one million of inhabitants ([ISTAT, 2011](#)), has the largest residential density in Italy. Since 2011, several have been the initiatives to make the city more sustainable from a transportation perspective. The Chiaia borough, located in the heart of the city, is a commercial area full of shops, characterized also by the presence of the waterfront. The cost of living in this borough is high in terms of house and rent prices, considering that on average the house price/m<sup>2</sup> in the Chiaia borough is € 3.692/m<sup>2</sup> while the average price in the municipality of Naples is € 2.272/m<sup>2</sup> ([www.agenziaentrate.gov.it](#)). It is considered among one of the most expensive borough of the city.

This area is accessible by: (i) private car, (ii) bus service (iii) two metro stations of Line 2. In the next year the accessibility of this area will be improved. Indeed, by the end of the year 2021, new metro stations of Line 6 will be inaugurated. Today, Line 6 is three kilometers long with four stations. The project will consider three more kilometers by 2021, in order to guarantee a modal interchange with Line 1 (see [Fig. 2](#)).

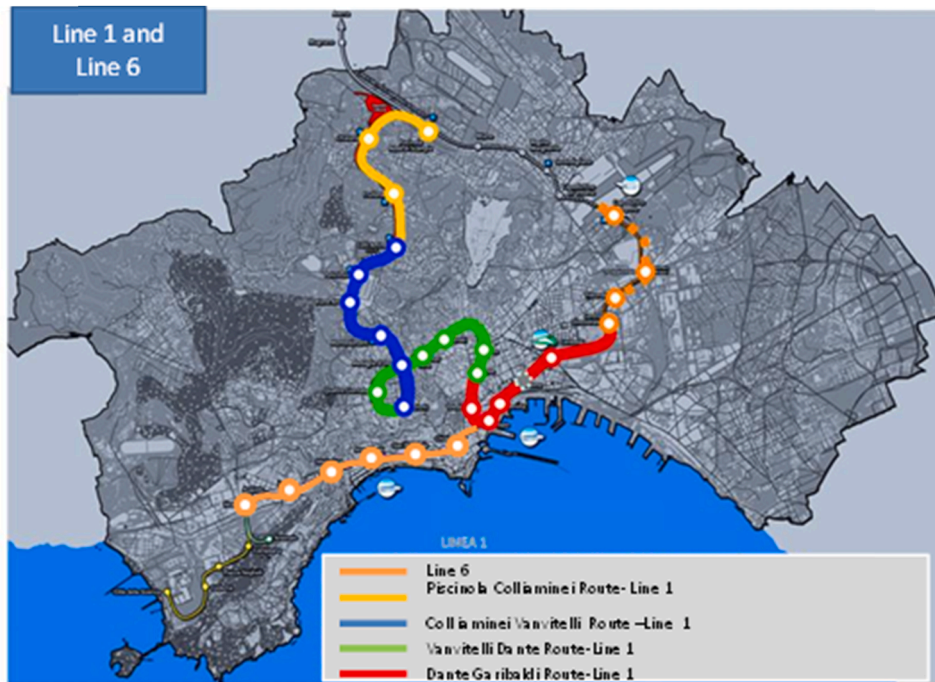
For the two metro lines of the city of Naples (Lines 1 and 6), several international architects were involved in the design of the stations in order to provide high esthetic quality standards for both the new and renewed stations. In addition to purely architectural elements (forms, colors, space distribution and lighting) the stations are characterized by contemporary art pieces, improving the esthetic quality of the terminals and in the surrounding area. In 2012 The Telegraph defined Toledo station of Line 1, "the most impressive underground railway stations in Europe".

In January 2020, a CAWI (Computer-Assisted Web Interviewing) survey, was employed and retailers were interviewed in the Chiaia borough. The stores chosen were those falling within a radius of 800 m from the metro stations. The objective was that of analysing the retailers' perceptions related to the future opening of the new metro stations of Line 6 serving the area itself. The questionnaire submitted was composed of five sections (see [Table 1](#)), each of which was made up of different questions, and for all the questions a scale with partial semantic autonomy with five levels was used, from: "in complete disagreement" to "completely in agreement". In the first section the perception of the attractiveness of the area was investigated; in the second section the degree of satisfaction with respect to the current transport system (benefits) was requested; in the third section the perception of the impacts deriving from the opening of the new metro



Source: Authors' elaborations

Fig. 1. Conceptual model.  
Source: Authors' elaborations



Source: Authors' elaborations

Fig. 2. Lines 1 and 6 of the Metro of Naples.  
Source: Authors' elaborations

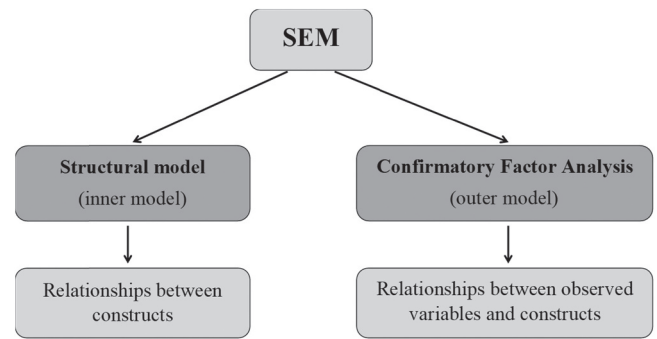
**Table 1**  
Structure of the questionnaire: Constructs with related indicators.

Construct	Indicators
<b>AZ: Attractiveness of the Zone</b>	<ol style="list-style-type: none"> <li>1. The population density of the area (being an area also residential) has influenced the choice</li> <li>2. The prestige of the Chiaia district has influenced the choice</li> <li>3. The price / rent of the store has influenced the choice</li> <li>4. The presence of other recreational activities (museums, cinemas, theaters, etc.) has influenced the choice of location</li> <li>5. The presence of greenery has influenced the choice</li> <li>6. The proximity to the waterfront has influenced the choice</li> <li>7. The presence of the schools has influenced the choice</li> <li>8. The presence of other similar shops has influenced the choice</li> <li>9. The presence of waterfront events has influenced the choice</li> <li>10. The presence of residents with greater purchasing power has influenced the choice</li> <li>11. The presence of any suppliers in the area has influenced the choice</li> </ol>
<b>BTS: Benefits of the Transport System</b>	<ol style="list-style-type: none"> <li>1. The proximity of the store to the new metro line 6 stations (S. Pasquale, Arco Mirelli) will have positive impacts (benefits)</li> <li>2. The proximity of the store to the metro line 2 stations (P.za Amedeo, Mergellina) has positive impacts (benefits)</li> <li>3. The store is well served by buses (nearby stop, working buses)</li> <li>4. Customers can easily find parking near the shops</li> <li>5. The presence of a bike sharing service will have positive impacts (benefits)</li> </ol>
<b>NMS: Impacts deriving from the opening of New Metro Stations</b>	<ol style="list-style-type: none"> <li>1. Local tourists will increase</li> <li>2. The number of Italians and / or foreign tourists will increase</li> <li>3. Sales and revenues will increase</li> <li>4. There will be a reduction of cars in the area</li> <li>5. There will be an increase in the value of the property</li> <li>6. There will be an increase in events organized on the promenade Caracciolo</li> </ol>
<b>CZ: Costs for locating the business in the zone</b>	<ol style="list-style-type: none"> <li>1. Costs to supply the store</li> <li>2. Supply times for the store</li> <li>3. Technical costs for commissioning the shop</li> <li>4. Staff costs</li> </ol>
<b>UR: Urban renewal</b>	<ol style="list-style-type: none"> <li>1. The benefits would have been the same without the renewal of the area around the station</li> <li>2. The beauty of the area inside the station is less important than the beauty of the external area</li> <li>3. Urban renewal leads to an increase of the safety in the area</li> </ol>

stations was asked; the fourth section aimed at investigating the satisfaction deriving from the urban renewal, which this area is experiencing due to the opening of the new stations and finally in the last section the perception of the costs related to the retail activity location (such as the rent/price of the property, etc.) area was required. The shops considered were 183, but only 79 owners/managers completed the questionnaire.

#### 4. The methodology

The family of Structural Equations Model (SEM) was chosen to verify the above hypotheses. SEM, in the literature, has been mainly applied to the retail sector for examining the influence of store and product



source: Aria et al. (2018)

**Fig. 3.** Structural Equations Model.  
source: Aria et al. (2018)

attributes on patronage behaviour of shoppers (Shukla et al., 2015). Therefore, this paper contributes to the international literature with an original contribution.

SEM consists of two models (see Fig. 3): (1) the structural or internal model that specifies the dependency relationships between theoretical constructs and latent variables; (2) the measurement or external model which specifies the relationships between the theoretical constructs and the measured variables (their indicators) (Aria et al., 2018).

SEM can use two types of techniques: covariance-based techniques (represented by Linear Structural Relations of Joreskog, LISREL) (Jör-eskog and Sörbom, 1989) and variance-based techniques (represented by Partial Least Squares Path Modeling, PLS-PM) (Monecke and Leisch, 2012; Vinzi et al., 2010; Tenenhaus et al., 2005).

The objectives of SEM area double: to check the goodness of the constructs (in terms of reliability and validity), i.e. the measurement model; the feasibility of the structure of causal relationships between constructs, i.e. the structural model. The last objective is the main one. Specifically, the principal assumption at the base of SEM is that a series of latent variables is available, measuring constructs related to human attitudes, and the aim is to verify the feasibility of a series of hypotheses about causal links between one or more constructs. These hypotheses, type Y depends on X and Z (Y, X and Z are three constructs) generate a number of causal equations whose coefficients should be measured and their significance verified.

To do this, SEM uses goodness indices which should respect the reference values, if these indices are confirmed, the SEM is well structured and suitable for empirically explaining what is claimed in the model. If, on the contrary, the indices are not respected, then it is necessary either to modify the model or to use statistical precautions to verify it (Golob, 2003). In this paper, being the sample size low and being the data not normally distributed, it was chosen to use the variance-based approach since the SEM techniques, based on covariance, do not allow estimating the model in these conditions. The PLS-PM models, instead of focusing on the statistical accuracy of the estimates, aim at maximizing the amount of variance explained. An iterative least squares algorithm is used to estimate the measurement and the structural models through a simple or multiple linear regression. For this reason the name of the procedures is partial (Aria et al., 2018).

Using PLS path models has several advantages: they can be used to estimate very complex models (presence of many latent variables) (Wold, 1985), they can be used for small samples (Vinzi et al., 2007) and they are also suitable for studying highly distorted distributions or when data are not normally distributed (Vinzi et al., 2010). To measure the statistical significance of the results, confidence intervals and p-values for the path coefficients are derived through a bootstrap resampling technique (Tenenhaus et al., 2005; Allini et al., 2018). The software used for modeling is ADANCO v. 2.1.

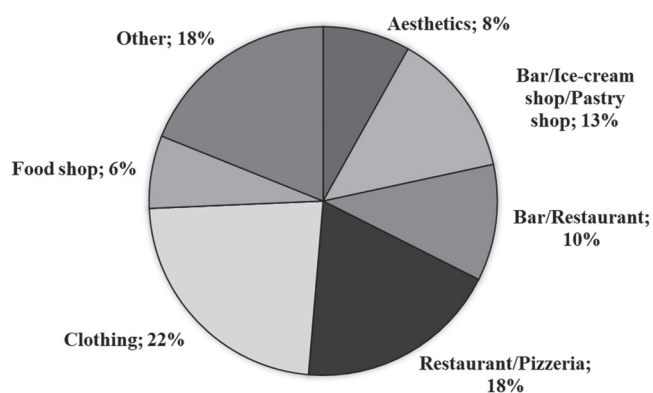
## 5. Results

### 5.1. Sample profile

The distribution of the retail stores type (see Fig. 4) was as follows: 27.8% was represented by clothing stores; 22.8% by bars, pastry shops or ice cream shops; 17.7% by restaurants and/or pizzerias; 7.6% by shops dealing with esthetics; 5% was represented by shops selling food; 3.8% by tobacconists, the remaining 15% was divided between optics, jewelry, antiques, electronics, hardware, florist. Most of the stores were not part of a chain (78.5%) and were the first commercial activity of the owner/ manager (68%). 67% of the shops surveyed were located on a secondary road while 33% were located on the main road (see Fig. 5). From 2016 till today twenty-seven newly opened retail stores have been inaugurated equal to 34% of the sample. The sample also considered "old" stores, i.e. already located in the area, the oldest of which was opened in 1870. Fig. 6 shows the inauguration year of the shops whose manager/owner was interviewed.

### 5.2. Results from the survey

Considering positive the answers with values 4 (partially agree) and 5 (completely agree) and negative the values 1 (completely disagree) and 2 (partially disagree) of the Likert scale, the questionnaire reveal that for interviewed managers/owners, the choice of locating their stores in the Chiaia borough was mainly affected by the population density of the area (68%), the prestige of the neighborhood (68%), the proximity to recreational activities (e.g. museums, cinemas, theaters, etc.) (49%) and also by the proximity to the waterfront (56%). The proximity of the area to the stations of metro Line 2 and the future opening of new metro stations of Line 6 are perceived as important benefits for the store location (52% and 48% respectively), while the possibility of parking, almost exclusively in the parking lots present nearby, are not seen as having a benefit (for 57% of the interviewees). The respondents hope that, with the opening of the new metro stations, there will be an increase of customers (84%), with a subsequent increase in sales and revenues, in the value of the property (51%) and in the events organized on the waterfront (61%). However, they do not believe that the inauguration of the new stations could lead to a reduction of the number of cars in the area. The urban renewal, which the area is experiencing, due to the opening of the new metro stations, is considered important for the increase of safety of the area (67%). Finally, the costs, due to the retail store location in the Chiaia borough, are not perceived higher than those due to the location in any other borough of the city of Naples.



Source: Authors' elaborations

Fig. 4. Distribution of the retail stores type.  
Source: Authors' elaborations

### 5.3. Results from SEM

The evaluation of the PLS-PM structural model consists of two main steps: the validation of the structural or internal model and the validation of the measurement or external model. To evaluate the overall goodness of fit of the PLS-PM model to real data, the SRMR (Standardized Root Mean Square Residual) index was used (Henseler et al., 2016), which represents the square root of the discrepancy between the covariance matrix of the sample and the model covariance matrix. The SRMR index varies between 0 and 1 and, as suggested by Kline (2011), a value of 0.1 or less indicates an acceptable model. In this case study, the model is acceptable since the SRMR index assumes a value of 0.099 for both the saturated and estimated models. An essential criterion for the evaluation of the structural or internal model is the determination of the coefficient  $R^2$  of the dependent or endogenous latent variables. Chin (1998) describes the  $R^2$  values, in the PLS path models, as substantial ( $>0.67$ ), moderate ( $>0.33$ ) and weak ( $>0.19$ ). Moderate  $R^2$  may be acceptable if some structures of the internal path model explain an endogenous latent variable with few exogenous or independent latent variables. Table 2 shows the values of  $R^2$  for all the endogenous latent variables of the model.

The estimation of the path coefficients and the adaptation of the model for the SEM are shown in Fig. 7.

The individual path coefficients are linear bivariate correlation coefficients, they are therefore equivalent to the standardized beta coefficients of the ordinary regressions at least squared. In Table 3 the statistical tests on the path coefficients for direct effects are reported.  $P$ -values are calculated using the bootstrap resampling procedure with 1000 samples.

For a coefficient to be significant, the  $p$ -value should be less than or equal to 0.05. Furthermore, for the validation of an hypothesis the sign of the path coefficients should be consistent with the sign a priori hypothesized, on the other hand, when the sign is opposite the hypothesis is rejected, regardless of the significance of the coefficient.

This aspect is fundamental since the model tests whether the hypotheses are satisfied or not and therefore if an impact exists or not. Indeed, sometimes, the impact might not exist (or might be negative) (Tong et al., 2017; Nocera et al. 2020).

In Table 3, the supported hypotheses are H1, H2, H3; Hypotheses H4 and H5 are rejected due to the low significance and discordance of the sign with the hypothesized one; the same happens for hypotheses H7 and H9 since the sign does not agree with the hypothesized one; the same for hypotheses H6, H8 and H9 due to the low significance.

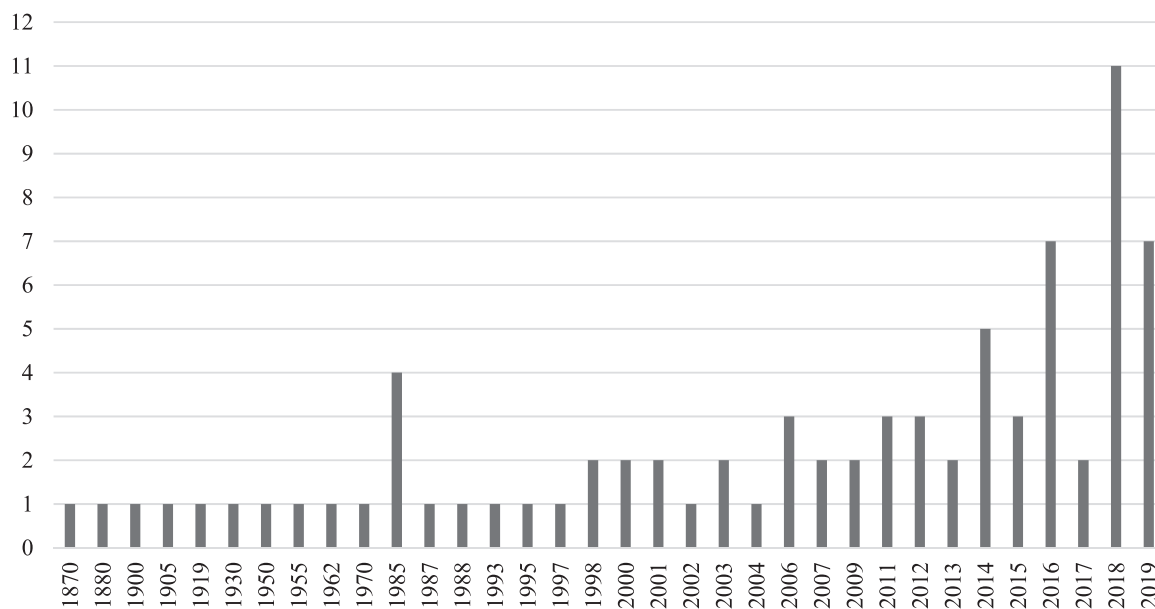
There are three important direct relationships between the constructs (see Table 4): the opening of the new metro stations positively affects the area thanks to the transportation system (with path coefficient 0.604), the transportation system positively increases the attractiveness of the Chiaia borough (with a path coefficient of 0.353), the opening of the two new metro stations of Line 6 improves the attractiveness of the area (with a path coefficient of 0.256). For each relationship between the two latent variables, in addition to evaluating the direct effects, it has been also possible to evaluate the presence and measure of the indirect effects (i.e. the measure of the relationship between two constructs that are indirectly connected to each other). In this case study, in the model there is only one important indirect relationship (see Table 4): the opening of new metro stations affects the attractiveness of the area (with a path coefficient 0.199).

Measurement models should be evaluated for reliability and validity. The first criterion to be verified is usually the reliability of internal consistency which is provided through an estimate of the correlations between the indicators, i.e. with the Cronbach's  $\alpha$  (1951). Cronbach's  $\alpha$  assumes that all the indicators are equally reliable (i.e. that all indicators have the same external load on the construct) and is also sensitive to the number of elements in the scale and generally tends to underestimate the reliability of internal consistency. Therefore, two different composite reliability measures have been also chosen:  $\rho_c$  by Joreskog (Werts



Source: Authors'elaborations

Fig. 5. Road network and metro stations analyzed. The main road is shown in red and the secondary roads in blue.  
Source: Authors'elaborations



Source: Authors'elaborations

Fig. 6. Inauguration year of the shops whose manager/owner was interviewed.  
Source: Authors'elaborations

Table 2  
Structural Equation Model assessment: R2 (n. observations 79).

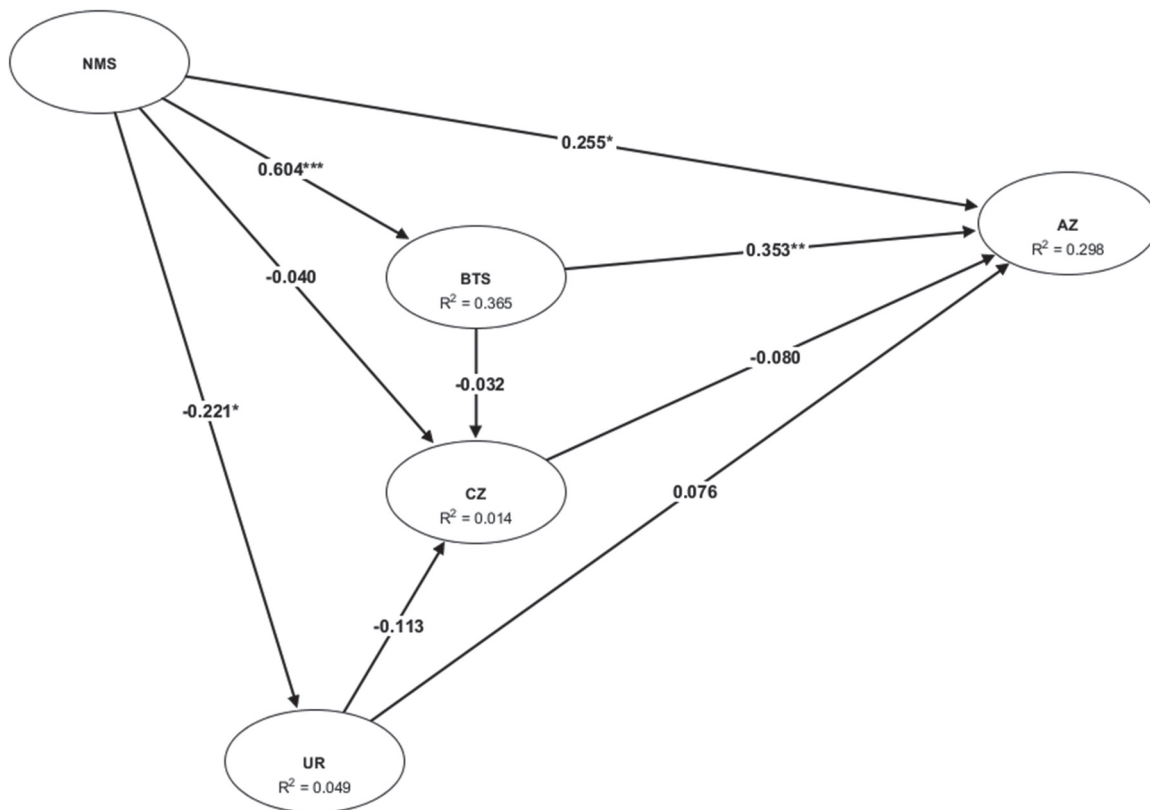
Construct	R2	Strength
AZ	0.298	Weak
BTS	0.365	Moderate
CZ	0.014	Low
UR	0.049	Low

et al., 1974) and  $\rho_a$  by Dijkstra-Henseler (Dijkstra and Henseler, 2015). For the reliability of the internal consistency in order to be considered satisfactory, the value assumed should be greater than 0.7 in the early

stages of the research and values greater than 0.8 or 0.9 in the more advanced stages (Henseler et al., 2016), a value lower than 0.6 indicates a lack of reliability. Good consistency is obtained for all constructs of the model (see Table 5).

For the model validity, two complementary aspects should be considered:

- Convergent validity evaluates how much a set of indicators represents the same underlying construct.
- Discriminating validity evaluates how much a construct is truly distinct from the other constructs of the model.



Source: Authors' elaborations

Fig. 7. Structural model estimation (n. observations 79).  
Source: Authors' elaborations

**Table 3**  
Structural Equation Model assessment: direct effects (n. observations 79).

Effect	Path coefficients	Standard bootstrap results			Result
		Standard error	t-value	p-value	
H1: BTS→AZ (+)	0.353	0.114	3.110	0.001***	Supported
H2: NMS→AZ (+)	0.256	0.127	2.014	0.022*	Supported
H3: NMS→BTS (+)	0.604	0.066	9.228	<0.001***	Supported
H4: BTS→CZ (+)	-0.032	0.148	-0.216	0.415	Rejected
H5: NMS→CZ (+)	-0.040	0.161	-0.247	0.403	Rejected
H6: CZ→AZ (-)	-0.080	0.102	-0.783	0.217	Rejected
H7: NMS→UR (+)	-0.221	0.112	-1.968	0.024*	Rejected
H8: UR→AZ (+)	0.076	0.099	0.761	0.223	Rejected
H9: UR→CZ (+)	-0.113	0.124	-0.912	0.181	Rejected

\*indicates that a direct effect between the two constructs is significant (P value ≤ 0.05.), \*\* (P value ≤ 0.01) or \*\*\* (P value ≤ 0.001) using bootstrap procedure with 1000 replications.

**Table 4**  
Structural Equation Model assessment: indirect effects (n. observations 79).

Effect	Path coefficients	Standard bootstrap results		
		Standard error	t-value	p-value
H1: BTS → AZ	0.003	0.020	0.129	0.449
H2: NMS → AZ	0.199	0.085	2.351	0.010**
H5: NMS → CZ	0.006	0.101	0.056	0.478
H8: UR → AZ	0.009	0.022	0.413	0.340

\*indicates that an indirect effect between the two constructs is significant (P value ≤ 0.05.), \*\* (P value ≤ 0.01) or \*\*\* (P value ≤ 0.001) using bootstrap procedure with 1000 replications.

**Table 5**  
Assessment of the measurement model: construct reliability (n. observations 79).

Construct	Dijkstra-Henseler's rho (ρA)	Jöreskog's rho (ρc)	Cronbach's alpha (α)
AZ	0.778	0.840	0.744
BTS	0.757	0.822	0.667
NMS	0.900	0.773	0.662
CZ	1.032	0.991	0.9881
UR	1.000	1.000	-

For the evaluation of the convergent validity, [Fornell and Larcker \(1981\)](#) suggest the use of the extracted mean variance (AVE). An AVE value equal to 0.5, or greater, indicates sufficient convergent validity, which means that a construct is able to explain, on average, more than half the variance of its indicators. On the other hand, an AVE value lower than 0.50 indicates that, on average, there are more errors in the

**Table 6**  
Convergent validity (n. observations 79).

Construct	Average Variance Extracted (AVE)
AZ	0.572
BTS	0.618
NMS	0.542
CZ	0.965
UR	1.000

indicators than in the variance explained by the construct. The results (see Table 6) confirm a good convergent validity for all the constructs.

Three different criteria can be used in the PLS model to evaluate the discriminating validity:

1. The Fornell and Larcker criterion (Fornell and Larcker, 1981): a construct should explain more variance with its indicators than with the other latent variables, this means that the AVE of a construct should be greater than the greater squared correlation of the latent variable with any other latent variable.
2. The heterotrait-monotrait correlation ratio (HTMT) for each construct (Henseler et al., 2016): by heterotrait correlation it is meant the correlations of the indicators within the same construct; by monotrait correlation it is meant the correlations of indicators inside the same construct. A construct has a good discriminating validity if it assumes a value lower than 0.90.
3. Cross loadings (Chin, 1998): the load of each indicator should be greater than all its cross loads.

In this study it was used the first of the three criteria, i.e. the Fornell and Larcker (see Table 7) and for confirming the results obtained, the HTMT correlation ratio was calculated (see Table 8). In these tables the results for both criteria are reported and as it can be observed that they are satisfactory for all the constructs.

## 6. Conclusions and further perspectives

In this manuscript a model has been developed to evaluate retailers' perceptions related to the changes that can be observed in a commercial area due to the opening of new metro stations.

This type of evaluation deserves to be carried out with latent variable models, in this specific case SEM. SEM techniques seemed more general than for example factorial analysis, because they incorporate the latter.

The results obtained (see Fig. 8) support hypothesis H1 (the benefits brought by the transportation system increase the attractiveness of the area), hypothesis H2 (the opening of new metro stations can lead to an increase of the attractiveness of the area) and hypothesis H3 (from the opening of new metro stations the transportation system can experience some benefits).

These results show that any increase of accessibility of a given area is evaluated by retailers as an increase in the attractiveness of the area itself leading to a larger number of customers for shopping (Dorantes et al., 2010; 2012; Zheng et al., 2016), consequently it is assumed that the number of shops located in that area will tend to increase. For this reason, the announce of the opening of the two new metro stations of

**Table 7**  
Discriminant validity: Fornell and Larcker criterion (n. observations 79).

Construct	AZ	BTS	NMS	CZ	UR	FL criterion
AZ	<b>0.572</b>					Satisfied
BTS	0.247	<b>0.618</b>				Satisfied
NMS	0.207	0.365	<b>0.542</b>			Satisfied
CZ	0.012	0.001	0.001	<b>0.965</b>		Satisfied
RU	0.001	0.031	0.049	0.010	<b>1.000</b>	Satisfied

Diagonal elements represent AVE, while non diagonal elements represent square correlations.

**Table 8**  
Discriminant validity: HTMT criterion (n. observations 79).

Construct	AZ	BTS	NMS	CZ	UR	HTMT criterion
AZ						Satisfied
BTS	0.691					Satisfied
NMS	0.530	0.652				Satisfied
CZ	0.118	0.058	0.083			Satisfied
UR	0.038	0.218	0.255	0.098		Satisfied

Line 6 has fostered the opening of new shops in the Chiaia borough of the city of Naples (27 new stores in three years).

The opening of the new metro stations is not perceived by retailers as an increase of operating costs that they can lead (hypotheses H4 and H5). The possible increase of the costs of locating and running a store (hypothesis H7) and urban renewal (hypothesis H8) does not affect the attractiveness of the area for retailers. Finally, urban renewal is not perceived as an increase of the cost of locating commercial activities in the Chiaia borough (hypothesis H9). On the basis of these results, it is possible to state that the interventions that have a higher effect on the increase of attractiveness of the area for retailers are those related to new interventions in the transit system.

Further research will consider more interviews in other commercial boroughs of the city of Naples, where metro stations have been inaugurated some years earlier and to apply the same methodology to other case studies in order to make a comparison. Moreover, a continuation of the work could be that of integrating SEM with discrete choice models, leading to the hybrid models (Ben-Akiva et al., 2002), which aim at overcoming the limit of both methodologies. Indeed, the first (SEM) as regards the implications of policy (market shares, willingness to pay) and the second (discrete choice) as regards psychometric surveys.

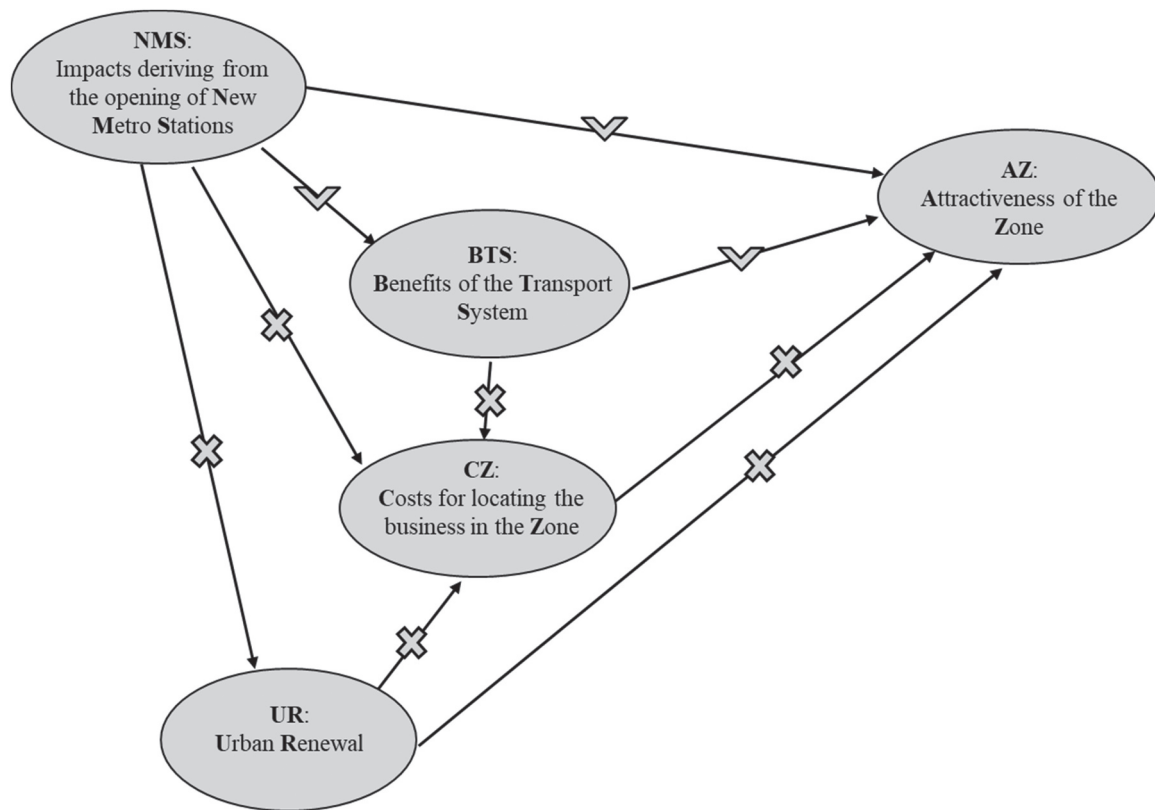
Further investigation would consider also the study of the effects of proximity to the new rail extensions on the observed performances of local retail firms. Specifically, the increase of sales, of employment and new firms' location are interesting aspects to monitor.

Some land use policy implications can be derived from this manuscript. Firstly, assessing and improving investments in public transit should represent a priority for public transport operators. Indeed, they are forced to place emphasis on the monitoring and improvement of the services provided with the objective of facing the increasing rate of car ownership and therefore the increase of traffic congestion, contributing to a better sustainable urban mobility (Tyrinopoulos and Antoniou, 2008).

SEM represents an appropriate statistical method that can be used by policy and decision makers to improve the transit services provided to the passengers. Based on the results and findings derived from the application of this method, public transport operators, authorities and policy makers may integrate in their strategic plans corrective actions and measures that can better tackle not only users' perception, but also the retailers' ones, as in this case study.

In conclusion, this research demonstrates how SEM may be used to analyze the variability of retailers' perceptions with respect to new investments in metro lines and how the results and findings of this process may contribute to policy and decision making. The public transit operators and authorities should include in their control programs such method, and facilitate the formulation of short- and medium-term action plans.

The interdisciplinary aspect of the research proposed is another point of discussion. Specifically, transportation engineers, transport economists, geographers, statisticians, mathematicians, and many other researchers can be interested in analyzing the phenomenon under study. Authors think that interdisciplinary represents the real success of research and this is the main message that they wish to leave the readers involved in land use policy.



Source: Authors' elaborations

Fig. 8. Structural model results (n. observations 79).

Source: Authors' elaborations

### CRedit authorship contribution statement

Francesca Pagliara has developed the concept and the supervision of the whole paper. Lucia Russo has contributed to the results of the paper. Massimo Aria has provided a contribution the specification of the SEM.

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