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A Back Step before Proposing Smart Interventions. Fitting People Needs with Innovations

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1 ABSTRACT

Nowadays, one of the main subjects of city planning is the environmental impact cities' transformation into smart cities, characterized by an innovative use of technologies and synergies' development between the public and the private sectors. The principal attempt is the increase of the level of well-being and the quality of life. It could pertain to different parts of the city, like suburbs and inner-city. Therefore it is necessary to adapt technologies to environmental and architectural heritage, in order to respect the sustainability principle.

In my PhD research I do a backward step trying to define a methodology to understand needs and expectations of inner-city inhabitants and I apply it to a case study represented by the renewal of Cagliari inner-city, with the objective to increase the residential satisfaction degree of the inhabitants, proposing smart interventions. The paper examines the different phases of the conducted study until now.

2 INTRODUCTION

In the present age, one of the issues that concern planners is represented by the ability to propose interventions that fit people's needs. This intention found its first affirmation in the sustainability principle. Indeed it is important that everybody, both present and future generations, should have the possibility to use the necessary energy supplies in order to achieve a good quality of life. Some planners' work is linked to the elaboration of methodologies that could be applied to define actions and plans with the purposes already mentioned. At this time, different aspects of people's life are being examined in order to pursue a higher level of life satisfaction. One of them is the residential satisfaction related to house and to neighbourhood.

In this paper, my PhD research conducted until now is presented. It has the objective to determine a method of this sort, that involves the use of some statistical models, in particular the discrete choice models, and to apply this technique to a case study. First of all, it has been necessary to outline numerous steps of the method for the purpose of creating a know-how that could be used to analyse well different situations. Then, the technique is applied to the renewal of Cagliari's inner-city, in order to understand city-dwellers' satisfaction degree related to their house and related to the historic neighbourhoods. Having achieved this kind of knowledge allows planners to propose interventions, some of them innovative that are intent on contributing to make the city smarter.

3 METHODOLOGY

The first step of research has been the definition of a methodology, taking the cue from some planning processes and plans in general and from the nature of discrete choice models. In succession its numerous steps are presented:

(1) Context analysis that consists of a territorial analysis, regarding either the city or the territory; in particular, in the case study we are going to present, the attention is focused on the city, and it is important to consider several aspects such as the historic-architectural aspect of urban morphology and the development of the city;

(2) analysis of plans relative to the context examined, so in the case study examined the analysis concerns the inner-city so it should be appropriate to consider urban plans such as the Urban Town Plan (PUC – Piano Urbanistico Comunale), the Detailed Inner-city Plan (PPCS – Piano Particolareggiato del Centro Storico), etc.; it is important to identify plans' objectives, in order not to contradict them in the last phase of research in which we are going to propose interventions;

(3) study of numerous econometric models and analysis of cases study related to the use of discrete choice models, for the purpose established; this step could be useful to understand which models are suitable to describe in the best way the situation we are considering;

(4) experimental part that includes two steps: the first one is the definition of a method to find out information and for instance, the technique could comprehend a questionnaire and a series of interviews

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addressed to people that live in the inner-city or that have interests in the considered context; the second step is represented by the gathering of information constructing a specific dataset;

(5) application of the statistical models and in particular discrete choice models (probit, logit or others such as tobit models) in order to obtain the data processing;

(6) analysis of outcomes that will be different depending on the model used and on the goal of the methodological application;

(7) proposal of interventions which will have to respect the goals of plans considered, and these actions should be oriented to an improvement of the quality of life.

4 CASE STUDY

The case study considered is represented by the renewal of Cagliari's inner-city. The methodology as presented above, is applied starting with an analysis of the history of Cagliari.

4.1 Context analysis

The Cagliari's site has been suitable for the development of a city because it occupies an important position for commercial purposes, being in the middle of the Mediterranean Sea and because, about three thousands of years ago, in this place essential resources such as salt and minerals were plentiful. Hence, Cagliari has been characterized by numerous historic events and it has been dominated by different populations (Colavitti, Usai, 2007). Both dominations and characteristics of the territory influenced the city's structure. In particular, the urban form was affected by different architectural styles and by territory's topography. For instance, during the domination by Phoenicians and Carthaginians (between 700 B.C. and 250 B.C.) there were: the neighbourhood of Castello enclosed by walls to protect the city, the neighbourhood of Stampace where magistrates were located and it was characterized by a temple and a port, the north-west neighbourhood with its necropolis and with the lagoon port for the wheat, the east neighbourhood of Bonaria with a necropolis and another port for the salt. Probably the first urban structure was fan-shaped, with a principal road between the port, the square and the Acropolis, intersected with a road along the sea and the pond. The only part that could have had an orthogonal structure is the neighbourhood of Stampace (Principe, 1988). At about 1000 A.C. Cagliari's urban structure was similar to the current form, with the port that represented a sort of extention of the main neighbourhood of Castello. Cagliari had got a particular urban shape, divided into four sectors, everyone with a defined function and independent from the administrative and military points of view. Since 1800-1850 A.C. Cagliari was represented by four neighbourhoods: Castello, Stampace, Marina, Villanova. These represent the present inner-city. The neighbourhood of Castello represented the administrative centre of the city and it had a spindle structure with numerous squares. It was organized by a road network with principal roads (rugae) that were longitudinal and linked two towers (the Lion tower and the Saint Pancras tower) and by alleys (traversae) that connected the main roads. The houses had numerous floors and the ground floor was used as warehouse. The neighbourhood of Stampace rose up on a place characterized by a regular topography so the roads are parallel to the rugae of Castello, determining tight e long blocks. The neighbourhood of Marina have represented a sort of continuation of Cagliari toward the sea (Romagnino, 1982) and together with Castello represented the main centre of the city. It arose in a very sloping area and it is characterized by alleys and high and tight houses. The neighbourhood of Villanova arose before 1250 A.C. and it is characterized by an irregular grid structure of parcels with a principal road which was parallel to the eastern boundary of Castello. Since 1415 A.C. there was an increase in the number of Cagliari's inhabitants. It caused an increment of construction density in the neighbourhoods of Castello and Marina, where the buildings became higher and the streets similar to tight corridors (Alziator, 2007). The increment of the population and the necessity after the Second World War to provide for an abode to everybody caused a disorganized development of the city structure. An increment in the urbanized surface occurred, occupying level lands so the expansion suited the geomorphologic and microclimatic conditions, with buildings arising in the north-east part and in the east part of Cagliari. Hence, Cagliari's structure can be considered as an upshot of a process of continuous adaptation to the natural conditions of landscape (Colavitti, 2005). Nowadays, some characteristics of housing heritage of Cagliari's inner-city are: numerous houses built before 1919; houses of lower quality than average quality in Cagliari, caused by absence of facilities and services such as heating system, conditioning system, etc.; high

percentage of family units composed by one person; percentage of houses occupied by owners is higher than the average percentage of Cagliari (Detailed Plan of Cagliari's Inner-city, pp. 77,78).

4.2 General Cagliari's inner-city plans objectives

In 1858 the architect Gaetano Cima elaborated the first local strategic plan of the city of Cagliari, in which the importance of the inner-city was affirmed but this plan wasn't applied (Malavasi, Zoppi, 1989). After the II World War a chaotic expansion occurred because bombardments destroyed lots of houses and there was the intention of giving people a house as soon as possible. The new plan was approved in 1938 and according to what established by the urban low n.1150/1942, it was changed in 1943. Numerous plans has focused on the renewal of Cagliari's inner-city. Firstly, the strategic plan in 1962 introduced the inner-city protection (Malavasi, Zoppi, 1989). Secondly, another plan, the "Piano Quadro" for the reclamation of inner-city, that became the Detailed Plan of inner-city, concentrated the attention on the requalification. This plan had the objective to establish a link between various parts of the city, in order to incorporate the inner-city in a united view and to preserve values of identity. In detail, its goals are: permanence of current residence (hoping for a better urban quality); construction of new houses after evaluation of accessibility conditions and of the possibility to transform the building heritage; incentive of presence of University students in the inner-city; regard of cultural and environmental resources; recovery interventions for some buildings in order to use them for new functions; amelioration of infrastructures; recovery of historical waterfront. In 1999 the Cagliari's Urban Plan was approved and its main objective was limitation of residential expansion in order to facilitate the recovery of existing building heritage. In particular, the objectives were: limitation of residential growth, requalification of inner-city and proposal of techniques that were economically feasible to make it. In 2006 another important plan was elaborated, the Regional Landscape Plan that puts the attention on different categories such as the inner-city with centres-of-ancient-and-first-formation category. It laid emphasis on the use of traditional techniques and materials to preserve the image of Cagliari's inner-city with the possibility to include technological innovations. All these plans permitted to delineate admissible interventions such as routine maintenance, emergency maintenance, restoration and conservative renewal, property renovation and completion (Detailed Plan of Cagliari's Inner-city). Considering all the objectives mentioned, we can affirm that the recovery can be considered as a way to reintegrate in the inner-city urban functions, given that Cagliari's inner city is characterized by a lack of services.

4.3 Brief digression about some applications of econometric models

This research's objective is the analysis of residential satisfaction degree referred to house and to neighbourhood. Hence, an useful step of this research is the analysis of numerous cases study about this topic. Some researchers such as Francescato, Weidemann and Anderson, Amerigo and Aragones, considered different dimensions of residential environment: affective, cognitive and behavioural dimensions (Francescato, Weidemann et Anderson, 1987; Amerigo et Aragones, 1999). Few scientists concentrated their attention just on some of these dimensions, such as Cooper that considered the affective dimension. Moreover other researchers such as Ha and Weber, Canter and Rees, defined the variables that influence the residential satisfaction considering different elements: socio-demographic characteristics of residents, objective characteristics of houses and relationships with neighbours (Ha and Weber, 1991, Canter and Rees, 1982). Different types of variables are due to researchers' background. For instance, planners generally consider environmental characteristics of houses, services, environmental security and relationships with neighbours, accessibility of functional areas in the residential area, as variables (Sam, Mohd Zain, Saadatian, 2012). The residential satisfaction is seen as a demonstration that inhabitants' needs are satisfied and that they live well in their houses. Different analysis are also linked to different models used to process data. Indeed some scientists preferred using logit or probit models such as Lu, Atkinson, Fang, others factor analysis and path analysis such as Temelova and Dvorakova and Speare (Lu, 1999; Parkes et all, 2002; Temelova et Dvorakova, 2012).

4.4 Experimental part

4.4.1 Elaboration of the questionnaire

The analysis of the cases study mentioned above permitted to take the cue from different kinds of approach and to elaborate a questionnaire. It is oriented towards Cagliari's inner-city residents. Its basis was the

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definition of residential satisfaction. Residential satisfaction is the measure of the difference between current residential conditions of people and desired conditions. The residential environment is defined as house, neighbourhood and relationships with neighbours, together. The questionnaire is realized in order to define all variables that influence the residential satisfaction and the degree of residential satisfaction itself. Having these data permits to apply econometric models in order to define quantitatively the influence of variables on satisfaction degree and to understand causes of dissatisfaction and consequently propose interventions. According to some psychologists it is important to discern between housing satisfaction and neighbourhood satisfaction so to use distinct questions, otherwise respondents can't unconsciously apply this distinction; hence, in the questionnaire there are different questions for residential satisfaction related to house and related to neighbourhood in order to prevent mistakes when city-dwellers answer (Amerigo et Aragones, 1999; Lu, 1999). A Likert scale was used to define the satisfaction degree: 1. Not satisfied; 2. A little bit dissatisfied; 3. Indifferent; 4. Enough satisfied; 5. Very satisfied. Hence, satisfaction degree is an ordered variable. Some questions in the questionnaire demand respondents' and family unit's characteristics. Indeed it is believed that respondent's age, job, education, family composition, have influence on satisfaction degree. Age is an important variable because there is a correspondence between life cycle's stage and expectations, whereas education and job can affect the kind of house in which people want to live. There are a lot of questions about interior housing characteristics, such as surface, number of rooms, heating system, conditioning system, etc.. All these questions permit to identify a condition of comfort in the house and to understand if there is a correspondence between this situation and a high satisfaction degree. Other questions check residents' moves in the past or in the future and they could be important to verify if a resident expresses the real satisfaction degree or not. Other questions try to identify neighbourhood characteristics, facilities and problems in order to understand the link between them and the satisfaction degree towards the neighbourhood and to propose useful interventions at the end of research.

4.4.2 Analysis through econometric models

This step consists in the implementation of some econometric models, after having created a dataset using Stata software. In particular, an ordinal Logit model and an ordinal Probit model are applied because the dependent variable that is the residential satisfaction is an ordinal variable. Hence, two models will be applied in order to have the possibility to compare the outcomes. These kind of models we are going to implement are characterized by a latent regression as presented in succession:

$$yi^* = \beta' xi + \varepsilon i \qquad i = 1,\ldots\ldots,n$$

where yi^* is the latent variable, not observed; xi represents the covariates or independent variables; β is the k-parameters vector and it is the object of inference and evaluation; n is sample's size. We know yi that is the satisfaction degree but we don't know yi^* that is the latent variable :

$yi = 0$ if $yi^* \leq 0$ with $\mu 0 = 0$

$yi = 1$ if $0 < yi^* \leq \mu 1$

$yi = 2$ if $\mu 1 < yi^* \leq \mu 2$

…..

$yi = j$ if $\mu j-1 \leq yi^*$

μ are unknown parameters that should be estimated with β (Greene, 1993). The residential satisfaction degree depends on both measurable factors (independent variables xi obtained through the questionnaire), and non-observable factors represented by ε. The yi^* in the model describes a continuous preference, not observed, whereas the yi is ordered because it can have just five values (mentioned above). The respondents will express their satisfaction degree that should represent their feelings towards the house and towards the neighbourhood. In an ordered Probit model there is a standard normal distribution for εi and the $Var[\varepsilon i|xi] = 1$, whereas in an ordered Logit model εi's distribution is a standardized logistic and the $Var[\varepsilon i|xi] = \pi 2/3$ (Greene, Henser, 2008). Assuming that xi has a constant element, we can assume that the first coefficient $\mu 0$ is equal to 0. Summing up, application of the econometric models has the objective to evaluate β coefficients for every considered independent variable. These coefficients are important to understand which variables influence mostly the residential satisfaction degree and if they have a negative or a positive influence. A hundred and fifty interviews have been conducted and their data are organized in a dataset and used to implement the model we described above using the Stata software. We can consider our sample a

representative sample of the Cagliari's inner-city population. The first step, after having done the interviews, has been the creation of a dataset containing all the variables obtained through the questionnaire and their values. We operated numerous changes to variables in order to have suitable data to use in the ordinal Logit and Probit models, but previously it was necessary to implement a simple linear regression between the dependent variable and the numerical explanatory variables in order to verify absence of multicollinearity. Then, we implemented the models numerous times. The first time we apply Probit and Logit models the degree of residential satisfaction related to house was considered as the dependent variable whereas the covariates were: gender, education, job, age of the respondent, family composition, type of house and possession, internal characteristics such as house surface and balcony surface, the presence of some facilities such as heating system, conditioning system, etc.. Then we implement those models using the degree of residential satisfaction related to neighbourhood as the dependent variable and the covariates were some dummy variables that express the lack of services in the neighbourhood, other variables that explain the presence of problems such as noise, garbage, etc.. An interesting aspect could be the implementation of a model in which the relation between the satisfaction towards the house and the satisfaction towards the neighbourhood are considered. Taking into account the studies conducted in the past about this topic, numerous psychologists affirmed that the satisfaction degree related to neighbourhood can influence the satisfaction degree related to house. We want to implement a model with the satisfaction degree of the house as a dependent variable, and considering the satisfaction degree of the neighbourhood as one of the independent variables, using also a nested model to introduce the variables that explain the satisfaction related to neighbourhood. This is a future step of the thesis. The first econometric model we talked about is:

$$Soddisfazc = \beta0 + \beta1*eta + \beta2*d\_gen + \beta3*rationucleo + \beta4*ratiosup1 + \beta5*\_Istudio + \beta6*\_Ilavoro + \beta7*\_Igodimcasa + \beta8*d\_riscald + \beta9*d\_pompe + \beta10* d\_ascens + \beta11* d\_sgacant$$

In which:

eta = dummy variables set representing respondent's age that is organized in cathegories (eta_categx1=1 if respondent is between 18 and 25 years old, 0 otherwise; similarly for eta_categx2 = 1 if the interviewed is between 26 and 40 years old, eta_categx3 = 1 if the respondent is between 41 and 60 years old, eta_categx4 = 1 if the interviewed is more than 60 years old);

d_gen = dummy variable for gender (d_gen=1 for female, d_gen=0 for male);

rationucleo = factor variable representing the ratio between number of people that live in respondent's house and average number of people in a family considering interviews' data;

ratiosup1 = factor variable obtained dividing house's surface for every resident interviewed for the average surface of respondents' houses in the sample;

_Istudio = dummy variables set for the degree of education of the respondent (istudio1 = 1 if the respondent is graduated or has a school leaving certificate, 0 otherwise; istudio2 = 1 if the respondent has a primary school certificate or a junior high school certificate, 0 otherwise);

_Ilavoro = dummy variables set for the kind of job of the respondent (jlavoro1 = 1 if the respondent is a public employee, 0 otherwise; jlavoro2 = 1 if the respondent is a freelance professional, 0 otherwise; jlavoro3 = 1 if the respondent is a student or a retiree or an unemployed, 0 otherwise);

_Igodimcasa = dummy variables set that expresses the kind of possession of interviewed towards the house (sgodimcasa1 = 1 if the respondent lives in a rental flat, 0 otherwise; sgodimcasa2 = 1 if the respondent is owner of a flat, 0 otherwise; sgodimcasa3 = 1 if the respondent is the owner of a single house, 0 otherwise; sgodimcasa4 = 1 if the respondent is the beneficial owner of a flat, 0 otherwise);

d_riscald = dummy variable for the heating system (d_riscald = 1 if there is the heating system, 0 otherwise);

d_pompe = dummy variable for the conditioning system (d_pompe = 1 if there is the conditioning system, 0 otherwise);

d_ascens = dummy variable for the presence of an elevator (d_ascens = 1 if there is an elevator in the building, 0 otherwise);

d_scagant = dummy variable for the presence of a junk room or a cellar (d_scagant = 1 if there is a junk room or a cellar, 0 otherwise).

As cited above, before implementing the ordinal Logit model a linear regression model for the dependent variable and the quantitative explanatory variables was implemented through Stata program. No problems of multicollinearity occurred. Indeed, a ordinal Logit model could be applied.

The results of the first model we implemented are:

```
. xi: ologit soddisfazc eta_categx2 eta_categx3 eta_categx4 d_gen rationucleo
> ratiosup1 i.studio i.lavoro i.godimcasa d_riscald d_pompe d_ascens d_sgacant
i.studio          _Istudio_1-2        (_Istudio_1 for studio==diplau omitted)
i.lavoro          _Ilavoro_1-3        (_Ilavoro_1 for lavoro==dip omitted)
i.godimcasa       _Igodimcasa_1-4     (_Igodimcasa_1 for ~mcasa==afapp omitted
> )

Iteration 0:   log likelihood = -168.54721
Iteration 1:   log likelihood =  -154.5344
Iteration 2:   log likelihood = -154.03179
Iteration 3:   log likelihood = -154.02993
Iteration 4:   log likelihood = -154.02993

Ordered logistic regression                     Number of obs   =        150
                                                LR chi2(16)     =      29.03
                                                Prob > chi2     =     0.0237
Log likelihood = -154.02993                     Pseudo R2       =     0.0861
```

soddisfazc	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
eta_categx2	-.6280022	1.110931	-0.57	0.572	-2.805387	1.549383
eta_categx3	-1.073229	1.032562	-1.04	0.299	-3.097013	.9505543
eta_categx4	-.7534717	.9836777	-0.77	0.444	-2.681445	1.174501
d_gen	.1627012	.3611298	0.45	0.652	-.5451003	.8705026
rationucleo	-.4475387	.497397	-0.90	0.368	-1.422419	.5273415
ratiosup1	1.51087	.5916083	2.55	0.011	.3513386	2.670401
_Istudio_2	-.3196608	.4971828	-0.64	0.520	-1.294121	.6547995
_Ilavoro_2	.3877155	.5952546	0.65	0.515	-.778962	1.554393
_Ilavoro_3	-.4398783	.5340986	-0.82	0.410	-1.486692	.6069358
_Igodimcas~2	.4689796	.6273792	0.75	0.455	-.760661	1.69862
_Igodimcas~3	-.9942119	.9785031	-1.02	0.310	-2.912043	.9236189
_Igodimcas~4	-1.253779	1.042937	-1.20	0.229	-3.297899	.7903399
d_riscald	.307466	.3602038	0.85	0.393	-.3985205	1.013452
d_pompe	-.0793798	.3843266	-0.21	0.836	-.8326461	.6738866
d_ascens	-.0827574	.3569776	-0.23	0.817	-.7824206	.6169058
d_sgacant	.3111558	.3774456	0.82	0.410	-.428624	1.050936
/cut1	-4.068754	1.51428			-7.036688	-1.100819
/cut2	-2.246556	1.376237			-4.94393	.4508179
/cut3	-1.322869	1.358073			-3.984644	1.338905
/cut4	1.61132	1.355211			-1.044844	4.267485

Fig. 1: Outcomes of the first Ordinal Logit Model implemented.

We can analyse the results considering that the Logit coefficients are in log-odds units and can't be read as regular OLS coefficients. There is not the value of the intercept and we can say that the intercept is absorbed by the first cutoff point. Observing the value of Prob > Chi2 can help us to deduce if the model is ok or not from this value. The number is less than 0.05 so all the coefficients are different from zero and the null hypothesis is rejected. The pseudo R2 value includes the amelioration of the likelihood estimated with this model rather than considering the null hypothesis. The z value tests the hypothesis that each coefficient is different from 1. The higher is the z the higher is the relevance of the variable. Two-tail p-values (P>|z|) test the hypothesis that each coefficient is different from 0. In the ordered Logit model it is useful to check the sign of the coefficients (UCLA Resources to learn and use STATA). So, we can deduce that a bigger family influence negatively the satisfaction degree towards the house rather than smaller families; so smaller families have a higher satisfaction degree than larger families, considering the other variables' values similar. Older people seem to have a lower satisfaction degree related to their house than young people (with an age between 18 and 25 years old). A lower educational level has a negative influence on satisfaction degree, so people less educated are less satisfied of their house than higher qualified people, considering the same characteristics for all the other variables. Paradoxically to expectations, the presence of the elevator and of conditioning system seems to influence negatively the satisfaction in the sense that people that live in buildings with no elevator and no conditioning express a higher satisfaction degree than the other people (always considering the same values of all the other variables). We can also observe that these two variables (d_ascens and d_pompe) are not significant considering that the P>|z| values are big and in particular are 0.81 and 0.83. We observe that women express higher satisfaction than men and we could explain it considering the fact that women generally spend more time at home than men do, being more affectively linked to their house and consequently expressing higher satisfaction. The variable ratiosup1 is a ratio that represents the size of house and we can see that it has a positive influence on satisfaction degree, so bigger is house's surface, then higher is respondent's satisfaction related to its house. Being a student, or a retiree or an unemployed seems to have a negative influence on residential satisfaction degree towards house rather than been a public employee; it could be due to the less economical possibilities for students, unemployed

and reteree people to apply changes to their residential condition and to their house in general. Differently, being a freelance professional has a positive influence on satisfaction degree rather than being a public employee. Finally, having a cellar or a heating system have a positive influence on residential satisfaction degree rather than not having them. The cutoff points represent the cutoff values so the threshold values for the probability that the satisfaction degree is 1-"Not satisfied" , 2 – "A little bit dissatisfied", 3 – "Indifferent", 4 – "Enough satisfied" or 5 – "Very satisfied". Hence, for instance if the predicted probability is lower than -4.07 we are going to have "Not satisfied", etc.. We can check the predicted probabilities and we can see that almost for every observation (interview) the biggest predicted probability is related to 4-"Enough Satisfied" and this probability is higher than 50% in the majority of cases. We have an higher probability related to 5-"Very Satisfied" and 3-"Indifferent" just for few cases.

Then we implement an Ordinal Probit model for satisfaction degree towards house and the results are presented in succession:

```
. xi: oprobit soddisfazc eta_categx2 eta_categx3 eta_categx4 d_gen rationucleo
>  ratiosup1 i.studio i.lavoro i.godimcasa d_riscald d_pompe d_ascens d_sgacan
> t
i.studio          _Istudio_1-2        (_Istudio_1 for studio==diplau omitted)
i.lavoro          _Ilavoro_1-3        (_Ilavoro_1 for lavoro==dip omitted)
i.godimcasa       _Igodimcasa_1-4     (_Igodimcasa_1 for ~mcasa==afapp omitted
> )

Iteration 0:   log likelihood = -168.54721
Iteration 1:   log likelihood = -155.35393
Iteration 2:   log likelihood = -155.26942
Iteration 3:   log likelihood = -155.26942

Ordered probit regression                       Number of obs   =        150
                                                LR chi2(16)     =      26.56
                                                Prob > chi2     =     0.0467
Log likelihood = -155.26942                     Pseudo R2       =     0.0788
```

soddisfazc	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
eta_categx2	-.4906967	.652873	-0.75	0.452	-1.770304	.788911
eta_categx3	-.6372653	.6032474	-1.06	0.291	-1.819609	.545078
eta_categx4	-.475534	.578843	-0.82	0.411	-1.610045	.6589773
d_gen	.1797358	.2039433	0.88	0.378	-.2199857	.5794572
rationucleo	-.2190771	.2744065	-0.80	0.425	-.756904	.3187498
ratiosup1	.7892276	.3018873	2.61	0.009	.1975394	1.380916
_Istudio_2	-.2116097	.2817451	-0.75	0.453	-.7638199	.3406006
_Ilavoro_2	.3673252	.3417519	1.07	0.282	-.3024963	1.037147
_Ilavoro_3	-.1744775	.2973543	-0.59	0.557	-.7572812	.4083262
_Igodimcas~2	.1803618	.3520492	0.51	0.608	-.5096419	.8703654
_Igodimcas~3	-.5575927	.5922791	-0.94	0.346	-1.718438	.6032529
_Igodimcas~4	-.7118773	.5699893	-1.25	0.212	-1.829036	.4052813
d_riscald	.2131366	.2011678	1.06	0.289	-.1811449	.6074182
d_pompe	-.0881107	.2189914	-0.40	0.687	-.5173259	.3411046
d_ascens	.0023302	.2037761	0.01	0.991	-.3970636	.4017239
d_sgacant	.1294141	.2181429	0.59	0.553	-.2981381	.5569663
/cut1	-2.107132	.8285655			-3.731091	-.4831736
/cut2	-1.29433	.7966991			-2.855831	.2671718
/cut3	-.8117085	.7896355			-2.359366	.7359486
/cut4	.8938249	.7861219			-.6469457	2.434596

Fig. 2: Outcomes of the first Ordinal Probit Model implemented.

The results in terms of negative or positive influence on residential satisfaction degree are almost the same, except for the variable of presence of an elevator. In this case it seems to have a positive influence on satisfaction degree but also in this case it is not significant, seen the high value of P>|z| that is 0.99. We can observe that also in this case, the variable ratiosup1 that represents the house surface has a positive influence and it is significant. The variable d_pompe that express the presence of conditioning system has a negative influence also using this model, but it is not significant. If we check the predicted probabilities we can see that also in this case the higher probability is related to 4-"Enough Satisfied" in almost all the observations.

Then, the second model, that tries to explain the influence of explanatory variables on satisfaction degree related to the neighbourhood is:

Soddisfazq = β0 + β1*eta + β2*d_gen + β3*rapportocoivicini + β4*d_altrifamiliari + β5*_Istudio + β6*_Ilavoro + β7*d_scuola + β8*d_supermercato + β9*d_poste + β10* d_giardini + β11* d_fermatebus + β12*d_var31 + β13*d_var34 + β14*d_var35 + β15*d_var37

In which:

Rapportocoivicini = dummy variables set that represents the relationship between respondent and neighbours.

d_altrifamiliari = dummy variable that expresses the residence of other familiars in the inner-city

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d_scuola, d_supermercato, d_poste, d_giardini, d_fermatebus = dummy variables that express when they are equal to 1 the absence of that particular service, 0 otherwise.

d_var31, d_var34, d_var35, d_var37 = dummy variables that represent the most frequent problems of the inner-city of Cagliari and they correspond to absence of parking, presence of wastes, traffic, and noise. All the other variables are the same used in the first model implemented.

```
. xi: ologit soddisfazq eta_categx1 eta_categx2 eta_categx3 eta_categx4 d_gen
> d_tranqzona i.rapportocoivicini d_altrifamiliari i.studio i.lavoro quartiere
> x1 quartierex2 quartierex3 quartierex4 d_scuola d_supermercato d_poste d_far
> macia d_giardini d_fermatebus d_var31 d_var34 d_var35 d_var37

Iteration 0:   log likelihood = -188.38222
Iteration 1:   log likelihood = -153.90482
Iteration 2:   log likelihood = -151.01711
Iteration 3:   log likelihood = -150.96298
Iteration 4:   log likelihood = -150.95974
Iteration 5:   log likelihood =  -150.9591
Iteration 6:   log likelihood = -150.95896
Iteration 7:   log likelihood = -150.95893
Iteration 8:   log likelihood = -150.95892

Ordered logistic regression                     Number of obs   =        150
                                                LR chi2(26)     =      74.85
                                                Prob > chi2     =     0.0000
Log likelihood = -150.95892                     Pseudo R2       =     0.1987
```

soddisfazq	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
eta_categx1	2.385868	1.243808	1.92	0.055	-.0519501	4.823686
eta_categx2	-.1318692	.7030301	-0.19	0.851	-1.509783	1.246044
eta_categx3	.0338594	.536413	0.06	0.950	-1.017491	1.085209
eta_categx4	(omitted)					
d_gen	.526471	.3808115	1.38	0.167	-.2199058	1.272848
d_tranqzona	1.235422	.4905138	2.52	0.012	.2740326	2.196812
_Irapporto~2	-1.876499	.557144	-3.37	0.001	-2.968481	-.784517
_Irapporto~3	-.9109474	.7207293	-1.26	0.206	-2.323551	.501656
_Irapporto~4	11.66992	741.8921	0.02	0.987	-1442.412	1465.752
_Irapporto~5	1.123618	.4731823	2.37	0.018	.1961975	2.051038
d_altrifam~i	-.0271145	.3922093	-0.07	0.945	-.7958307	.7416017
_Istudio_2	-.4222615	.5002836	-0.84	0.399	-1.402799	.5582764
_Ilavoro_2	-.1863877	.6433438	-0.29	0.772	-1.447318	1.074543
_Ilavoro_3	-.2639752	.5535974	-0.48	0.633	-1.349006	.8210557
quartierex1	-.7805241	.643699	-1.21	0.225	-2.042151	.4811028
quartierex2	-.5038201	.6314853	-0.80	0.425	-1.741509	.7338685
quartierex3	-.1204849	.541811	-0.22	0.824	-1.182415	.9414451
quartierex4	(omitted)					
d_scuola	.5098697	.5081983	1.00	0.316	-.4861807	1.50592
d_supermer~o	-.4435028	.5726138	-0.77	0.439	-1.565805	.6787997
d_poste	.1616444	.5913734	0.27	0.785	-.9974261	1.320715
d_farmacia	.308826	.9111098	0.34	0.735	-1.476916	2.094568
d_giardini	-.1212487	.4527091	-0.27	0.789	-1.008542	.7660447
d_fermatebus	.7419845	.8110506	0.91	0.360	-.8476456	2.331615
d_var31	.2797726	.4604194	0.61	0.543	-.6226329	1.182178
d_var34	-.822367	.413129	-1.99	0.047	-1.632085	-.0126491
d_var35	-.22743	.3891568	-0.58	0.559	-.9901632	.5353033
d_var37	-.9698914	.4168591	-2.33	0.020	-1.78692	-.1528625
/cut1	-3.259664	1.184646			-5.581526	-.9378012
/cut2	-1.184782	1.128448			-3.3965	1.026936
/cut3	-.723454	1.124984			-2.928381	1.481473
/cut4	2.796802	1.159603			.5240218	5.069583

Fig. 3: Outcomes of the second Ordinal Logit Model implemented.

We can observe that a variable about the relationship with the neighbours (_Irapporto4) has a very big coefficient and a big value of P>|z|, so it is not significant. Women express higher satisfaction degree towards the neighbourhood than men and being women seems to have a positive influence on this kind of satisfaction. The presence of markets and public green spaces have a negative influence on satisfaction degree, whereas the presence of bus stops, pharmacy and post offices have a positive influence. These findings about the variables d_supermercato and d_giardini are in contradiction with our expectations but they are not significant, considering P>|z| values. The absence of parking spaces (d_var31) has a positive coefficient in the definition of satisfaction degree towards neighbourhood in the sense that absence of parking causes an increase in the rank of satisfaction degree, considering the same values for the other variables. Also this outcome can be explained with the fact that this variable is not significant considering that its P>|z| value is about 0.559. The other problems such as presence of rubbish (d_var34), traffic (d_var35) and noise (d_var7) have negative coefficients, so they have negative influence on satisfaction degree. Finally we can check the predicted probabilities for the different values of the satisfaction degree towards the neighbourhood and we can observe that in the majority of cases the higher probability is related to 4-“enough satisfied”, but in some cases the higher is 2-“a little bit satisfied” or 5-“very satisfied”.

Considering the implementation of an Ordinal Probit model for the satisfaction degree related to the neighbourhood the results are:

```
. xi: oprobit soddisfazq eta_categx1 eta_categx2 eta_categx3 eta_categx4 d_gen
>  d_tranqzona i.rapportocoivicini d_altrifamiliari i.studio i.lavoro quartier
> ex1 quartierex2 quartierex3 quartierex4 d_scuola d_supermercato d_poste d_fa
> rmacia d_giardini d_fermatebus d_var31 d_var34 d_var35 d_var37

Iteration 0:   log likelihood = -188.38222
Iteration 1:   log likelihood = -150.68067
Iteration 2:   log likelihood = -149.80701
Iteration 3:   log likelihood = -149.78458
Iteration 4:   log likelihood = -149.78172
Iteration 5:   log likelihood = -149.78128
Iteration 6:   log likelihood = -149.78122
Iteration 7:   log likelihood =  -149.7812

Ordered probit regression                       Number of obs   =        150
                                                LR chi2(26)     =      77.20
                                                Prob > chi2     =     0.0000
Log likelihood =  -149.7812                     Pseudo R2       =     0.2049
```

soddisfazq	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
eta_categx1	1.397719	.7416645	1.88	0.059	-.0559169	2.851355
eta_categx2	-.0707565	.4025859	-0.18	0.860	-.8598104	.7182974
eta_categx3	.0353671	.3062211	0.12	0.908	-.5648152	.6355494
eta_categx4	(omitted)					
d_gen	.2677285	.2165119	1.24	0.216	-.156627	.692084
d_tranqzona	.6976578	.2761681	2.53	0.012	.1563783	1.238937
_Irapporto~2	-1.066036	.3153273	-3.38	0.001	-1.684066	-.4480059
_Irapporto~3	-.5507622	.3676726	-1.50	0.134	-1.271387	.1698629
_Irapporto~4	3.783534	129.1095	0.03	0.977	-249.2664	256.8334
_Irapporto~5	.6209009	.2656475	2.34	0.019	.1002415	1.14156
d_altrifam~i	-.0414339	.221678	-0.19	0.852	-.4759149	.3930471
_Istudio_2	-.3367687	.2919361	-1.15	0.249	-.908953	.2354156
_Ilavoro_2	-.0939604	.3678357	-0.26	0.798	-.8149051	.6269843
_Ilavoro_3	-.1805245	.3132807	-0.58	0.564	-.7945434	.4334943
quartierex1	-.3193464	.3545891	-0.90	0.368	-1.014328	.3756355
quartierex2	-.2094566	.3629554	-0.58	0.564	-.9208361	.5019229
quartierex3	.0091165	.3123687	0.03	0.977	-.603115	.6213479
quartierex4	(omitted)					
d_scuola	.2554482	.2816296	0.91	0.364	-.2965357	.8074322
d_supermer~o	-.3199828	.325296	-0.98	0.325	-.9575513	.3175856
d_poste	.1653041	.3268746	0.51	0.613	-.4753584	.8059666
d_farmacia	.2561195	.5051342	0.51	0.612	-.7339254	1.246164
d_giardini	-.0277771	.2522478	-0.11	0.912	-.5221738	.4666196
d_fermatebus	.4073116	.4526557	0.90	0.368	-.4798772	1.2945
d_var31	.182327	.2628898	0.69	0.488	-.3329275	.6975816
d_var34	-.4499318	.2270027	-1.98	0.047	-.8948489	-.0050147
d_var35	-.1031759	.2248586	-0.46	0.646	-.5438905	.3375388
d_var37	-.5937252	.2359598	-2.52	0.012	-1.056198	-.1312525
/cut1	-1.785626	.6684301			-3.095725	-.4755274
/cut2	-.61305	.6421694			-1.871679	.6455789
/cut3	-.3444725	.6418126			-1.602402	.9134571
/cut4	1.696742	.6617372			.399761	2.993723

Fig. 4: Outcomes of the second Ordinal Probit Model implemented.

The results through this model are almost the same as those with Logit model in terms of negative or positive influence on the satisfaction degree. Variables that have negative influence against expectations are not significant with high values of P>|z|. Differently from the previous analysis, living in the neighbourhood of Stampace seems to have a positive influence on satisfaction degree towards the neighbourhood. The other results are similar and the coefficients are not very different in terms of order of magnitude. If we check the predicted probabilities for this model, we can observe that the situation is quite similar to that obtained using the Ordinal Logit model; hence, in lots of cases the bigger probability is associated to 4- "Enough Satisfied", but there are several cases in which the higher probability is linked to 2 – "A little bit dissatisfied" and 5- "Very satisfied".

4.4.3 Proposal of smart interventions

According to what these first results express, we can finally propose interventions in order to increase the residential satisfaction degree and the quality of life of Cagliari's inner-city-dwellers. Firstly, the absence of some services is determinant in the definition of a low satisfaction degree so it could be important to provide inner-city with some important services such as bus stops, post offices and pharmacies. A sense of isolation came to light from the interviews, related in particular to some parts of the inner-city such as the neighbourhood of Castello. The lack of some services determined a lower residential satisfaction degree towards the neighbourhood. A proposal could be to increase the bus network in these parts of the city, in order to give the possibility to its inhabitants to reach the locations of public services more easily. Indeed, the majority of Cagliari's inner-city dwellers are elderly people so they have difficulties to move far from their house. Another proposal could be to give people, especially elderly people (who represent an important share of Cagliari's inner-city population), the possibility to do grocery shopping ordering it through telephone and to receive it at home without any additional cost. Traffic seems to have a negative influence on the satisfaction degree, so we could propose a smart intervention to deal with this issue: we could organize parking areas just outside the inner-city, near its bounds, in order to reduce cars' circulation; it could be a way to transform Cagliari's inner-city in a pedestrian area giving the residents the possibility to park inside the inner-city just for a limited time, for instance for a couple of hours, but giving in advance notice of it

through a short message or a call to a specialised centre that has the mansion to manage inner-city parking spaces. Contextually, parking areas just outside the inner-city should be reserved for residents, giving just one pass to every resident family. Considering relationships with neighbours, very good relations influence positively the residential satisfaction degree, whereas being just acquaintances has a negative influence. So, it could be reasonable to propose an intervention that contributes to ameliorate relationships between neighbours, for instance creating an aggregation centre for every neighbourhood of the inner-city, in which people can spend time socializing, etc.. In order to address another important problem represented by garbage collection which has a negative influence on the residential satisfaction degree, we could propose to create a particular system of rubbish collection characterised by dustbins located underground; in this way we hope to limit the visual impact of garbage in the street corners in order to improve urban cleanliness.

5 CONCLUSION

These are just partial results which will be further developed in the PhD thesis. Other models are going to be implemented especially the most important ones, an ordinal Logit model and a Probit model to explain the influence that satisfaction towards neighbourhood has on satisfaction towards house. This is fundamental in order to identify quantitatively the influence that all the variables considered in the first model together with the satisfaction degree related to the neighbourhood have on the satisfaction degree related to the house. In future steps of the thesis we could also implement the models and we could implement another particular analysis considering separately the four neighbourhoods of Cagliari's inner-city in order to verify if in some of them the results are different from the outcomes just obtained. Finally, we are going to propose a set of interventions based on the outcomes obtained through these different analyses; these actions should fit people needs and expectations in order to pursue a better quality of life and a higher sense of well-being.

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