Improving service quality in healthcare organisations through geomarketing statistical tools

Abstract

Purpose - The purpose of this paper is to demonstrate how geomarketing statical tools (notably, gravitational models) can support healthcare organizations to improve the quality of their services.
Design/methodology/approach – Geomarketing tools were applied to the analysis of data (91,478 observations) concerning the performance of nuclear magnetic resonance.
Findings - Geomarketing models can support and enhance the planning of service provisions of healthcare organisations. Drawing the planning actions on the patient needs and actual behaviours allow the healthcare organisations to obtain better market performance.
Practical implications – The results support the health service planning activities related to covering the so-called "offer gaps".
Originality/value – This is the first study to apply geomarketing to improve the quality of healthcare services.
Keywords – Geomarketing, Gravitational models, Quality improvement, Healthcare organisations
Paper type – Research paper

Introduction

Since the 20th century the theme of improving healthcare has received increasing attention. This growing importance has led to consider the patients as customers (Grönross and Monthelie, 1988; Norgren, 2008). According to several authors, healthcare organizations get greater success by considering the patients/customers point of view (Gustavsson et al., 2016).
In the current scenario, after the global crisis, governments have to deal with a big dilemma. On one hand, they have to reduce the costs and expenditures but on the other hand they have to improve the quality (Carter and Silverman, 2016). Reaching this goal is particularly difficult in the healthcare systems due to their complexity (Mosadeghrad, 2015). As a consequence, healthcare organizations are trying to allocate resources more efficiently and effectively (Carter and Silverman, 2016). In this perspective, several management approaches and tools have been experimented by healthcare organisations to improve their services quality (such as TQM, 5S, Six sigma, Kaizen) but up to now geomarketing (Baker and Baker, 1999; Markowitz, 2005; Eagle, 2005; Cliquet, 2006; Freire e Santos, 2012) and gravitational type models (Daskin and Dean, 2004; Taket and Mayhew, 1981; Mayhew, Gibberd and Hall, 1986) have been ignored. In this perspective, this paper aims to fill this gap by highlighting how geomarketing can support the strategic decision and quality improvement of a central healthcare organization, A.T.S. (Agenzia di Tutela della Salute) in Bergamo, located in North of Italy, by examining real data concerning the performance of nuclear magnetic resonance imaging (NMRI). A.T.S., in Italy (otherwise known as LHA -Local Health Authority), is the public institution who purchase the services on behalf of the citizens (likewise insurance companies in the U.S.A.).
The purpose of these analyses is to support health policy assessments, leading to a targeted implementation of healthcare efforts by the service providers, in order to satisfy epidemiological needs of the population.
The remaining of the article is articulated as follows: in the next paragraph the relevant literature is reviewed; after that the method is explained and the results are presented and discussed; conclusions and limitations complete the paper.

Literature review

By geomarketing, reference is made to an analytical, strategic and operative multi-disciplinary approach which pursues management and marketing objectives by using geographical concepts and instruments, maps, statistics and information technology. According to the definition of Value Lab[1], it "consists mainly in analysing the behaviour of economic subjects bearing in mind notions of space in order to understand the market and to implement more effective marketing strategies" (Cavallone and Di Marco Pernice, 2014, p. 134).

There have been many reasons why scholars have been encouraged to develop a discipline that combines geography and marketing. In literature three factors emerge that have been all-important for the birth of the discipline: the change in the economic climate as stated in the studies of Cliquet (2006), technological progress to which Freire and Santos (2012) refer and an evolution in consumers' behaviour (Markowitz, 2005; Eagle, 2005), which appears to be the most important factor. According to Fiori (2003) and Markowitz (2005), the tastes and preferences of individuals change depending on where they are or have been and according to the cultural aspects linked to the places. Other scholars (Mittal, Kamakura and Govind, 2004; Bradlow, Bronnenberg et al., 2005) believe that the concept of utility and the degree of customer satisfaction in particular vary, being direct manifestations of the social-demographic aspects that characterise each individual territory.

For these reasons, geomarketing presents itself as a very adaptable instrument especially as a result of the various advantages that can be attributed to it. Various scholars (Dennis and Carte, 1998; Smelcer and Carmel, 1997; Miller et al., 2005) attribute to geomarketing the capacity to encourage and speed up the decisional process; other authors such as Galante and Preda (2008), Desiati and Laterza (2010) and Gazzei (2010), consider it to be useful for simplifying the reading of data, while Baker and Baker (1999) assert its capacity to improve the efficacy of market analyses. To this should be added the potential described by Cliquet (2006) to renew marketing strategies and increase companies' competitiveness, reactivity and dynamism (Cliquet, 2006; Gazzei, 2010).

According to the latest research (Petac, Alzoubaidi Abdel and Prodan-Palade, 2014), use of geolocalisation is necessary for every economic activity. The potential deriving from connecting existing and potential customers to information concerning their geographical location is considerable, as it enables very precise marketing strategies to be formulated.

The use of geo-referenced information is useful both for private firms and for public authorities: one of the areas in which the potential of geomarketing is more evident is, in fact, the health sector. Computerised information systems of the "GIS" type can contribute towards various tasks of the National Health Service, dealing as much with assistance as prevention, supervision and control, by means of a knowledge of the territorial distribution of elements such as the incidence or prevalence of pathologies and risk factors, planning and assessment of health measures (accessibility, localisation, quality/appropriateness, equity, etc.), the construction of environmental models, transmittable disease surveillance systems (Senin, Dellacasa, De Rosa and Demattè, 2011).

As stated by Pérez Romero and Suàrez Meaney (2009), the usefulness of geomarketing in the health sector derives from its capacity to study the needs of the population in order to create a health service that is useful for the welfare of the entire community.
Geomarketing also proves useful in order to understand in depth the criteria behind choices made in this sector, bearing in mind that "one of the most important elements that scholars must take into

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[1] Value Lab is a Management Consulting & Information Technology firm and the leading Italian advisor on Marketing, Sales and Omnichannel Customer Experience. Since 1990 Value Lab supports its clients to achieve sustainable competitive advantage through increased revenue and cost optimisation, operating on an international scale. http://www.valuelab.it/en/.

account concerns consumers' mobility which no longer seems to be solely linked to distance" (Desiati and Laterza, 2010). In fact, distance is a factor that is certainly significant in establishing the choice of health services by the patient and should also be considered together with other types of variable (Comber, Brunsdon and Radburn, 2011). The accessibility of the health services is a more complex mechanism which covers a wide range of factors linked to behaviour and perceptions deriving, in their turn, from qualitative factors such as the perceived quality of the service, opening times and previous experiences (Comber, Brunsdon and Radburn, 2011).

The choice factors in the health sector include many value categories and, more specifically: cost, equipment, training and attitude of the medical staff, environment, timescale, relations, *brand image* of the healthcare facility and added value (Lee, 2010).

Further studies confirm the trends described above (Segbers, 2010). Past experiences, whether the patient's own or those of friends and family and, more in general, word of mouth, are a widely used instrument for the choice of healthcare facility (Moscone, Tosetti, Vittadini, 2012) and shape the patient's perception of the healthcare provider's reputation and quality. Again according to these authors, this reputation is considered much more influential when choosing the healthcare facility than the doctor's recommendations or the cost: the first has an influence of 65.7%, the second 40.4% and the third variable 28.5%. In addition, the patient satisfaction is influenced by the waiting time for a service. Higher waiting times cause dissatisfaction and are generated by different factors included limited capacity of planning (Ishijima et al, 2016).

However, quality remains an essential prerequisite dealing with the appropriateness of the outcome, which remains the main value, surpassing even aspects linked to logistical convenience. The final aim consists in evaluating, from the point of view of public health policy makers who are "those who purchase the services on behalf of the citizens" (as we previously described, the A.T.S. in Italy or the insurance companies in the U.S.A.), where the purchases of healthcare facilities should be implemented in order to satisfy the epidemiological need of the population.

Method

The data analysed include all the 91,478 NMRIs performed in the year 2015 in favour of patients of the A.T.S of Bergamo, in any healthcare facility accredited by the A.T.S. of Bergamo and reported by means of the flow of services performed under an agreement with the national health service for specialist outpatient care (known as flow "28SAN"). In general, access to the health services is characterised by geographical factors, such as, for example, distance and journey time, as well as demographical-social factors, such as ethnic group, social-cultural level, income and advice of the general practitioner. As far as some specialist services that are not equally distributed throughout the territory are concerned, such as some radiology tests, accessibility may be limited by proximity, which can be measured as the journey time from the patient's home to the healthcare facility. For this reason, the NMRI service is chosen. In fact, it is a standardised service in which the presence of the human component is very low. In this way, we reduced the number of variables that can influence the choice of the organisation. The NMRI performed were traced by means of the codes applied to the national health care range of fees (codes from 88.91.1 to 88.95.6). The NMRI performed on patients of the A.T.S. of Bergamo reported by structures outside the province (Table 1) have been excluded due to their low number (10% of the total) and by their heterogeneous territorial distribution over the territory of Lombardy.

As far as the measurement of the geographical accessibility is concerned, a matrix of the average distances and journey times was used. The distance is understood as the actual distance in kilometres on the basis of the shortest route by road and, therefore, not on the basis of the simple distance as the crow flies between municipal centroids. The georeferencing of the addresses of the

centroids[2] of the patients' municipalities of residence and the municipalities where the healthcare facilities are located was carried out by means of a GIS software (MapInfo Professional v.11.5, Pitney Bowes Inc., 2014). The average journey time was provided by AREU[3] as the average actual time under normal traffic conditions, on the basis of the monitoring of the accident and emergency services[4].

The journey time was calculated according to the average journey time from each municipal centroid to each possible destination point, bearing in mind the various options offered by the road network. This choice was made as an alternative to using simple distances in kilometres as it is more representative of the actual conditions of access from the individual municipalities evaluated from their specific geographical and logistic frameworks. For all the statistical evaluations that follow, a decision was taken to use the concept of "municipality of location of the healthcare facility" as sum of the services provided by all the healthcare facilities located in a single municipality (Table 3). In the thematic maps below, the municipalities in which there are facilities providing the service are marked with the symbol of a blue cross. Furthermore, the administrative boundaries of the ATS management districts are shown in black with writing superimposed to facilitate a reading dedicated to the programming of the public health service in the territory.

The assessment of the data was based on a descriptive statistical analysis for the main variables: frequency of the NMRI tests per municipality, rate of use per population of patients, journey time from the municipal centroid of the patient's home to the municipal centroid of the healthcare facility location, the distance from the municipal centroid of the patient's home to the municipal centroid of the healthcare facility location. The statistics describing the journey time and the distance travelled were calculated for each single NMRI according to the patients' addresses. The accessibility indicator, calculated as the average journey time in minutes, was subdivided in the maps into categories: 0-15 minutes, 15-30 minutes, 30-45 minutes, 45-60 minutes, more than 60 minutes. These categories can basically be superimposed on the quartiles of the frequency distribution of the index itself. The gravitational type model was applied by means of a Generalised Linear Model (GLM) to calculate the coefficients of attraction exerted by the healthcare facilities providing the service; for this purpose, the association between an *outcome* (characterised as the maximum number of NMRI received by the patients of each municipality from the healthcare facilities of the "winner" municipality) and factors such as the distance, waiting time, force of attraction, etc[5] were assessed. The family of the model was chosen on the basis of the Modified Park Test, while the link function was chosen on the basis of the Pearson correlation tests and the link of Pregibon which provided, as a result, a GLM model with a gamma family and as a link function the logarithmic function (Nelder and Baker, 2006). The cartographic representation of the rates of consumption was the result of both choropleth mapping techniques and an interpolation of the data of the IDW type (Inverse Distance Weighting). The statistical analyses were made by means of SPSS software (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) and STATA (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP). The choropleth maps were produced by means of the software MapInfo Professional v.11.5, Pitney Bowes Inc., 2014.

Results

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2 Centroid is the pair of geographical coordinates identifying the location of the Muncipality's town hall.

3 AREU - Azienda Regionale Emergenza Urgenza (Regional Accident and Emergency Service), AAT Bergamo.

[4] A decision was taken to use the municipal centroids for georeferencing and not the actual address using the coordinates of the street and street number, as the province of Bergamo does not have any "metropolitan" areas, except the municipality of Bergamo; however, even in this case the error of proximity does not have any influence as the intra-municipality distance between the health facilities located in the city of Bergamo does not really have any influence on the journey time from any municipality in the province.

[5] The overall production capacity, in its absolute quantitative or percentage translation, was used as an expression of the force of attraction in assessing the gravitational model applied here.

The analysis concentrated on the 91.478 tests provided to patients of the ATS of Bergamo by hospitals in the Bergamo region (Table 1).

Table 1 – Basis of the study: NMRI reported in flow 28SAN and their distribution		n.	%
TOTAL N. OF NMRI IN FLOW 28SAN		115.464	
BG patients in non-BG healthcare facilities		11.887	10.3%
BG healthcare facilities		103.577	89.7%
for the benefit of	Non-BG patient in a BG healthcare facility	12.099	11.7%
	BG patient in a BG healthcare facility	91.478	88.3%

When performed as a service charged under an agreement with the national health service for specialist outpatient care, the NMRI are classified according to a coded system for each anatomical apparatus. Table 2 shows the distribution of the NMRI per specific apparatus of the total number of 91.478 NMRI performed in 2015.

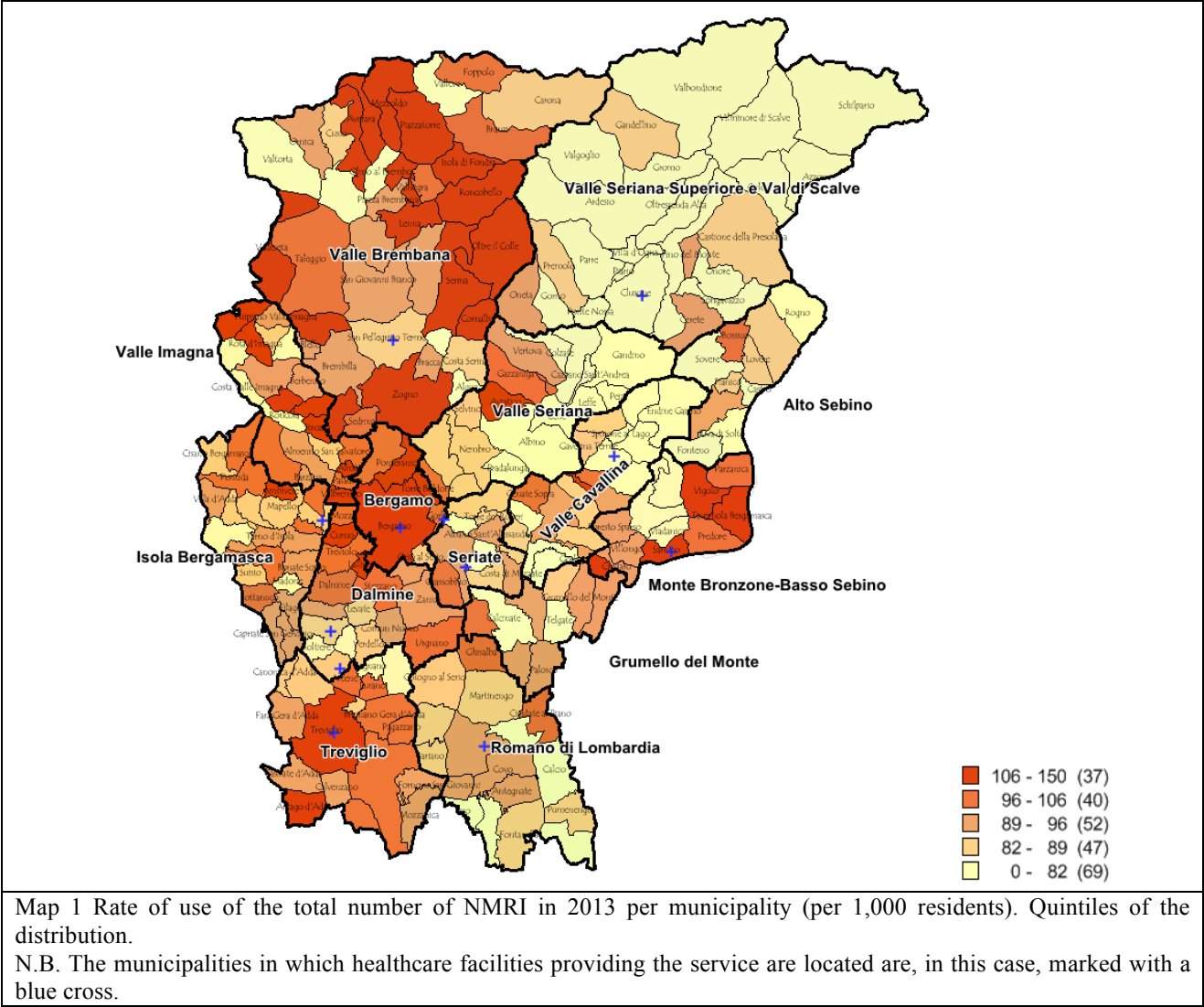| Table 2 – Distribution per specific apparatus of the NMRI	n. NMRI	%
NMRI muscle-skeleton	38.377	42.0
NMRI spine	30.125	32.9
NMRI brain	14.342	15.7
NMRI abdomen	5.099	5.6
NMRI facial bones	1.873	2.0
NMRI neck	1.097	1.2
NMRI heart	285	0.3
NMRI chest	217	0.2
NMRI breast	63	0.1
Total NMRI	91.478	100.0

The first two types in order of frequency are also those at the greatest risk of inappropriateness as they can be replaced by less invasive and more effective methods, or, in any case, they are not useful for modifying the clinical treatment of the patient (Società Italiana di Radiologia Medica, 2004).

Maps 1 and 2 show the territorial distribution, on the basis of the municipality of residence of the patients making use of the service and the rate of use of NMRI (per 1.000 residents) in 2015 in the province of Bergamo. The average rate of use for the province is equal to 83 NMRI per 1.000 patients/year. Map 1 is the simple choropleth representation of the rates of use in their distribution in quintiles. In the case of "rare" events in areas of small statistical sizes, as is the case of the NMRI requested by the municipalities in the province of Bergamo, problems of excessive variability may arise in the evaluations. As a result, it is difficult to identify the aggregate component, insofar as at least two other components of variability, the component of error and heterogeneity are present (Cislaghi et al., 1995). To allow this component to transpire, a geostatistic technique can be used known as "interpolation", which enables point data to be visualised as a continuous surface[6]. In this paper, the IDW technique of interpolation has been adopted (Inverse Distance Weighting; Fisher et

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[6] Specific literature should be referred to for further knowledge of these techniques.

al., 1987; Shepard, 1968), founded on similarity among close points, which does not take into account whether autocorrelation is present or not. Each value considered in estimating a cell calculation (corresponding to a municipal territory) is weighted according to its distance from the centre of the cell. As interpolation calculates a weighted average on the inverse of the distance, the further the point is from the centre of the cell, the less influence it has on the value associated with it.

Map 2 is an IDW interpolated map of the rates of use of NMRI according to the municipality of residence.

■	106 - 150 (37)
■	96 - 106 (40)
■	89 - 96 (52)
□	82 - 89 (47)
□	0 - 82 (69)

Map 1 Rate of use of the total number of NMRI in 2013 per municipality (per 1,000 residents). Quintiles of the distribution.
N.B. The municipalities in which healthcare facilities providing the service are located are, in this case, marked with a blue cross.

To calculate the IDW, the general formula is the following:

$$z_0 = \frac{\sum_{i=1}^{s} z_i \frac{1}{d_i^k}}{\sum_{i=1}^{s} \frac{1}{d_i^k}}$$

where z_0 is the unknown value being estimated, z_i is the known value at location i, s is the total of the points known, d is the distance between location i and the location of z_0, and k is the exponential that d is raised to (Chang, 2010). The greater the value of k, the greater the influence of each interpolated point compared with the ones close by. Usually, the most widely used value of k is 2. In the graphical representation, the values of the cells have been grouped in a spectrum of colours starting from the maximum and minimum values of the table. In the model used, blue was used for the minimum value and red for the maximum value. Five inflection points have been defined: the gradual transition from one colour of an inflection to another illustrates the distribution of the data. When analysing the data, two main phenomena emerge: the prevalence of use in the mountainous areas such as the district of the Brembana Valley, located in the north west of the map and the district of the Lower Sebino - Mount Bronzone to the east, a district overlooking Lake Iseo, as well as a predominance focused on the district of Bergamo city.

🟥	140,93
🟨	97,33
🟩	89,6
🟦	79,68
🟦	40,77

Map 2 Rates of use NMRIs in 2013 per municipality (per 1,000 residents). Interpolated map by means of IDW (see text)
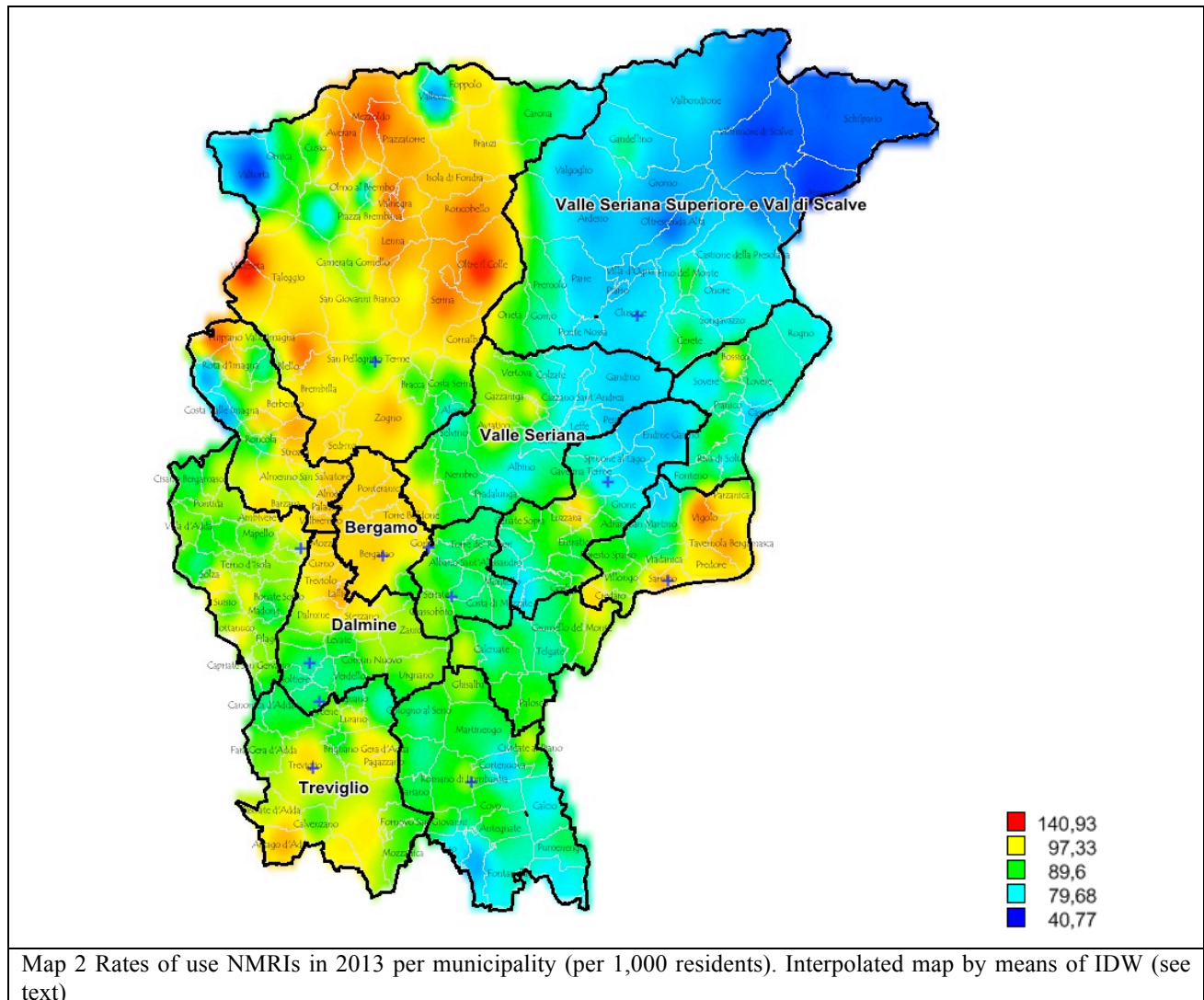
As stated before, the waiting time for a service is a variable that influenced the satisfaction of patients. Table 3 shows the minimum, average and maximum waiting times (declared) in days for each healthcare facility providing the service. It should be remembered that the services assessed in the article in question are outpatients' and not inpatients' services and that there are urgent services with a guaranteed minimum waiting time (usually they do not exceed, from a quantitative point of view, a share equal to 2-3% of the total performed), which have not been extrapolated here from the overall quantitative context.
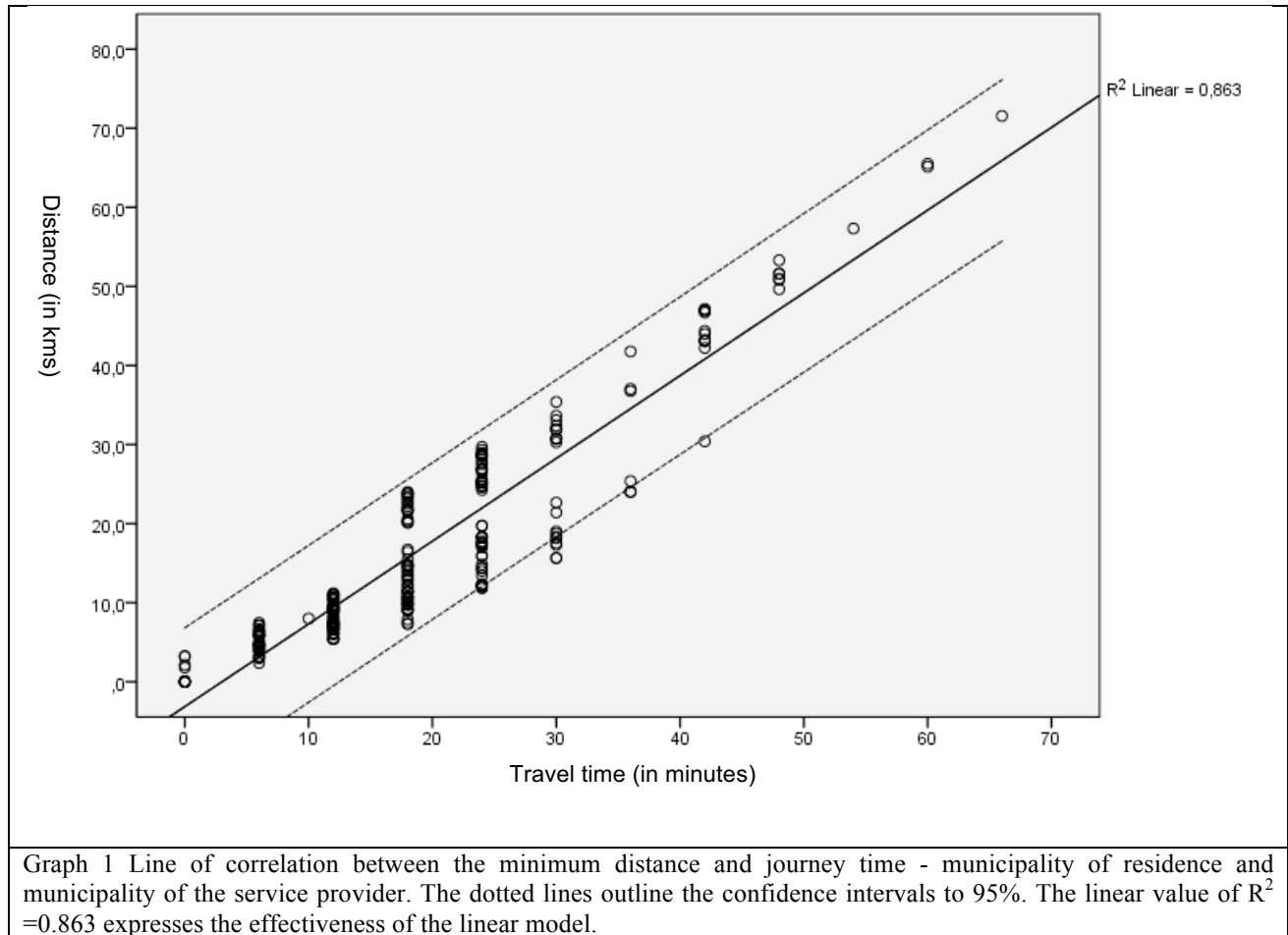
Table 3 Average, minimum and maximum waiting times per healthcare facility providing the service				
Service provider code	Description of service provider	Average wait in days	Minimum wait in days	Maximum wait in days
301002201	ISTITUTO CLINICO QUARENGHI - S. PELLEGRINO TERME	33.72	31.01	35.41
301003601	POLICLINICO SAN PIETRO - IST. OSPED. BERGAMASCHI - PONTE S. PIETRO	18.17	15.08	19.58
301004301	CASA DI CURA S. FRANCESCO - BERGAMO	41.19	41.09	41.29
301004501	CENTRO RADIOL.E FISIOTER.SRL - GORLE	13.75	11.1	15.54
301004601	CASA DI CURA CASTELLI – BERGAMO	20.01	15.62	22.64
301004701	CASA DI CURA BEATO PALAZZOLO - BERGAMO	10.18	6.24	17.22
301009401	POLICLINICO SAN MARCO - IST. OSPED. BERGAMASCHI – ZINGONIA	19.29	12.83	23.35
301014001	CASA DI CURA HABILITA – ZINGONIA	15.69	9.87	19.75
301014801	CLINICHE GAVAZZENI	30.61	23.02	39.46
301015236	CASA DI CURA HABILITA SARNICO	9.54	5.47	11.94
301015248	CASA DI CURA HABILITA BERGAMO - BERGAMO	11.59	6.10	14.59
301015250	CASA DI CURA HABILITA CLUSONE - CLUSONE	12.29	10.28	14.01
301015251	CENTRO DIAGNOSTICO TREVIGLIO di IOB	12.26	10.99	12.92
962000401	OSPEDALE PAPA GIOVANNI XXIII - BERGAMO	46.47	24.49	69.84
963000901	POLIAMBULATORIO OSP.TREVIGLIO - TREVIGLIO	39.03	37.18	40.75
963001101	POLIAMBULATORIO OSP. ROMANO L. - ROMANO DI LOMBARDIA	30.49	26.21	34.42
964001001	POLIAMBULATORIO OSP.BOLOGNINI - SERIATE	28.98	28.60	29.36

Table 4 shows the same elements presented briefly per "municipality providing the service" and as provincial values (for which the values of the standard deviations – sd are also presented).
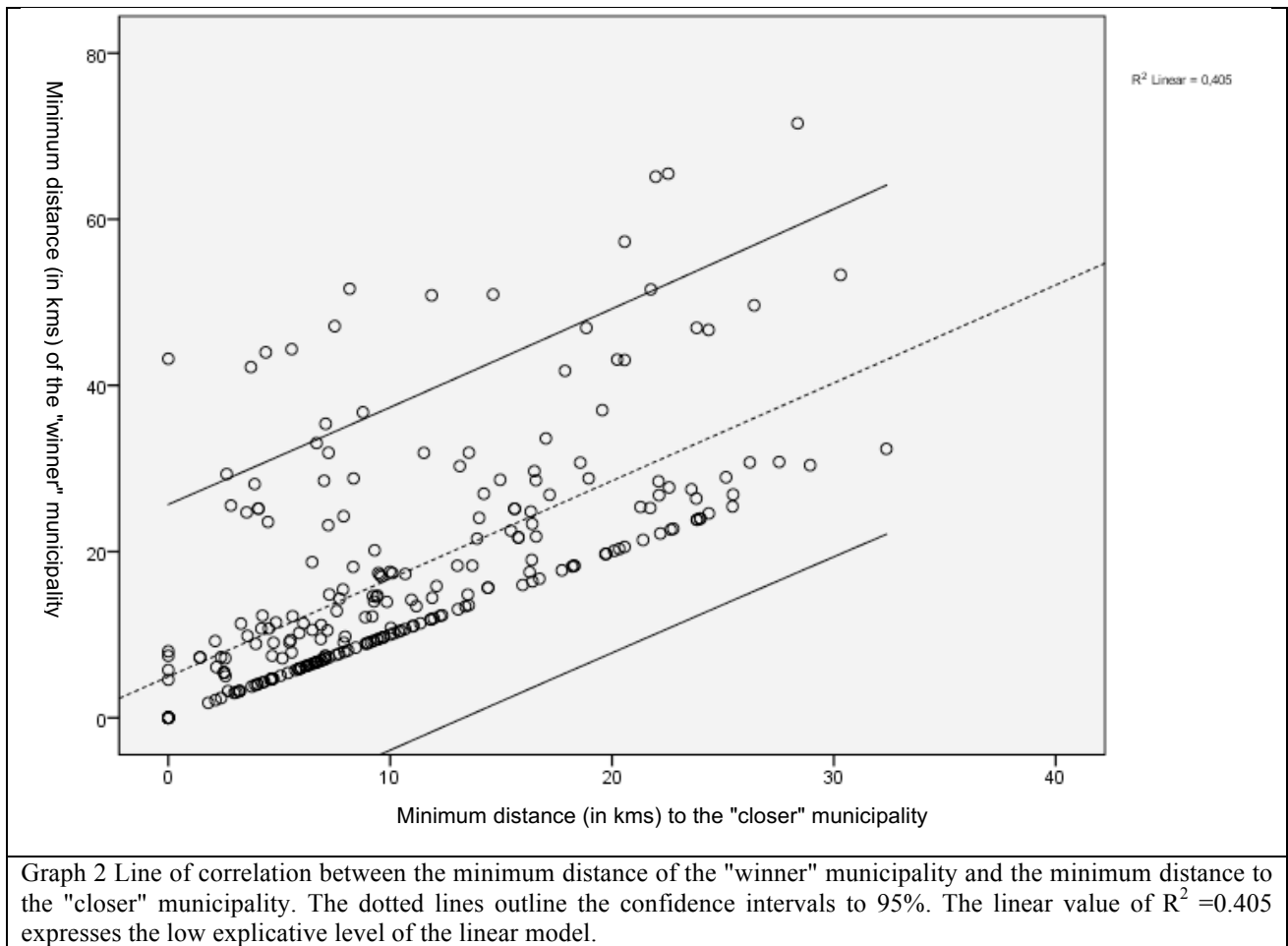
Table 4 Average, minimum and maximum waiting times per municipality providing the service and per province				
National ID Code for municipality	Description of Municipality	Average waiting time in days	Minimum waiting time in days	Maximum waiting time in days
016024	BERGAMO	26.91	19.46	34.70
016058	CASAZZA	21.36	21.36	21.36
016075	CISERANO	15.44	9.72	19.44
016077	CLUSONE	13.61	11.85	15.13
016115	GORLE	13.49	10.93	15.18
016153	OSIO SOTTO	18.66	12.39	22.78
016170	PONTE SAN PIETRO	18.17	15.08	19.58
016183	ROMANO DI LOMBARDIA	30.49	26.21	34.42
016190	SAN PELLEGRINO TERME	35.28	32.47	37.01
016193	SARNICO	10.07	6.33	12.27
016198	SERIATE	28.98	28.60	29.36
016219	TREVIGLIO	24.45	22.94	25.60
Average values of the Province		24.14 (sd 20.35)	19.3 (sd 20.36)	28.39 (sd 26.80)

The two previous tables show a discrete heterogeneity in the waiting times for the service, both for the individual healthcare facilities and with reference to the concept of "municipality providing the service". The high variability is shown by the high values of standard deviation.

The following graphs illustrate the distribution of the waiting time, distance in kilometres and average journey time variables, in order to have a better understanding of the relationships which exist among them, even though they are not always immediate.

Graph 1 Line of correlation between the minimum distance and journey time - municipality of residence and municipality of the service provider. The dotted lines outline the confidence intervals to 95%. The linear value of R^2 =0.863 expresses the effectiveness of the linear model.

Graph 1 highlights a high level of correlation, as could be expected in a certain sense, between the actual average journey time and the distance in kilometres between the receiving municipality and the municipality providing the service.

Graph 2 Line of correlation between the minimum distance of the "winner" municipality and the minimum distance to the "closer" municipality. The dotted lines outline the confidence intervals to 95%. The linear value of R^2 =0.405 expresses the low explicative level of the linear model.

Graph 2 shows the absence of correlation between the minimum distances of the "winner" municipality and the minimum distances towards the "closer" municipality (natural afference municipality on the pure basis of distance in kilometres).
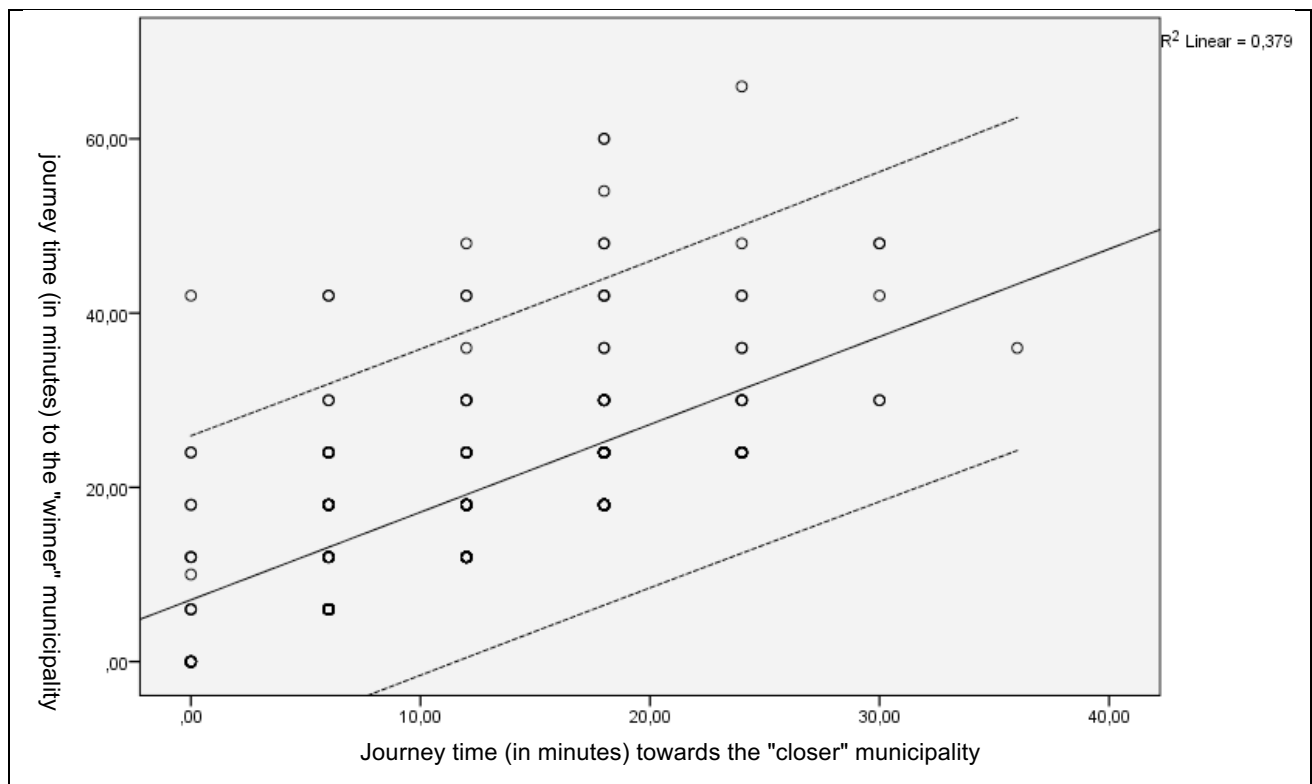
Graph 3 Line of correlation between the journey time (in minutes) to the "winner" municipality and the journey time (in minutes) towards the "closer" municipality. The dotted lines outline the confidence intervals to 95%. The linear value of R^2 =0.379 expresses the low explicative level of the linear model.

Graph 3 also shows the substantial absence of correlation between the two journey times.

The matters described so far show how the two variables "journey time in minutes" and "distance in kilometres" towards the "winner" municipalities are highly correlated and, therefore, not being independent, they bring redundant information inside the model, which will then be explored.

A Generalised Linear Model (GLM) has been used to calculate the probability of association between an *outcome* (established as the maximum number of NMRI received by the patients of each municipality from the healthcare facilities of the "winner" municipality) and the factors of distance, waiting time, force of attraction (using, in this case, the overall production capacity of the municipalities in which one or more healthcare facilities providing the services are present as a surrogate variable). For the statements made in the assessments of correlation referred to above, a model has been adopted that creates the highest level of interaction between the predictor variables.

Table 5 GLM: parameter estimates related to outcome "maximum number of NMRIs supplied by winner municipality-	Parameter estimates						
			95% Wald Confidence Interval for Exp(B)				
	Parameter	Exp(B)			Hypothesis Test		
Factor			Lower	Upper	Wald Chi-Square	df	Sig.
Mean waiting time (in days)	8-14 days	Reference category					
	15-25 days	1.203	.786	1.842	.724	1	.395
	26 or more days	.841	.286	2.468	.100	1	.752
Journey time (in minutes)	0- 15 min	Reference					

		category						
	15-30 min	4.021	1.638	9.870	9.227	1	.002
	30-45min	2.350	.999	5.532	3.829	1	.050
	More than 45min	2.445	.985	6.066	3.716	1	.054
Distance (in kms)	0- 5 km	Reference category					
	6-15 km	14.467	6.306	33.185	39.781	1	.000
	16-30km	5.460	3.248	9.177	41.044	1	.000
	More than 30km	2.348	1.422	3.877	11.121	1	.001
Municipality supply productivity (number of NMRIs)	0-5000	Reference category					
	5001-10000	.208	.139	.311	58.222	1	.000
	More than 10000	.437	.143	1.334	2.112	1	.146
Akaike's information criterion (1974) has been adopted for choosing final statistical model							

The values of Exp(B), net of the interactions between variables, highlight the following phenomena:
1. the probability of requesting an NMRI tends to decrease as the average waiting times increase. However, this observation does not reach the levels of statistical significance[7]
2. the probability of requesting an NMRI decreases as the average journey time increases. This observation reaches the level of statistical significance
3. the probability of requesting an NMRI decreases as the distance in kilometres increases. This observation reaches the level of statistical significance
4. the probability of requesting an NMRI increases as the production capacity increases. This observation reaches the level of statistical significance.

Discussion and managerial implications

The findings of this study suggest that statistical tools useful in geomarketing (notably, gravitational models) can support and enhance the planning of service provisions of healthcare organisations. In the healthcare sector, quality improvement is become a priority but this objective collides with poor resources (monetary and human) (Carter and Silverman, 2016). As Mosadeghrad (2015) highlights, the enhancements of service quality can be obtained through proper planning activities. Drawing the planning actions on the patient needs and behaviours allow the healthcare organisations to obtain better performance (Gustavsson et al., 2014; Ugolini et al., 2014). In particular, by using the tools provided by geomarketing, healthcare organisations can identify the voids in the supply processes and better responds to patient/customer needs. Gravitational model also contributes to interpret information about customer needs, resulting in enhanced decision processes.
Following the TQM-based principles, this study agrees with the importance to focus on the patient perspective and with the necessity to allocate the resources in an effective and efficient way (Mosadeghrad, 2015). In this perspective, the implications for health service planning can be considered linked to the so-called "offer gaps", which force patients to move about, as the need for diagnoses can only be fulfilled at a considerable cost in terms of logistics.
On the side of service providers, these considerations may prove useful in order to extend their offer by creating for example other/new "satellite" centres of diagnosis in order to satisfy demand or again by moving its own specialists provided with mobile equipment that operate according to the principles of telemedicine around the territory when it is technically possible. Furthermore, this

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[7] On this matter see the column significance of the Wald hypothesis test.

could lead to the development of models of considerable interest for setting up alternative scenarios such as the use of so-called "road-graphs" to direct the flow of patients from the place of residence to the healthcare service provider and access optimisation models based on the journey time and overall production availability of a hospital.

Conclusions, limitations and future research

Our analysis contributes to the literature about service quality in the healthcare sector in several ways. Healthcare organisations can adopt geomarketing tools for their service planning actions. These tools contribute to make the decision processes more effective and as a consequence to increase the services quality.

The analyses performed highlight how the choices of supplier are made regardless of the mere spatial vicinity of a healthcare facility offering the service but also how, in the province of Bergamo, the great majority of patients undergo an NMRI after a journey time of less than 15 minutes. The generalised linear model shows how the probability of requesting an NMRI decreases as the average waiting time (waiting list) and the average journey time/distance in kilometres increase, while it increases as the production capacity of the facility providing the service increases (gravitational model).

This work has given priority to a description of the method and the results, limiting possible approaches of an interpretative nature. These assessments could be enriched in a subsequent phase by a comparison with other phenomena (by example, transfers for reasons of work, power of attraction of individual professionals, etc.) which are not currently usable or translatable into quantitative indicators on the basis of the routine flows present in health information systems.

Health information systems represent an important challenge for epidemiologists and for health programmers who must develop new strategies for the purpose of improving and governing the health system. Furthermore, they represent an important resource which must lead, using instruments of epidemiological methodology, to combining a territorial demand with the offer of services and healthcare, reducing inappropriateness and increasing the efficacy and efficiency of the whole system.

This study presents several limitations, as well. First, the analysis is based only on the Italian context. Moreover, other healthcare services should be considered in the future to enrich our understanding about the contributions of gravitational models. Further research is needed to corroborate the findings of our research and to enrich our understanding of other possible applications of the geomarketing tools and of gravitational models.

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