

JOIN COUNT SPATIAL AUTOCORRELATION OF MUNICIPALITY WEBSITES: A CASES STUDY IN BOHOL¹

by

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Abstract

Bohol implemented their web page on 2011 and has been a major venue to promote governance most especially for tourism. The site provides photo galleries, activities, developments and news of the province. Some of the municipalities and cities are now developing their own web pages. The study aimed to determine if the arrangement of self-government websites in Bohol is spatially autocorrelated. Data was obtained from www.philgis.org and Google. Information was added as an attribute to the shapefile of Bohol. A database was created in a PostGIS structure with spatial and non-spatial attribute of the province. This was used for querying and storage of information. Join count statistics were used to investigate second-order effects in an area-type spatial binary data. Statistical test of spatial autocorrelation was done per methodology outlined in Kobucnik and Bacik (2013).

Keywords: spatial autocorrelation, binary area data, join count statistics, shapefile

Introduction

Bohol is the tenth largest island in the Philippines and one of the biggest islands in the Visayas. Bohol also emerged as one the country's best governed province in according to the Department of Interior and Local Government (DILG). The province has been assessed in terms of administrative, social, economic and environmental governance, transparency, participation and financial accountability.

The emergence of new information and communication technologies has all the attributes of imparting added value to the process that give identity, form and relationships that characterise good governance. Hence, Electronic Governance (eGovernance) offers an opportunity for the governments to re-invest themselves, get closer to citizenry and forge closer alliances and partnerships with diverse communities of interest, practice, expertise, conviction and inter-dependence within the context of national development agenda (Okot-Uma, 2000).

Bohol implemented their web page on 2011 and has been a major venue to promote governance most especially for tourism. The site provides photo galleries, activities, developments and news of the province. Some of the municipalities and cities were also developing their own web pages.

The study aims to determine if the arrangement of self-government websites in Bohol is spatially autocorrelated. This is in reference to the study of Klobucnik and Bacik (2013) using joint count methodology.

Data

Two datasets were used in the implementation of the study. One is a shapefile containing the boundary of Bohol and its municipalities. Data was obtained from www.philgis.org, an

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Inabanga		
Jagna	http://jagna.gov.ph/	2011
Jetafe		
Lila	http://www.lila-bohol.gov.ph/V2/	2012
Loay		
Loboc	http://www.lobocbohol.gov.ph/	2016
Loon	http://www.loon.gov.ph/	2016
Mabini	http://mabinibohol.gov.ph/	2016*
Maribojoc	http://www.maribojoc.gov.ph/	2016
Panglao	http://panglao.gov.ph/	2013
Pilar		
Pres. Carlos P. Garcia		
Sagbayan		
San Isidro		
San Miguel	http://www.sanmiguel-bohol.lgu.ph/	2016*
Sevilla		
Sierra Bullones	http://www.sierrabullones-bohol.gov.ph/	2014
Sikatuna	http://www.sikatunabohol.gov.ph/	2011
Tagbilaran City	http://www.tagbilaran.gov.ph/	2016*
Talibon	http://www.talibon-bohol.gov.ph/	2015
Trinidad	http://trinidad-bohol.gov.ph/	2013
Tubigon	http://www.tubigon.gov.ph/	2010
Ubay		
Valencia	http://valencia-bohol.gov.ph/	2016

**has website but copyright year was not indicated*

Spatial Autocorrelation using Join Count Statistics

Join count statistics were used to investigate second-order effects in an area-type spatial binary data. Here, value-location matches were achieved through joins in values that match the expressed joins in space.

We define $x_i = \begin{cases} 1, & \text{if with website (red (R) in choropleth map)} \\ 0, & \text{if no website (yellow (Y) in choropleth map)} \end{cases}$

The types of joins are

$$RR = \frac{1}{2} \sum_i \sum_j w_{ij} x_i x_j$$

$$YY = \frac{1}{2} \sum_i \sum_j w_{ij} (1 - x_i)(1 - x_j)$$

$$RY = \frac{1}{2} \sum_i \sum_j w_{ij} (x_i - x_j)^2$$

where w_{ij} is a proximity weight. In this paper, proximity is in Queen-contiguity sense.

The sum of the joins is represented by $L = RR + YY + RY$.

Representations of occurrence and absence of municipal website were Red and Yellow respectively. Table 2 shows the summarized number of municipalities with and without websites per period (2010, 2013 and 2016). Based on the gathered data, there is an increase number of municipalities having their own websites (Figure 2).

Table 2. Website Count by Year
(across 48 municipalities)

	With	Without
2010	3	45
2013	9	39
2016	25	23

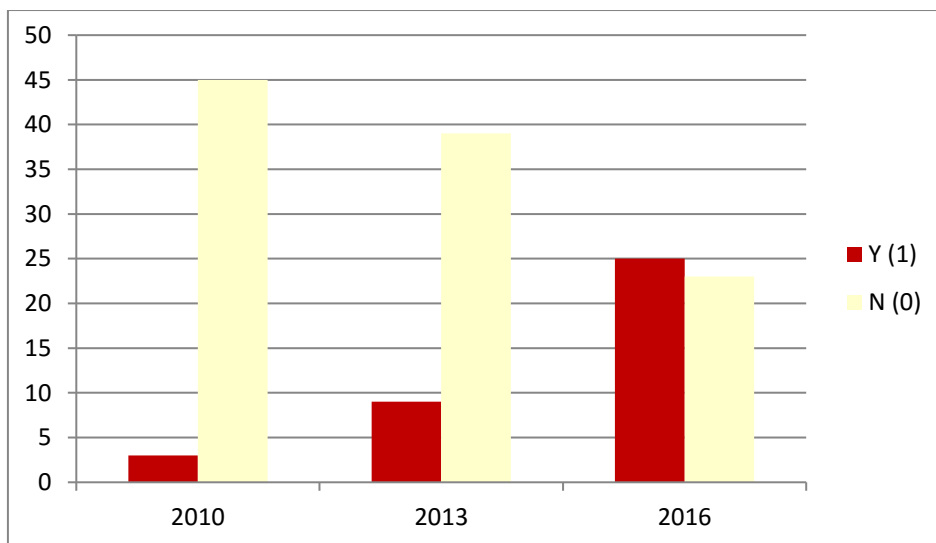


Figure 2. Number of municipalities with Own Website

Computation of Join Counts and Probabilities (Lembo, 2007)

- a. *Probability of the occurrence of a relevant phenomenon in a spatial unit from all analysed units.*

$$Pr = \frac{Nr}{N}$$

Where:

Pr = probability of phenomenon (with website)

Nr = number of municipalities with website

N = total number of municipalities

The probability of absence (Py) and the mutual probability (Pry) were computed as follows:

$$Py = 1 - Pr \quad \text{and} \quad Pry = 2PrPy$$

Table 3 shows the computed probabilities in every period.

Table 3. Presence, absence and mutual probability of Municipality website

Period	Pr	Py	Pry
2010	0.0625	0.9375	0.1172
2013	0.1875	0.8125	0.3047
2016	0.5208	0.4792	0.4991

b. Calculation of two variables L and K

Table 4 illustrates the computation of joins by municipality in year 2010. Recall that variable L was computed as the sum of all joins (RR + YY + RY). Define K as the amount $L(L-1)/2$. For 2010, $K = 924/2 = 462$. The join counts in 2010, 2013 and 2016 are summarized in Table 5.

Table 4. Illustrative Example for Join Match Counts by Municipality for 2010 Data

FID	Name	Colour	RR	YY	RY	L	L(L-1)
0	Albuquerque	Y	0	5	0	5	20
1	Alicia	Y	0	5	0	5	20
2	Anda	Y	0	2	0	2	2
3	Antequera	Y	0	6	0	6	30
4	Baclayon	Y	0	3	0	3	6
5	Balilihan	Y	0	9	0	9	72
6	Batuan	Y	0	6	0	6	30
7	Bien Unido	Y	0	2	0	2	2
8	Bilar	Y	0	6	1	7	42
9	Buenavista	Y	0	4	0	4	12
10	Calape	Y	0	3	1	4	12
11	Candijay	Y	0	5	0	5	20
12	Carmen	Y	0	6	1	7	42
13	Catigbian	Y	0	5	1	6	30
14	Clarín	Y	0	3	1	4	12
15	Corella	Y	0	6	0	6	30
16	Cortes	Y	0	5	0	5	20
17	Dagohoy	Y	0	5	0	5	20
18	Danao	Y	0	8	0	8	56
19	Daus	Y	0	1	0	1	0
20	Dimiao	R	0	0	3	3	6
21	Duero	Y	0	4	0	4	12
22	Garcia Hernandez	R	0	0	4	4	12
23	Guindulman	Y	0	4	0	4	12
24	Inabanga	Y	0	4	0	4	12
25	Jagna	Y	0	2	1	3	6
26	Jetafe	Y	0	2	0	2	2
27	Lila	Y	0	3	1	4	12
28	Loay	Y	0	3	0	3	6
29	Loboc	Y	0	6	0	6	30

30	Loon	Y	0	3	0	3	6
31	Mabini	Y	0	3	0	3	6
32	Maribojoc	Y	0	3	0	3	6
33	Panglao	Y	0	1	0	1	0
34	Pilar	Y	0	8	0	8	56
35	Pres. Carlos P. Garcia	Y	0	0	0	0	0
36	Sagbayan	Y	0	6	0	6	30
37	San Isidro	Y	0	4	1	5	20
38	San Miguel	Y	0	6	0	6	30
39	Sevilla	Y	0	4	0	4	12
40	Sierra Bullones	Y	0	6	1	7	42
41	Sikatuna	Y	0	5	0	5	20
42	Tagbilaran City	Y	0	3	0	3	6
43	Talibon	Y	0	5	0	5	20
44	Trinidad	Y	0	5	0	5	20
45	Tubigon	R	0	0	4	4	12
46	Ubay	Y	0	5	0	5	20
47	Valencia	Y	0	4	2	6	30
Total			0	194	22	216	924

Table 5. Number of Joins across Periods

Period	RR	YY	RY
2010	0	194	22
2013	7	152	57
2016	58	55	103

c. Calculation of Expected neighbours (joins)

Expected neighbours (joins) were calculated using the following:

$$E(RR) = (Pr)^2L$$

$$E(YY) = (Py)^2L$$

$$E(RY) = (PrY)L$$

Table 6. Expected neighbours (joins) per period

	E(RR)	E(YY)	E(RY)
2010	0.8438	189.8438	25.3125
2013	7.5938	142.5938	65.8125
2016	58.5938	49.5938	107.8125

d. Calculation of standard deviations

Standard deviations were computed using the following formula:

$$\sigma(RR) = \sqrt{Pr^2L + Pr^3K - Pr^4(L + K)}$$

$$\sigma(YY) = \sqrt{Py^2L + Py^3K - Py^4(L + K)}$$

$$\sigma(RY) = \sqrt{2PrPyL + PrPyK - 4Pr^2Py^2(L + K)}$$

Table 7. Standard deviations per period

	$\sigma(RR)$	$\sigma(YY)$	$\sigma(RY)$
2010	0.9727	6.8397	6.5629
2013	3.1307	9.7429	8.5588
2016	8.6009	8.0424	7.3621

e. *Statistical test of spatial autocorrelation*

Using the formula $Z = (\text{observed} - \text{expected}) / \text{standard deviation}$, test statistics for every period were computed. Together with the Z values, two-colour maps showing the municipalities with and without websites are shown in Figure 3.

Table 8. Test statistics of joins per period

	Z(RR)	Z(YY)	Z(RY)
2010	-0.8674	0.6077	-0.5047
2013	-0.1897	0.9655	-1.0296
2016	-0.0690	0.6722	-0.6537

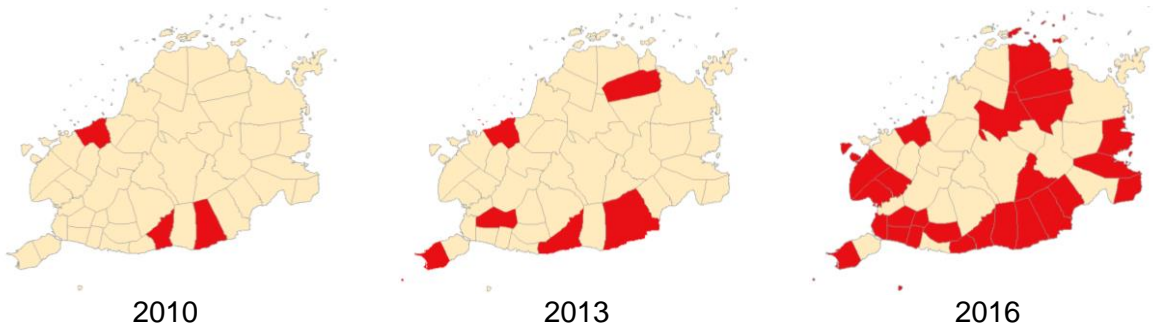


Figure 3. Two-colour maps of municipalities with and without websites per period

Data was also analyzed taking out Pres. Carlos P. Garcia island which has zero joins on RR, YY and RY. The resulting statistics (Table 9) shows that the earlier conclusion of no spatial autocorrelation still holds.

Table 9. Test for Spatial Autocorrelation (without Pres. C.P. Garcia Island)

	E(RR)	E(YY)	E(RY)
2010	0.8800	189.3056	25.8144
2013	7.9203	141.1969	65.8828
2016	61.1136	47.3264	107.5600
	$\sigma(RR)$	$\sigma(YY)$	$\sigma(RY)$
2010	0.9944	6.8986	6.6134
2013	3.2020	9.7803	8.5676
2016	8.7389	7.8842	7.3802
	Z(RR)	Z(YY)	Z(RY)
2010	-0.8849	0.6805	-0.5768
2013	-0.2874	1.1046	-1.1535
2016	-0.3563	0.9733	-0.6179

Discussion

Periods of observation (2010, 2013 and 2016) for this study were based on the data gathered with an equal interval of 3 years. Municipalities of Dimiao, Garcia and Tubigon pioneered in creating their own websites on 2010. It can be observed that during the first three year time span (2010 – 2013) there was a 12% increase on the number of municipalities having website. However, the next three years showed remarkably an abrupt increase of 33%. There may be discrepancies regarding on the origination of websites due to incomplete information. Municipalities with no copyright year were considered in the 2016 period.

Join count or neighbours count was used to determine if spatial autocorrelation among data exists. Together with the increase number of municipalities having websites from 2010 to 2016, Table 5 shows that there is an increase RR joins, drop of YY and an increase of RY joins. However, no sufficient statistical evidence of spatial autocorrelation was found at 5% level of significance. Same results can be noted in the 2013 and 2016.

Despite the results of the statistical test, it is worth noting that there is an increasing value of Z statistics. Per binary maps produced, most of the municipalities with website (red) in the first and second year have neighbours with no websites (yellow). In 2016, there may be adjacency of municipalities with websites most especially in the southern part of the island. However, many of them have neighbours that have no websites as well. This observation appears to offer indication that municipalities with websites and no websites over the years are getting spatially autocorrelated, albeit not yet significant at this time. One thing is clear, that there is spatial trend in the sense that spread of municipalities with websites are located in coastal areas and municipalities adjoining them (towards the center of the island) have none.

Conclusion

Joint count statistics for spatial autocorrelation shows that the presence and absence of municipal websites in Bohol are not spatially autocorrelated. This conclusion was obtained from the three periods 2010, 2013 and 2016. It appears that mounting an official website is a matter of internal initiative on the part of the LGU to showcase their municipality and not as a matter of contagion from adjacent LGUs. It must be inspiration, not competition that drives presence of municipality websites in Bohol.

Recommendation

Due to the increase usage of internet, local governments in Bohol have been actively using this new technology for e-Governance. The province also uses the internet as a venue to promote their tourism which is one of the dominating economic sectors within the island.

The study should be applied in other islands of Luzon and Mindanao wherein the number of neighbours is significant for spatial autocorrelation analysis. Correlation between municipalities having websites and municipality class (1st, 2nd, etc class municipality) should also be incorporated. Is the spread of e-Governance affected by the economic status of the municipality or cities?

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