

ASSESSING THE SEVERITY OF RECREATIONAL BOATING ACCIDENTS

F. Javier Otamendi¹
José Ramón González de Vega²
Universidad Rey Juan Carlos
¹Departamento Economía Aplicada I
Paseo Artilleros s/n
28032 Madrid, Spain
E-mail: franciscojavier.otamendi@urjc.es
¹Comisariado Español Marítimo
Pintor Juan Gris 4
28020 Madrid, Spain
jrgonzalez@comismar.es

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ABSTRACT

The severity of the incidents of recreational boats in Spain during 2011 is analyzed in terms of the region in which the crafts were registered. The data was obtained and coded from the damage reports of one of the main Spanish marine surveyors, source that has been used for the first time to our knowledge in the academic literature. About 1400 incidents are statistically compared in terms of location, craft characteristics and skipper accreditations. Multiple hypothesis tests of averages are used to determine which categories of the study variables by location are different than the country average.

INTRODUCTION

Iberia is a peninsula with very good weather, so recreational boating might be practiced year round. In Spain alone, the number of registered crafts was more than 200,000 in 2011. Recreational crafts are defined as "those of all kinds, irrespective of the means of propulsion, having a hull length of between 2.5 and 24 meters, designed and intended for recreational and sports purposes, and carrying not more than 12 passengers" (Spanish Royal Decree 1434 / 1999).

In the scientific literature, only one reference has been found relative to recreational boating practices (Virk and Pikora, 2011) although some others might be lately found relative to marine accidents (O'Connor and O'Connor, 2005; Warner et al., 2000; Mullai and Paulson, 2011; LeBlanc et al., 2001; Psarros et al., 2010).

With regards to location, these studies are country specific: Australia, New Zealand, Norway, Sweden or the Mississippi river. They use different types of data sources: coroner's data, the administration (Marine

Safety Based Units, Swedish Maritime Department, Lloyd's Register FairPlay or the Norwegian Maritime Directorate) or even telephone interviews. The main aim of these studies is the classification of the causes of the incidents, which are usually divided into human, environmental or craft/equipment related. Another primary aim is to identify the types of those incidents, classified as collision between crafts, rammings with objects or grounding.

The objective of this research is to study the costs of incidents related to recreational boating in Spain so as to determine location profiles for future insurance studies, framing the analysis within the current literature, but using an additional data source that might be of help: data from damage reports elaborated by the marine surveyors. There are more than 1600 reports dated in 2011 and signed by the Comisariado Español Marítimo (COMISMAR), one of the main marine surveying companies in Spain that covers about 25% of the incidents. These reports include information relative to the incidents, the crafts and the skippers.

Section 2 includes an explanation of the sources of data and the methods that have been used, which include descriptive analysis, multiple hypothesis testing and linear regression analysis. Sections 3, 4 and 5 are devoted to introduce the severity results by region while section 6 is used to conclude and show future lines of research.

DATA AND METHODS

Concerning the incidents, the marine surveyor produces expert reports that are kept in text format. For its records, COMISMAR also keeps some key information in a computerized database, although it does not include all the necessary data fields to perform a full analysis of recreational boating practices. Manual coding of the damage reports is therefore necessary.

The basic MsAccess database, with 1646 registers for 2011, includes the following incident fields: a code to

uniquely identify the incident, the name of the craft, the date of the incident, the type of the incident, **the severity of the incident in monetary value**, the date of the requirement for expert evaluation and the closest harbor to the incident. As a first step, the harbor location is further coded into country and region.

In order to deepen the study, the database was updated with information included in the text damage reports. Some variables were related to the craft (brand, length, power, propulsion, manufacturing year, list and registry number, navigation certificate) and some to the skipper (education certificate, gender, age, validity of certificate, telephone, ID number, name).

After the tedious coding process of the reports, carried out by just one experienced researcher in data coding to avoid inter-coder reliability (Dietz et al.2000), an additional cleaning task was performed. Duplicated registers (same craft, amount and date) were eliminated to get a first set of 1525 registers. Then those registers with a missing data on width, power or registry number were also eliminated. Locations outside Spain were maintained. The full coded database for 2011 of 1368 complete incidents from the marine surveyor was therefore ready for analysis.

First, a descriptive analysis is performed by region, based on the variable called “**Monetary Value**”, which defines the repair cost determined by the marine surveyor. The variable is crossed with each of the coded variables.

Second, an inferential method is performed to determine which categories of the variables by region are statistically different than the grand country average. Multiple hypothesis tests of averages are performed following statistical quality control principles (Grant and Leavenworth, 1988), in which each category is individually compared against a grand total. In this case, average values are studied using the so-called \bar{x} -charts which adjust for different sample sizes. These tools have already been applied in the social sciences with success to establish location profiles (Cañibano et al., 2011).

Third, linear regression techniques are used to identify the skipper and boat characteristics that jointly affect the severity of the incidents.

Throughout the analysis, a word of caution is however necessary. COMISMAR’s average of analyzed incidents is considered to be 25% of the total number in Spain, so there might be slight deviations in the conclusions, but without losing their generality.

DESCRIPTIVE ANALYSIS OF INCIDENTS

Table 1 includes the relative frequency of the categorical variables that were fully answered and therefore were liable to serve as the basis for the sound

study of 1368 incidents that required expert analysis by COMISMAR.

Table 1. Incident frequency univariate distributions

Type	Rammings (31.07%); Collision (20.25%); Grounding (17.25%); Other (10.89%); Environment (7.46%); Theft (7.38%); Capsize (3.87%); Craft (1.02%); Fire (.8%)
Location	Balearic Islands (25.0%); Andalusia (18.64%); Galicia (11.77%); Valencia (10.31%); Catalonia (9.58%); Murcia (7.6%); Cantabria (4.97%); Basque Country (4.31%); Canary Islands (2.63%); Asturias (2.19%); Castilla-LaMancha (.58%); Madrid (.51%); Ceuta (.44%); Melilla (.37%); Extremadura (.29%); Aragon (.22%); France (.22%); Sardinia (.15%); Castilla-Leon (.07%); Gibraltar (.07%); Greece (.07%)
Registry Code	Balearic Islands (20.61%); Catalonia (18.86%); Andalusia (17.69%); Valencia (13.67%); Galicia (8.99%); Murcia (7.02%); Basque Country (4.17%); Cantabria (4.09%); Canary Islands (2.49%); Asturias (1.9%); Ceuta (.29%); Melilla (.22%)
Length	00-08 (61.62%); 08-12 (28.95%); 12-15 (6.14%); 15-18 (1.9%); 18-24 (1.39%);
Power	001-065 (28.58%); 125-250 (22.88%); 250-500 (18.79%); 065-125 (16.15%); 500+ (13.6%)
Propulsion	Motor (80.63%); Sail (19.37%)
Navigation certificate	Yes (81.14%); Not given (14.25%); No (4.61%)
Degree	PER – Recr. Boat Skipper (55.41%); Not provided (16.3%); PY – Yacht Skipper(14.04%); PNB – Basic Skipper (5.85%); Not necessary (3.51%); CY – Yacht Captain (2.92%); Association (1.75%); PMN – Jet ski Skipper (.15%); out-dated PER (.07%)
Gender	Male (96.35%); Female (3.65%)

The majority of incidents occurred in the Balearic Islands. Of course, it is the region with the highest number of registered crafts. Small boats are involved in more accidents, which is again consistent with the fleet categorization and other studies (dinghies – O’Connor and O’Connor, 2005). Power patterns are not so obvious, especially if the ratio between power and length is to be maintained for all the classes. This ratio appears to be a possible significant factor of incidents (O’Connor and O’Connor, 2005). More incidents are related to motor-propelled crafts with correct certification, although not in the proportion of motor-propelled boats in the fleet.

Concerning the skippers, almost all of them males, they had obtained different accreditation degrees, with PER being the most frequent. PER means “Patrón de Embarcación de Recreo”, or Recreational Boat Skipper, which allows the skipper to practice within 12 miles of the shore. It is also worth mentioning that skippers with at least a PER-level education (which include yacht skippers and captains) are 72.37%.

DESCRIPTIVE ANALYSIS OF SEVERITY

The selected measure for the study of severity is the average of the damage included in the marine surveyor reports. This measure is included in the main MsExcel spreadsheet kept by COMISMAR. The analysis by region is included in Table 2. The inferential analysis by boat and skipper characteristics is left for the next section.

Valencia shows a large total due to a single accident that involves a large yacht. The rest of the regions do not show large differences.

Table 2. Severity per region

AVERAGE OF COSTS	
Region	Total
Andalusia	3686.0
Asturias	5297.0
Balearic Islands	5901.3
Valencia	21905.0
Canary Islands	4957.9
Cantabria	2468.7
Catalonia	4420.8
Ceuta	2555.1
Galicia	4162.9
Melilla	1690.3
Murcia	5611.9
Basque Country	4813.3
Total general	6976.3

INFERENCE ANALYSIS OF SEVERITY

Hypothesis testing

The selected tool to compare among regions is the \bar{x} -chart, which performs a series of hypothesis tests on the averages, adjusting for different sample sizes.

This chart belongs to the set of tools used in Total Quality Management (TQM) in general, and Statistical Process Control (SPC) in particular (Grant and Leavenworth, 1988). First, the average population behavior is estimated using the whole sample, receiving the name of grand average. Second, the average of each sample is compared against the grand average using traditional tests of hypothesis.

This exercise is performed in this case both for the whole population, comparing across regions or by craft or skipper characteristics.

Figure 1 shows the results after comparing each region against the Spanish grand average of 6976.3 €. The only significantly different behavior is that of Melilla (1690.0 €), well below the overall average. Valencia is not significantly different since the variability within this region is very high.

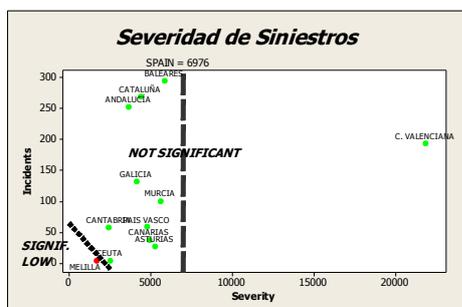


Figure 1. Severity by region

It seems appropriate though to perform the study by categories of craft and skipper, looking for further significant factors that affect the severity of the incidents.

In terms of boat characteristics, Table 3, incidents involving short crafts of less than 8 meters (3680.5 €) are significantly less severe in Cantabria (2066.9 €). Ceuta (2526.5 €), Melilla (272.0 €) and the Basque Country (1900.1 €) show a lower cost than the grand average (5480.8 €) regarding boats between 8 and 12 meters. Andalusia (3299.4 €), Asturias (3037.4 €), the Canary Islands (2840.9 €), Cantabria (903.9 €) and the Basque Country (2316.0 €) are below the grand average of 5741.3 € for boats between 12 and 15 meters. Finally, for large boats between 15 and 18 meters (7292.1 €), Andalusia (2790.5 €) and the Balearic Islands (2204.1 €) show a low average whereas the Basque Country (32230.5 €) shows a very high average cost.

Regarding power, for the low-powered crafts with less than 65 HP (3729.7 €), Galicia show very high costs (5844.9 €) and Asturias (1653.6 €) and Cantabria (2477.6 €) very low totals. For boats between 65 and 125 HP, Andalusia (1892.7 €), the Canary Islands (2079.8 €) and Ceuta (290.0 €) are below country average (3590.7 €). For the medium-powered boats between 125 and 250 HP (4162.5), only Cantabria shows a low average (1403.2 €). Finally, for high-powered boats between 250 and 500 HP, four regions – Asturias (933.4 €), Valencia (3085.3 €), Galicia (3176.9 €) and the Basque Country (1012.2 €) – incur in a significantly lower severity than the grand average of the category (4862.9 €).

There are no differences found in motor boats across regions. Sail boats (4379.1 €) incur in less severe incidents in Asturias (712.6 €), Cantabria (2456.6 €), Melilla (272.0 €) and the Basque Country (1956.1 €).

One interesting category is that of the certificate of navigability. Those incidents with a valid certificate do not show differences across regions, although the average is as high as 7643.4 €. If the certificate is not provided, Asturias (1849.1 €), Ceuta (1237.6 €) and the Basque Country (1247.8 €) incur in less severe accidents than the grand country average of (4005.6 €). The Balearic Islands (1957.9), Galicia (1865.2 €) and Melilla (710.0 €) show a low total compared to Spain (5251.8).

In terms of the skipper characteristics (Table 4), and the degree of the diploma, those that are yacht captains (7585.1 €) are involved in very severe accidents in Murcia (14986.1 €) and low-cost incidents in Asturias (2567.2) and the Canary Islands (4563.1 €). For skippers with just an association permit (3682.2), the severity is lower in the Canary Islands (514.5 €), Catalonia (1198.3 €) and the Basque Country (240.3 €).

Interestingly enough, for the practitioners certified with the more common education diploma (PER - 55%), there are no severity differences whereas the incidents in which a degree was not necessary showed lower totals across the regions.

Lastly, males (7080.4 €) are less costly in Melilla (1690.3 €) and females (4234.5 €) incur in less severe accidents in Andalusia (1021.6 €), Cantabria (1290.8 €) and the Basque Country (1412.0 €).

Table 3. Regions with significant incident frequencies compared with the country average by craft characteristics (++, larger at 0.01; +, larger at 0.05; -, lower at 0.05; lower at 0.01).

	LENGTH					POWER					PROP.		CERTIFICATE of NAVIGABILITY		
	00-08	08-12	12-15	15-18	18+	001-065	065-125	125-250	250-500	500+	Sail	Motor	No	Not Given	Yes
ANDALUSIA			-	-											
ASTURIAS															
BALEARIC ISLANDS															
VALENCIA															
CANARY ISLANDS															
CANTABRIA	-														
CATALONIA															
CEUTA															
GALICIA						+									
MELILLA															
MURCIA															
BASQUE COUNTRY					+										
SPAIN	3680.5	5480.8	5741.3	7292.1	163097.6	3729.7	3590.7	4162.5	4862.9	25500.2	4379.1	7605.1	5251.8	4005.6	7643.4

Table 4. Regions with significant incident frequencies compared with the country average by user characteristics (++, larger at 0.01; +, larger at 0.05; -, lower at 0.05; lower at 0.01).

	DEGREE									GENDER	
	Yacht captain	Association	Not provided	Not necessary	PER – Recreational boat skipper	Out-dated PER	Jet ski skipper	Basic skipper	Yacht skipper	Female	Male
ANDALUSIA											
ASTURIAS											
BALEARIC ISLANDS											
VALENCIA											
CANARY ISLANDS											
CANTABRIA											
CATALONIA											
CEUTA											
GALICIA											
MELILLA											
MURCIA											
BASQUE COUNTRY											
SPAIN	7585.1	3682.2	18309.8	4409.8	4248.7	18089.4	679.6	3500.1	5926.1	4234.5	7080.4

Location patterns

Starting at the Northwest, Galicia incur in severe accidents with small boats and in mild incidents with large crafts. Going East, Asturias and Cantabria are less severe with medium-size, low-powered vessels, and also with sail boats. The Basque Country shows a similar pattern, but it also has a significant high severity with long crafts.

Andalusia, in the South, shows low severity with medium-size, medium-power boats.

At the Mediterranean Sea, Catalonia and Murcia do not show any differences with the country average, whereas Valencia show a low severity with high-powered boats.

Concerning the islands, the Balearic Islands show low severity of long vessels and the Canary Islands' pattern is similar to that of Andalusia.

Ceuta and Melilla are significantly below the average in boats with a length between 8 and 12 meters.

REGRESSION ANALYSIS

The location patterns are not concerned with absolute monetary values, but with relative differences within a category. To assess severity quantitatively, as a prior step before converting it to insurance premiums, a linear regression analysis is to be performed.

The model is to include all the variables that cover the craft or the skipper characteristics and that are liable to identify factors that might be controlled when setting insurance policies.

The dependent variable for each recreational boat is the severity or average cost and the independent variables are the craft and skipper variables that have been used throughout the paper, but coded to have numerical values.

Regarding the craft, both length and power are already continuous, whereas propulsion is coded as a binary variable (0 = sail; 1 = motor). The navigation certificate is coded as follows: 1 = yes, 0.5 = not given, and 0 = no.

The skipper variables are studied as follows. For gender, males are assigned a value of 1 and females a value of 0. The accreditation degree is coded with a discrete variable: 3 (CY - Captain of yacht), 2 (PY - Yacht Skipper), 1 (PER) and 0 otherwise.

After running the linear regression model, the craft characteristics that are significant are the length and the power, which are directly proportional to the severity. Regarding the skipper, there are no significant factors as shown by the low absolute t-values. The model is significant even if the r^2 value is not high.

Table 5. Significant factors affecting severity

	SEVERITY is LOWER if:						
	Constant	SHORTER Length	LESS Power	NO Propulsion	NO Certificate	NO Degree	NO Gender
Coefficient	-38484.65	3.0829	0.0199	6636.120356	5678.4491	-2077.9023	5953.1282
Error	16538.66	0.7979	0.0090	7036.6705	6313.2846	5169.8452	12711.2260
t		3.8640	2.2177	0.9431	0.8994	-0.4019	0.4683
r^2	3.4%						
F	8.3505	2.1050		Significant Model			
df	1414						
k	6						

CONCLUSIONS

The marine surveyor reports have proven to be a very good source to quantify the severity of the incidents of recreational boats.

Location profiles indicate the regions of Spain that incur in milder incidents. There are clear differences among the seas and coasts of Spain.

The obvious direct relationship between severity and the length and the power of the boats has been established, so it can be used to set insurance premiums. In order to do so, this first analysis is going to be coupled with the analysis of the frequency of incidents in future studies.

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AUTHOR BIOGRAPHIES



F. JAVIER OTAMENDI received the B.S. and M.S. degrees in Industrial Engineering at Oklahoma State University, where he developed his interests in Simulation and Total Quality Management. Back in his home country of Spain, he received a B.S. in

Business Administration and a Ph.D. in Industrial Engineering. He is currently a simulation and statistics consultant and university professor at the Rey Juan Carlos University in Madrid.



JOSÉ RAMÓN GONZÁLEZ DE VEGA is a Naval Architect by the “Universidad Politécnica de Madrid”. He is the Technical Manager of COMISARIADO ESPAÑOL MARITIMO, in charge of all the technical net of the company that carry

out more than 2.000 pleasure craft damage inspection per year. His work involves the investigation of the main cause of the damages, environmental conditions and human behaviour. He has a large experience in ship casualties investigation. He is a member of the Spanish Naval Architect Association, Class surveyor on behalf International Naval ship Bureau (INSB), Panama flag surveyor and RINAVE surveyor. He is a certified ISM auditor by BV, and a ISPS auditor by STET. He has the pleasure craft license PER (Patrón de Embarcaciones de Recreo).