Semantic Web Usage in the Tourism Industry in Andalusia, Spain

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Abstract

Andalusia got the 4th place of tourists' favorite destinations among 17 autonomous communities in Spain in September 2023 and almost returned to pre-pandemic normality regarding tourism. Although Spain is famous for its "sun and beach", its tourist industry is facing new challenges in socio-economic, environmental and territorial issues; therefore, the role of artificial intelligence cannot be ignored in the evolution and transformation of the tourism business. AI algorithms reinforce decision-making capabilities through analysing real-time data. Effectiveness and efficiency of AI algorithms are dependent on well-structured, well-described and machine-readable meta data network which can be provided by Semantic Web standards. This article empirically study the current usage of Semantic Web formats, ontologies and touristic topics in 65 tourist-relevant web sites in Andalusia. Results show that just 57 % of examined sites used semantic markup with most of the semantic annotations (98.5%) made in three formats: Microdata, JSON-LD and RDFa. Furthermore, the Ontologies used in almost 90% of markups are 'Schema.org', 'Data Vocabulary' and 'RDF', but none of the special tourism ontologies appeared in examined tourism web sites. Therefore, Andalusia tourism websites should be enhanced with much more widespread Semantic Web in order to achieve a better performance in a future in which AI technologies will be widespread.

Keywords: Semantic Web, Tourist intelligence, Ontology, Artificial intelligence, Tourism in Andalusia.

1.   Introduction

Spain recorded 83.7 million tourists in 2019, marked the fifth consecutive year of record-beating numbers, as it is shown in Figure 1. Tourism activity in Spain reached 157,355 million euros in 2019, 12.6% of the country GDP, which led to 2.67 million jobs related to tourism (12.7 % of total employment). The global travel restrictions caused by the Covid-19 disease damaged the tourism industry in 2020 severely, as can also be seen in Figure 1.

*Figure1: Contribution of tourism to GDP in Spain (millions of euros)*
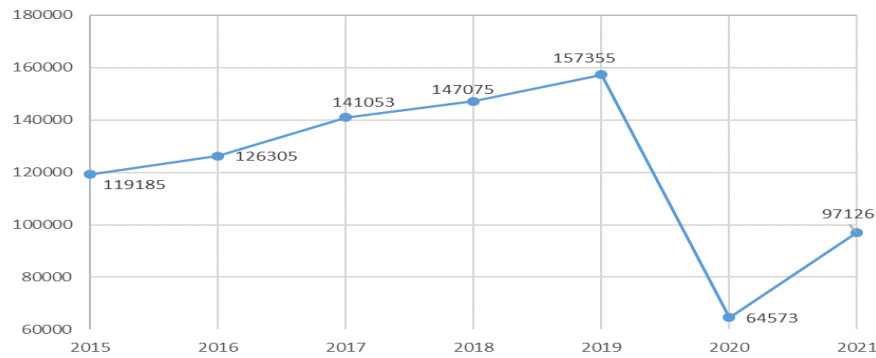
Statistics of tourist movements released by the National Institute of Statistics (INE) show that in the first nine months of 2023 the number of tourists visiting Spain increases by 18.8% and exceeds 66.5 million. Comparing the accumulated statistics of 2023 with the first nine months of 2019, before the pandemic, shows that tourist arrivals recovery rate was 94% (National Institute of Statistics (INE), 2023).

Figure 2 shows the statistics of tourist's arrivals in 17 autonomous communities of Spain. Andalusia had received 9.6 million international arrivals in the first nine month of 2023, which was 14.45 % of the total arrivals in Spain, and got the 4th place of tourists' favorite destinations in Spain.

Although Spain is famous for its "sun and beach", its tourist industry is now facing new challenges in socio-economic, environmental and territorial issues, therefore the role of tourist intelligence as one of the axes in the new tourism strategy of Spain 2030 cannot be ignored (Ministry of industry and tourism, 2023). Artificial intelligence (AI) starts playing a vital role in the evolution and transformation of tourism industry. Artificial intelligence algorithms reinforce decision-making capabilities of users through collecting and analysing real-time data about their behaviour, preferences and travel history, and external relevant factors such as price, offers, events, availability of services and products, weather, transportation. Therefore, they can offer personalized opportunities that best suit customers' budgets and wishes. Furthermore, AI algorithms also help tourist businesses to enhance their decision-making processes, and Dynamic pricing strategies to maximize revenue and customers' satisfaction.This is possible through predictive and prescriptive models based on analysing real-time data such as tourism flow, booking patterns, users online searches, social media interactions, market demand, external factors (e.g. weather and events) and customer satisfaction.

Effectiveness and efficiency of AI algorithms are dependent on well-structured, well-described and machine-readable meta data which can be provided by semantic web technologies. This article analyzes the current usage of semantic web formats, ontologies and touristic topics in 65 tourist-relevant web sites in Andalusia to find out the amount of proper data infrastructure which has been prepared for AI algorithms and technologies. Use of Semantic annotations are strongly recommended by leading search engines such as Google, Yahoo, Bing, etc., in order to optimize search results. For this purpose this survey exctracts the amount of semantic annotation in the examined websites, analyzing formats, ontologies and common touristic topics which are used in those websites.

Figure 2: Tourist's arrivals for main Spanish communities (first nine months of 2023)
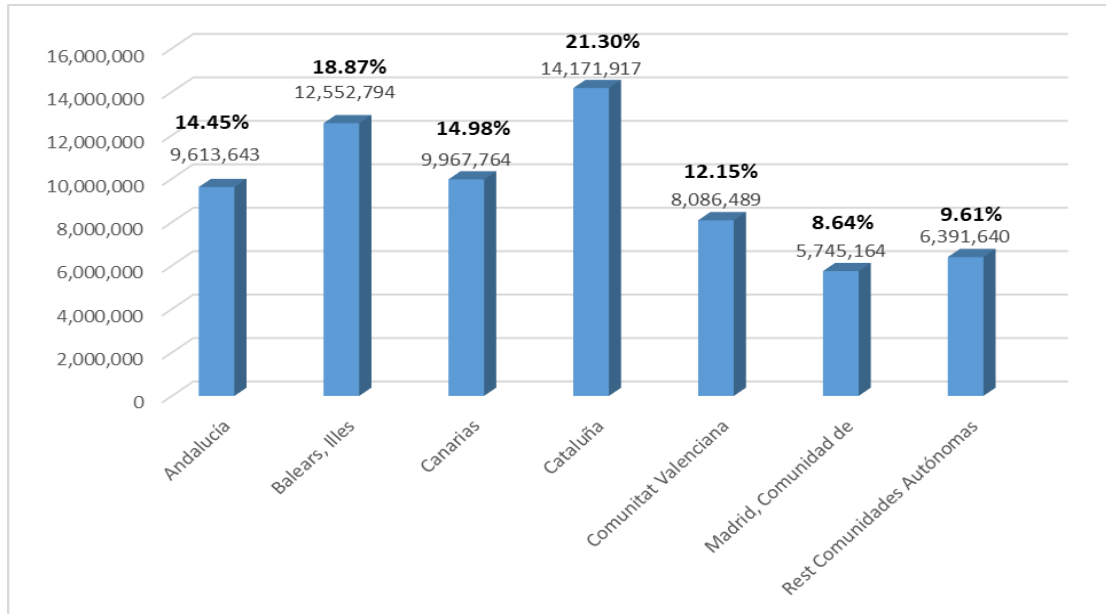
Source: (National Institute of Statistics (INE), 2023)

2. State of the art

Berners-Lee expressed his vision of the Semantic Web as follows:

"I have a dream for the Web [in which computers] become capable of analyzing all the data on the Web – the content, links, and transactions between people and computers." (Berners-Lee, 1999). The semantic web technologies transfer human readable repository content to machine-readable information (Rhayem et al., 2020) and brings better visibility in the search results of leading search engines (Toma et al., 2014). Ontologies are considered as backbone of the semantic web (Rawat, 2023). The popularity of semantic data models such as ontologies and knowledge graphs has grown significantly in recent years (Alexopoulos, 2020).

When experts are developing tourism websites and their relevant services, they may face difficulties choosing the most suitable vocabularies (Ontologies) between independent common Ontologies and tourist-specific ontologies (Vandenbussche et al., 2017). Schema.org as a common vocabulary did not support the accommodation properties such as number of beds available in a room or pets friendly places until version 3.0 has been released (Kärle et al., 2017) while tourism-specific vocabularies can bring better visibility and integration of travel information systems (Soualah-Alila et al., 2015).

A previous study on 133 Austrian regional tourism organizations indicated that 59% of subjects used semantic web annotations in their web sites and the rest did not used any semantic markups. In addition, the result shows that the top 20 regions make 89% of the total amount of semantic markups (Lohvynenko& Nedbal, 2019). Smart tourism ontologies can provide big advances in tourism organization and development that worth to investigate (Navío-Marco et al., 2018).

3.   Methodology

The methodology of this empirical investigation started with selection of the examination objects and proceeded by description of the data extraction process and preparation of the semantic markups for analysis. Further, it continues by describing how incomplete and erroneous annotations were identified and how they were assigned to groups that emerged during this analysis.

3.1   Selection of the Examination Objects

Andalusia is the southernmost autonomous community in Spain, which is the second largest, and the most popular one. The territory of Spain is divided into eight provinces which are named as Almería Cádiz, Córdoba, Granada, Huelva, Jaén, Málaga and Seville which is the capital of Andalusia. Andalusia tourism-relevant websites were selected as the main examination objects of this analysis. For having a more general analysis, and doing a comparison between Andalusia as the chosen target and the entire territory of Spain, the researcher used some official tourism websites related to the entire territory of Spain as the examination objects either. For this analysis, totally 65 tourism websites had been selected, considered as the most relevant and representatives of the region. Each of them provides information about the local culture, history, cuisine, and natural beauty of the municipality or region, as well as practical information for visitors, such as how to get there, where to stay, and what to see and do. They also offer a calendar of events, festivals, and cultural activities taking place throughout the year in each area, as well as information about outdoor activities and tourist services and provide a comprehensive guide for anyone planning a trip to Andalusia.

3.2   Data Extraction Process

In this study, the researchers used data from Web Data Commons, making raw web page data, extract metadata, and snippets of individual web pages available to the public. The data collection entitled "Web Data Commons - RDFa, Microdata, Embedded JSON-LD, and Microformats Data Sets - October 2022" (Bizer et al., 2023) has been used as basis of data extraction. The data was represented in the form of RDF quads with subject, predicate, and object as well as the URL of the web page from which the data had been extracted as fourth element.

In order to unpack each file and examine the presence of semantic annotations, a Powershell script had been developed. Some formats included too many files so files had separated in different folders and developed totally 72 customized script for each group in order to process multiple files at the same time. The Scripts were run in windows PowerShell ISE environment. The files of each folder had been processed by relevant script in order to find semantic annotations in examination websites.

A Windows PC using an Intel(R) Core(TM) i5-9400T CPU had been used to run the scripts in parallel of six in order to maximize CPU usage so the extraction time was reduced significantly. The extraction process took approximately 20 days, and in this process, 7 Gigabytes of information were downloaded for further analysis.

The 262,885 extracted relevant records to examination websites, previously mentioned in section 3.1, had been transformed to a new table. In order to identify different types of structured data in websites of Andalucía tourism regions, the table had been extended with additional information such as website name, relevant region, Format, NameSpace and Datatype, Ontology, Class, Properties, Topic, remark. It should be mentioned that remark contains notes about errors and incomplete semantic annotations found in the analysis of

extracted data, most of which were previously described in the study of Meusel and Paulheim (Meusel & Paulheim, 2015)

4. Analysis Results

This section indicates the main findings of the survey on the Usage of Semantic Web in Andalucía selected websites.

4.1 Amount of examination tourism websites Using Semantic Annotations

The results show that among 65 selected examination websites only 37 sites (56.92 %) use Semantic Web annotations in their content, while the remaining 28 websites (43.08%) did not use any semantic markup. Figure 3 shows the statistics of examination objects in each region to find out the number of total websites and those used semantic in their content. As one can conclude, in most regions, only a few number of websites used semantic annotation in their contents.

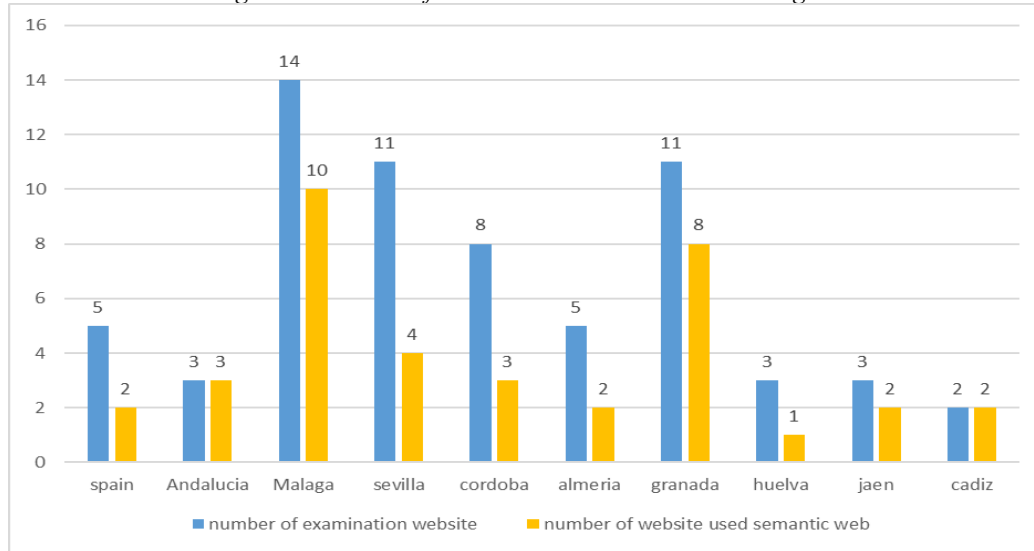*Figure 3: Statistic of Examination websites in each Region*

Figure 4 shows the statistics of RDF quads identified in the study of different regions. Granada websites are leaders with a 52.81% of the total amount of semantic markup. Surprisingly, only two of five websites selected in whole Spanish region, used semantic markup, which include 315 semantic markups equal to 0.12% of the total markup obtained in 37 structured web sites.

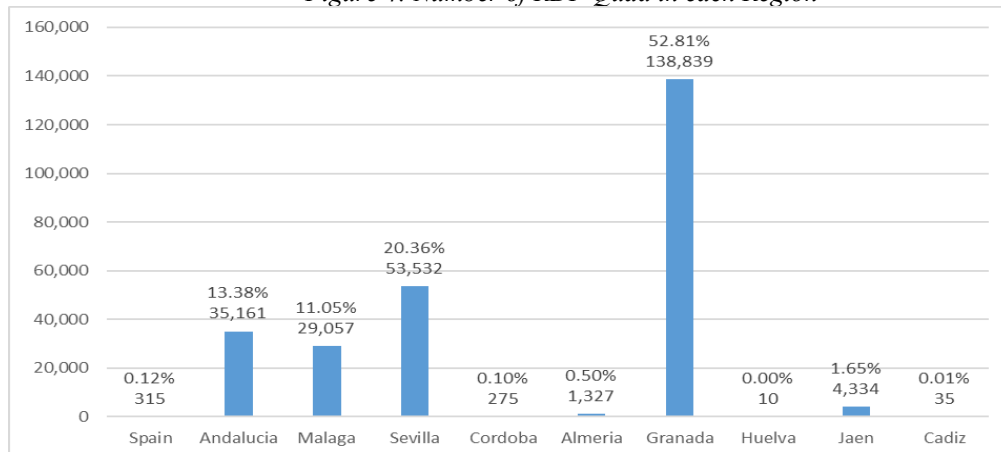*Figure 4: Number of RDF Quad in each Region*

Figure 5 shows the top 10 websites, which markup 255,639 RDF quads equal to 97.24% of all RDF Quads among 65 websites in this study. The leading site is www.granadatur.com which has 92337 RDF quads equal to 35.12 % of the entire data set. Second place in this ranking is occupied by www.turismosevilla.org with 53416 RDF quads equal to 20.32% of the entire data set and www.Andalucia.com has the third place in ranking by 33570 RDF quads equal to 12.77 % of the entire data set. The other seven websites shown in the figure use more than 2000 RDF quads equal to 23.08% of the entire data set.

Figure 5: Top 10 tourism websites by absolute number and percentage of RDF quads
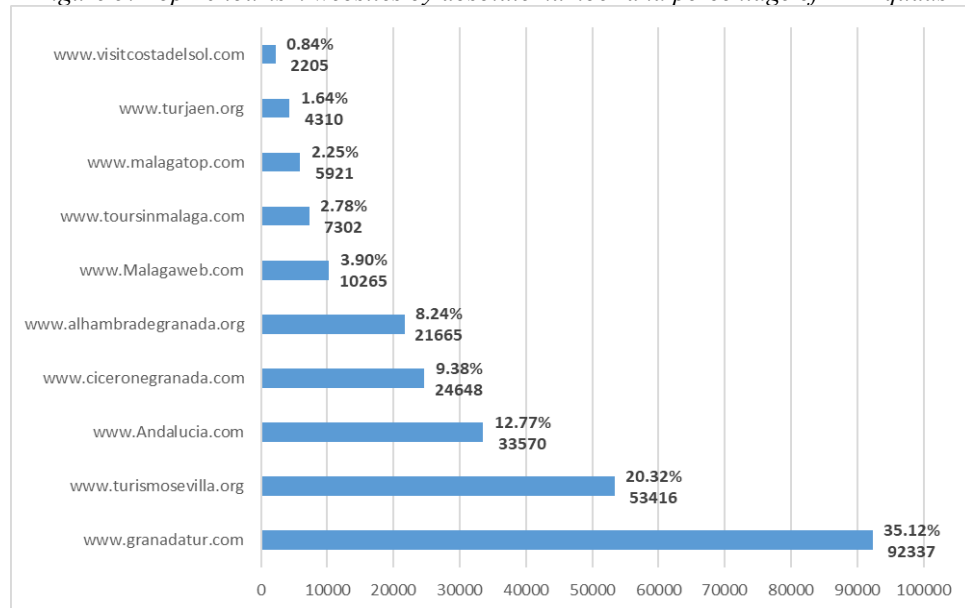
4.2   Formats

Figure 6 shows different Semantic Web formats used in extracted RDF quads. The results show Microdata format has the first ranking by 129,372 (49.21%) uses in the RDF quads. JSON-LD was used in 68,431 RDF quads (26.03%) and RDFa was used in 61,297 RDF quads (23.32%) and the usage of Microformats was only 3,785 (1.44%) in total RDF quads.

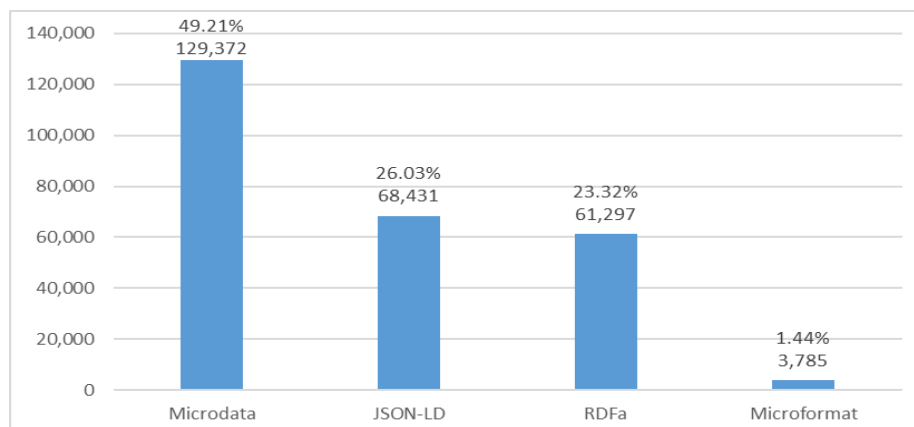*Figure 6: Number and percentage of RDF quads according to Format*

Figure 7 shows that nine (24.32%) of the 37 tourism websites only used one format of semantic annotation in their website content, while 13 websites (35.14%) used two formats,

10 websites (27.03%) used three formats and the rest 5 websites (13.51%) used all four semantic annotation formats.

Figure 7: Percentage of number of used formats in structured websites
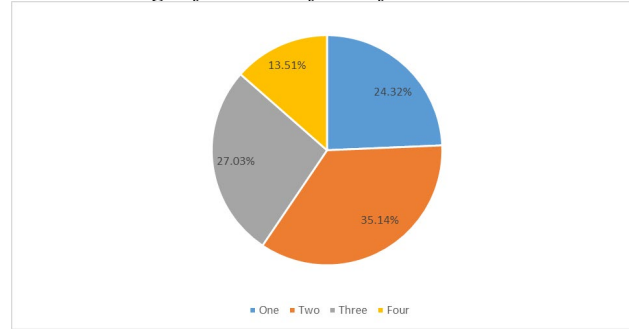
4.3 Structured Data Markup: Ontologies

The examined websites used only 15 different ontologies. As Figure 8 shows, the most used ontology is Schema.org with 38.94% in the whole number of RDF quads. In the second place is Data-Vocabulary.org with 28.70% and RDF with 21.37% is in the third place. The total usage of remaining ontologies (Vcard, foaf, DC Term, og, content, xfnv, rdfs, skos, sioc, dbpedia-owl, icaltzd) is 3.25% of all semantic markups. The remaining 7.74% of RDF quads did not use any ontology in their semantic markups. Interestingly, none of the specific tourist vocabularies were found in the examined objects.

Figure 8: Ontologies used in structured websites by percentage
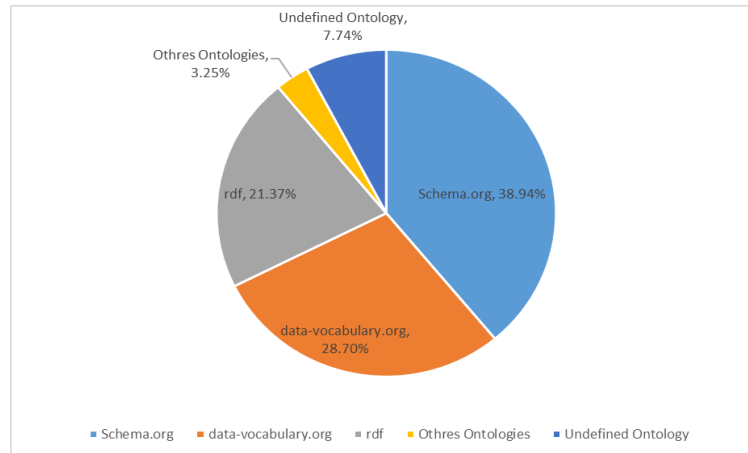
4.4 Topic

Similar web contents have been annotated via data class in different ontologies, therefore the identified data class in this study has been classified into 12 different topics taken from the study of Christina Lohvynenko & Dietmar Nedbal (Lohvynenko& Nedbal, 2019). However, we changed the topic 'Address' to 'Contactpoint', which is a higher level and can cover more data classes. The results are shown in Table 1.

Table 1: Topics and their relevant ontologies and data classes

	Topic	Relevant ontologies and data classes
1	Action	S: Action, S: CommunicateAction, S: ConsumeAction, S: potentialAction, S:query-input,S: target, S: urlTemplate
2	Blog	S: Article, S: Blog, S: CreativeWork,S: HowTo, S: HowToDirection, S: name, S: publisher, S: Recipe, S: short_name, S: SocialMediaPosting , S: wordCount, xfnv: co-worker-hyperlink, dbpedia-owl: wikiPageExternalLink
3	ContactPoint	S: ContactPoint, S: GeoCoordinates, S:location, S: PostalAddress, S: telephone
4	Event	dc:date, icaltzd:description, S:EventS: EventAttendanceModeEnumeration, S:startDate, S:text
5	Images	S: image_url, S: ImageObject, S: photo, S: photos, S: thumbnail, S: thumbnailUrl, S: width, foaf:Image, rdf:type
6	Local Tourism Business	S: FoodEstablishment, S:LocalBusiness, S: Place, S: Accommodation, S: CivicStructure
7	Navigational Information	dv: Breadcrumb, rdfs: label, S:ItemList, S:keywords, S: ListItem, S:url
8	Organization	S: Organization
9	People	S: Person, foaf: Document, vcard:hcard
10	Product Data	S: AggregateRating, S:availability, S:description, S:LodgingBusiness, S:Offer, S:Offers, S:Product, S:Rating, S:Review, S:seller, S:sku,S: starRating, S: StructuredValue, S:validFrom, S:valueAddedTaxIncluded, XHTML:item, sioc:Item, sioc:num_replies
11	Social Media	Og: description, og:image, og: title, og:tyop: og:url, og: fbmladmins, og: fbmlapp_id, xfnv:me-hyperlink, xfnv:mePage, S:sameAs
12	Website Information	S:inLanguage, S:MediaGallery, S: MediaObject, S:WebPage, S:WebSite, content:encoded, foaf:homepage, skos:prefLabel, dc:title

In Table 1, ontologies are abbreviated as following: "s:" stands for "Schema.org", "dv:" for "data-vocabulary.org", "dc:" for "Dublin Core", "foaf:" for "friend of a friend", "sioc:" for "Socially Interconnected Online Communities", "og:" for "Open Graph Protocol" and "skos:" for Simple Knowledge Organization System.

The 37 tourism websites that have used semantic markups were analyzed according to the usage of topics and the results are presented in Table 2.

Table 2. Topics usage for the 37 websites that used semantic markups

Topics	RDF Quads		Website Counts	
	Num	Percentage	Num	Percentage
Action	3978	1.55%	5	13.16%
Blog	22095	8.58%	28	73.68%
ContactPoint	5465	2.12%	4	10.53%
Event	2378	0.92%	10	26.32%
Images	67028	26.04%	21	55.26%
Local Tourism Business	2273	0.88%	5	13.16%
Navigational Information	118556	46.06%	23	60.53%
Organization	2634	1.02%	7	18.42%
People	3868	1.50%	18	47.37%
Product Data	17790	6.91%	23	60.53%
Social Media	2686	1.04%	13	34.21%
Website Information	8618	3.35%	18	47.37%

5.   Discussion

The analysis revealed that although Semantic Web observed in tourist-relevant websites of Andalusia is compatible by the standards recommended by leading search engines such as Google, Yahoo, Bing and Yandex, their usage has not been widespread in the examined tourism websites. The results show that 57 % of examined sites used semantic markup, in which only 5 websites had marked up 85% of the semantic annotations while the usage of total annotations in each of the 32 remaining websites did not exceed 3 percent. Observed figures are similar to those found in a previous study for Austrian regions (Lohvynenko& Nedbal, 2019).

The results also indicate that websites which are categorized under tourist-relevant geographic names such as Spain, Andalucía, Málaga, Córdoba, Almería, Huelva, Jaén and Cádiz, have a smaller share in the annotation markup. Surprisingly, only two of five websites selected in Spanish region used semantic markups, which include only 315 semantic markups, 0.12% of the total. On the other hand, Granada and Sevilla regions have much greater share in the use of the Semantic Web. Granada is the leader by making 52.81% of the total amount of semantic markups and one of its relevant website, www.granadatur.com, makes 35.12 % of the entire data set on its own. Furthermore, Sevilla had made 20.36 % of all markups which was mainly related to website www.turismosevilla.org.

Analysis of semantic annotation formats and Ontologies showed that 98.5% of semantic annotations were made by three formats: Microdata, JSON-LD and RDFa while Microformat accounted for only 1.5% of the cases. In addition, out of 16 ontologies which have been identified in this analysis, only three of them (Schema.org, Data Vocabulary and RDF) have been preferred by most websites and used in almost 90% of all markup. Regardless of the semantic annotation formats and ontologies, the twelve thematic topics used give us an overview of Andalucía tourism websites. The results showed almost 72% of annotation related to two general topics: "Navigational Information" and "Images". Data Classes and properties related to the tourism industry have been addressed in different ontologies such as Schema.org that is used by almost 40 % of all annotation in this study. However, the examined websites used only a few classes and properties that are specifically developed for tourism usage. The usage of classes related to tourism in this ontology is discussed in the following paragraphs:

- "Lodgingbusiness" class with specific types such as: Hotel, Motel, Hostel, campground, Resort, vacationRental, BedAndBreakfast, only used by website www.alhambradegranada.org. This class had been used in 77 RDF quads, with 50 records defined as "Hotel", 10 records defined as "campground" and no specific type used for the rest 17 records.

- "Accommodation" class with specific types such as Apartment, House, Room, Suite, CampingPitch is used only by www.alhambradegranada.org site. Obviously more detailed information about accommodations, play a key role in booking process by people or search engine agent. Properties like "amenityFeature", "numberOfRooms", "bed", "starRating", "reviewRating" , "priceRange", "currenciesAccepted", "paymentAccepted", "petsAllowed", "smokingAllowed" have been defined in "Schema.org" Ontology to describe an accommodation though these properties were not semantically annotated in examined objects.

- "CivicStructure" class with more specific Types such as: Airport, Aquarium, Beach, BoatTerminal, Bridge, BusStation, BusStop, Campground, Cemetery, Hospital, MovieTheater, Museum, MusicVenue, Park, ParkingFacility, PerformingArtsTheater,

PlaceOfWorship, StadiumOrArena, SubwayStation, TaxiStand, TrainStation, Zoo has been used only by www.alhambradegranada.org website. This class was used in 51 RDF quads defined as "Museum

- "Place" class with more specific Types such as TouristInformationCenter, CivicStructure, LandmarksOrHistoricalBuildings, Residence, TouristAttraction, TouristDestination has been used by only two websites www.alhambradegranada.org and www.granadatur.com . This class was used in 171 RDF quads including 141 records defined as "LandmarksOrHistoricalBuildings", 15 records defined as "TouristInformationCenter" and 13 records defined as "TouristAttraction".

- "FoodEstablishment" class with more specific Types such as: Bakery, BarOrPub, Brewery, CafeOrCoffeeShop, Distillery, FastFoodRestaurant, IceCreamShop, Restaurant, Winery has been used by www.granadainfo.com website. Only one RDF quad addressed this class defined as "Restaurant".

- "SportsActivityLocation" class with more specific Types such as: BowlingAlley, ExerciseGym, GolfCourse, HealthClub, PublicSwimmingPool, SkiResort, SportsClub, StadiumOrArena, TennisComplex was not founded in this study.

- "Event" class with more specific Types such as: ComedyEvent, DanceEvent, ExhibitionEvent, Festival, FoodEvent, MusicEvent, SaleEvent, ScreeningEvent, SocialEvent, SportsEvent, TheaterEvent, VisualArtsEvent has not been annotated semantically in the examined websites, though some information about these type of events was observed in the content of these websites.

- "Offer" class which includes properties such as "availability", "price", "priceCurrency", "acceptedPaymentMethod", "aggregateRating", "priceValidUntil", "review" was used only by two websites: www.alhambradegranada.org and www.turismointeriordemalaga.com. This class had been used in 89 RDF quads that extended properties and annotated relevant data semantically, while there were more information about offers in the content of the websites.

The analysis of the extracted classes and relevant properties shows that despite the existence of many useful tourist-relevant contents in the websites, the specific semantic annotations are not very much implemented. Generic classes have been used in most websites contents, while this issue should be improved by using more precise classes and properties, permitting the application of smart and automatic technologies.

6.   Conclusion

The present empirical study of the usage and application of Semantic Web in tourism industry in Andalucía Spain shows that 57 % of examined tourism websites used semantic markup in their contents. Even if this is a high ratio in comparison with international and industry section, it is important to note that not all websites played the same share, as 85% of all semantic annotations were made by only 14 % of all examination objects. Granada and Sevilla websites were the ones that used more structured data, with Granada leading by 52.81% markup and Sevilla following by 20.36 %. Most semantic annotations (98.5%) were made by three standard formats: Microdata, JSON-LD and RDFa and only three Ontologies 'Schema.org', 'Data Vocabulary' and 'RDF' used in almost 90% of all markups. However, none of the special tourism ontologies was specifically used in the examined tourism web sites, though some more general topic classes were used.

The main limitation of the present study is its basis on a secondary source that had extracted information from 1.5 billion HTML pages including structured data out of the total 3.15 billion pages. Further, the data sets consists of 86 billion RDF quads, were extracted in a single point in time (October 2022), so it was not possible to check the results in current time. It is recommended to duplicate the study to observe the progress of Semantic Web usage based on the new data sets extracted in October 2023 that has been released on 2024/01/08. Another limitation of this study is the presence of several errors in the semantic annotations of the websites, however those errors have been fixed as much as possible to avoid any wrong classification by the researcher. Using artificial intelligence tools to find out these errors and offering proper suggestion to fix them automatically would be also an interesting future research.

As an overall conclusion this study shows that semantic markups and in particular tourism relevant semantic annotations were not widely used in the examined tourism websites of Andalusia. Thus, there is a large margin of improvement regarding semantic markup and annotations that will allow for further development and modernization of the tourism industry, a change much needed for the AI tools and applications that already exist and that are growing at an astonishing rate, and that can change the way the tourism industry is managed nowadays.

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