

Emotional Reactions to the Perception of Risk in the Pompeii Archaeological Park

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ABSTRACT

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The assessment of perceived risk by people is extremely important for safety and security management. Each person is based on the opinion of others to make a choice and the Internet represents the place where these opinions are mostly researched, found and reviewed. Social networks have a decisive impact: 92% of consumers say they have more trust in social media reviews than in any other form of advertising. For this reason, Opinion Mining and Sentiment Analysis have found interesting applications in the most diverse context, among which the most innovative is certainly represented by public safety and security. Security managers can use the perceptions expressed by people to discover the unexpected and potential weaknesses of a controlled environment or otherwise the risk and security perception of people that sometimes can be very different from real level of risk and security of a given site. Since the perceptions are the result of mostly unconscious elaborations, it is necessary to go deeper and to search for the emotions, triggered by the sensorial stimuli, that determine them. The objective of this paper is to study the perception of risk within the Pompeii Archaeological Park, giving emphasis to the emotional components, using the semantic analysis of the textual contents present in Twitter.

1. INTRODUCTION

Risk perception assessment is important for security management. In that regard, each person relies on the other's opinion to make a choice and the Internet is where these opinions are mostly researched, found and reviewed. Opinion mining and sentiment analysis represent useful tools from this point of view. They were initially used as market research tools to find out opinions about brands and products and they have now evolved to become applicable in other sectors too such as safety and security. For example, security managers can use the perceptions expressed by people to discover any unexpected and potential weaknesses of a controlled environment, or otherwise, the security perception of people sometimes can be very different from real level of security of a given site. It is therefore useful to have these tools to provide feedback in continuum about risk perception so that it is possible to know the effect on the perceived risk and security and plan appropriate counter measures [1-10].

The purpose of this paper is to illustrate a methodology for opinion mining and sentiment analysis that illustrates risk perception for the Pompeii Archaeological Park in Italy. Collecting the opinions to be used for this purpose involves searching through various open sources (OSINT - Open Source INTelligence) and hence dealing with huge amount of data in digital form where information and knowledge are to be extracted from. In our case, Twitter has been used as the

source and a proper analysis of keywords, contained into various tweets, was performed. Keywords were selected considering that the assessment of the perceived risk is strongly related to psychological aspects, through emotional reactions arouse from a specific site.

The rest of the paper is organised as follows: In Section 2, a description of the Pompeii Archaeological Park is provided. Section 3 illustrates in detail the sentiment analysis approach followed. Section 4 provides a detailed analysis of the results.

2. POMPEII ARCHAEOLOGICAL PARK

Pompeii is known for its tragic history, since in 79 A.D. a terrible eruption of Vesuvius volcano completely buried the city with all its inhabitants. It was only in 1748 A.D. that, by the will of the Bourbons monarchs, investigations began in Pompeii and therefore the opening of the excavations. From that moment on, the fame of Pompeii spread all over the world thanks to its riches and, despite the centuries has been looted and stripped of numerous precious objects, it continues to surprise today. This is perhaps the reason why, with its more than 3 million visitors a year, the Pompeii Archaeological Park is the second most visited place in Italy after the Colosseum in Rome. The extension and the great historical-artistic importance of the archaeological evidence are at the base of the uniqueness of Pompeii confirmed by UNESCO in 1997

with the recognition of it as World Heritage site. The wonder of Pompeii with mosaics, paintings, houses, temples and streets contrasts with the complexity of its management. In fact, most of the excavations are exposed to weathering and this affects their conservation status. The material and structural deterioration, the erosion caused by rainwater or by the tourist influx are only some of the main causes of deterioration that, if not properly contrasted, can lead to serious damages.

Pompeii Archaeological Park (PAP) extends over an area of about 66 hectares, 33 of which are opened to the public and whose accessibility depends on the presence of maintenance or restoration interventions but also on the sustainability of the tourist flow. The excavated area, of about 44 hectares, is divided into 9 regions (Figure 1) and includes 3.2 km of walls, 80 insulae, 1,500 domus, 1,200 square meters of floors, 242,000 square meters of masonry surfaces, 20,000 square meters of plasters, 17,777 square meters of painted surfaces, 20,000 square meters of roofing.



Figure 1. Map of Pompeii Archaeological Park

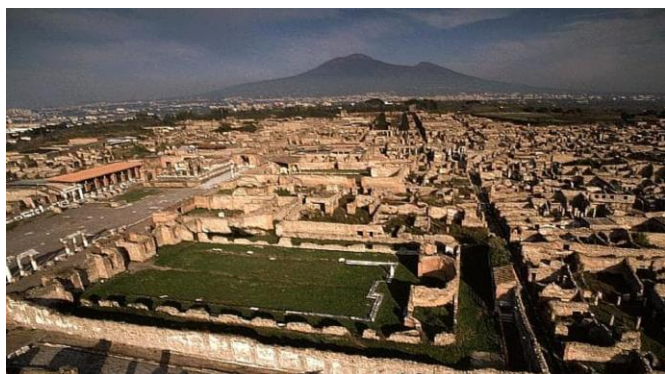


Figure 2. Excavations of Pompeii with Vesuvius volcano in the back

There are numerous attractions such as: the ‘Foro Civile’ (Public Forum), once the beating heart of the city; the Sanctuary of the Public Lari, considered a real place of worship and where now some casts of the victims of the eruption are preserved; the great Amphitheatre that could host up to 1200 people to watch gladiatorial games; the theatre; the gymnasium etc. Some pictures of the considered site are shown in Figures 2, 3, 4, 5, 6. Nowadays, great events are still hosted in this unique site. Pompeii strongly influenced artists such as Mozart, Goethe, Stendhal, etc. who visited it in the past, due to its inimitability. This unique worldwide site inevitably arouses emotions in visitors determining their perception of the risk in the considered site. Unique and complex cultural heritage sites, such as this, require a significant effort to ensure security and safety, cultural

heritage preservation and protection as well as accessibility for visitors, with particular reference to visitors with disabilities, and for personnel normally present for site management.



(a) Partial view of the ancient city with Vesuvius volcano in the back

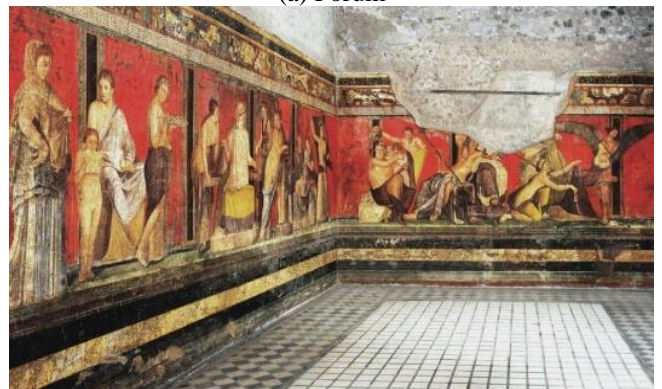


(b) One of the streets of the ancient city

Figure 3. Pictures of ancient Pompeii



(a) Forum



(b) Interior paintings of Villa of Mysteries.

Figure 4. Pictures of excavations of Pompeii



(a) Group of people



(b) Only one person

Figure 5. Pictures of human casts of ancient inhabitants of Pompeii caused by Vesuvius volcano eruption



(a) Gymnasium



(b) Interior of a Villa

Figure 6. Pictures of ancient Pompeii

These aims can be achieved using integrated systems [11, 12] and innovative technologies, such as Internet of Things (IoT) / Internet of Everything (IoE) which can connect people, things (mobile terminals, smart sensors, devices, actuators;

wearable devices; etc.), data/information/knowledge and processes [13, 14]. The IoT/IoE system must implement and support an integrated multidisciplinary model for security and safety management (IMSSM) for this specific site [15, 16]. For this reason, proper projects such as Safety & Security for Pompeii Archaeological Park and Smart@Pompeii which are strongly connected and integrated between them, have been activated.

The scope of this paper is to study the perception of risk within the Pompeii Archaeological Park, giving emphasis to the emotional components, using the semantic analysis of the textual contents present in Twitter. It serves as a useful tool serving key purposes, namely i) providing constant feedbacks about risk perception, ii) help plan future activities aimed at increasing effective or perceived security as counter measures and iii) to know the effect on the perceived risk and security.

3. OPINION MINING

The semantic information enclosed in the data can be extracted using Sentiment Analysis, also known as Opinion Mining. This analysis derives the subjective opinions of the users on an object of interest through the analysis of the polarity of the feeling (which can be positive, negative or neutral) used to describe the experience with the latter. In general, the Sentiment Analysis is performed according to the steps indicated in Figure 7.

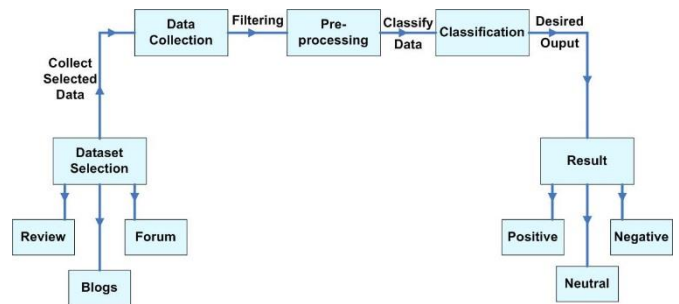


Figure 7. General opinion mining steps

The study focused on the analysis of the tweets (both in Italian and English) of PAP with the aim of extracting the emotions and opinions of visitors to assess their perception of the risk of the location. Twitter has been chosen as the source of data from which to draw texts as it is one of the most used social networks in the world and also because it has the highest percentage of public profiles compared to others (Facebook® profiles and comments are generally private). Moreover, the text is the main component (Instagram® contains mainly photos) whose brevity, 280 characters / tweet, allows to analyse each tweet more easily and more effectively.

There are many software available for network analysis, but NodeXL is generally the most common because it does not require the knowledge of any programming language. NodeXL is a free plug-in for Excel and the basic version, used for this work, allows to import data and process it using metrics. Through the limited Twitter API, it is possible to extract up to 2000 tweets or at least tweets no older than 7-8 days. In the specific case, the metric ‘Words and word pairs’ has been applied, which counts the words and the pairs of words that appeared in the tweets. Practically, this metric performs the Sentiment Analysis simply by scanning the text, identifying the words that are present in the two ‘Lists of

Sentiment Words' with the number of occurrences. The keywords used as search term are listed in the Table 1.

Table 1. Summary of the keywords used as search terms

Keywords	
Italian	English translation
Parco archeologico di Pompei	Pompeii archaeological park
Pompei scavi	Pompeii excavations
Pompei parco archeologico	Pompeii archaeological park
Pompeii sites	Pompeii sites
Scavi di Pompei	Excavations of Pompeii

In addition to the list of positive and negative words, a third category named 'Awareness words' was adopted. It represents a category suitable to highlight if and how the location is mentioned in the mass media. The words are therefore names of newspapers, TV channels, broadcasting companies and events (known above all to the Italian public) that took place in the Pompeii archaeological park.

To guarantee a significant result of the analysis, the word list, which identifies the classification in one of the three categories, is created step by step, relying on the default English settings of the software. It is well known that vocabularies for the Italian language useful for this kind of analysis are already available but, since some words are specific to the context, it was decided to create a new lexicon of sentiments.

Pompeii is characterized by the looming presence of Vesuvius volcano whose view immediately recalls the natural catastrophe that ended the city. For this reason, all the words referring to the eruption (both in Italian and in English) were found and included in the negative list, because they are linked to the primary emotion of fear. At this point, in order to extract the emotional reactions of visitors, each word (positive or negative) was associated with the primary emotion evoked by it. To reach this goal, a proper questionnaire was created and filled by a randomly collected statistical reference sample consisting of 41 people including 21 males aged between 17 and 70, and 20 females between 14 and 70 years of age was used. Once the results of the questionnaires were collected and analysed, it was possible to combine the dominant emotions with each word.

4. RESULTS

The processing of the data thus carried out produced a huge amount of information summarized in the Table 2.

Table 2. Total number of words for the analysis

Word	Count
Words in Sentiment List#1: Positive	3168
Words in Sentiment List#2: Negative	650
Words in Sentiment List#3: Awareness	7468
Non-categorized Words	48174
Total Words	59460

It must be noted that the set of un-categorized words is widely populated and this due to the inclusion in this list of all the keywords (such as Pompeii excavations, Pompeii sites, etc.), and because in a usual conversation the words that express a clear polarity, whether positive or negative, represent a minority. Figure 8 shows the distribution of the

number of tweets through the considered timeline.

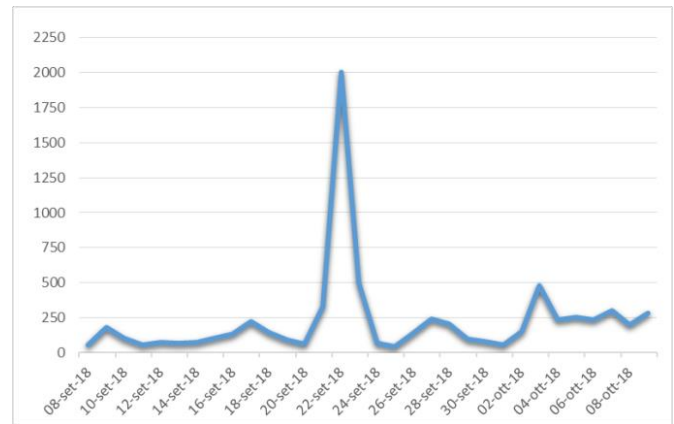


Figure 8. Considered timeline of tweets

From Figure 8, it is clear that the main peak occurs at the broadcasting of a television program (named 'Night in Pompeii' by the Italian conductor Alberto Angela) on the main Italian national TV channel which illustrated the last hours of the city before the explosion of Vesuvius volcano, revealing many curiosities about the various findings and the life of the Pompeians. This event has undoubtedly turned the spotlight on the considered site and has sparked a lot of media ferment.

Figure 9 shows the distribution of 'Awareness words'. Most of the citations and mentions of Pompeii are made through the broadcast media (45%). Another sizable slice of the distribution chart is occupied by retweets (31%); indicator of strong sharing by users; while also the term "Url" has many occurrences since the limit of 280 characters leads people to post links of other websites in which their own point of view can be fully expressed.

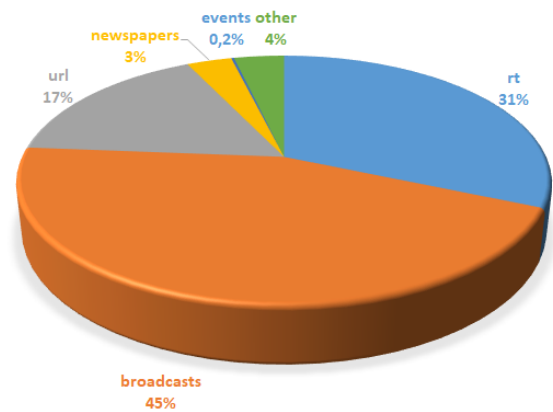


Figure 9. Distribution of Awareness words

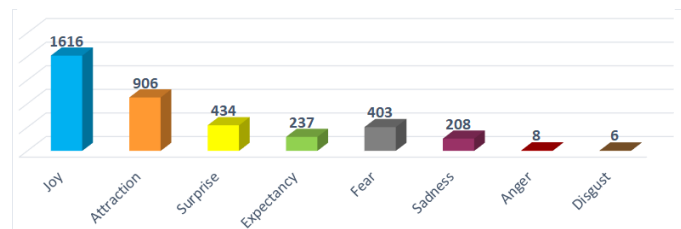


Figure 10. Incidence of every primary emotion

Regarding emotional reactions, however, it emerged that

considering 3818 Italian words, between emotions with positive or negative valence, almost half of them express 'Joy' as shown in Figure 10.

It is therefore possible to state that the overwhelming emotion evoked by the experience of visiting the Pompeii Archaeological Park is Joy (42.3%). Negative emotions are represented in low percentages except for Fear (10.5%), a negative sentiment of greater frequency, followed by Sadness (5.4%); while Anger and Disgust were irrelevant, as shown in Figure 11.

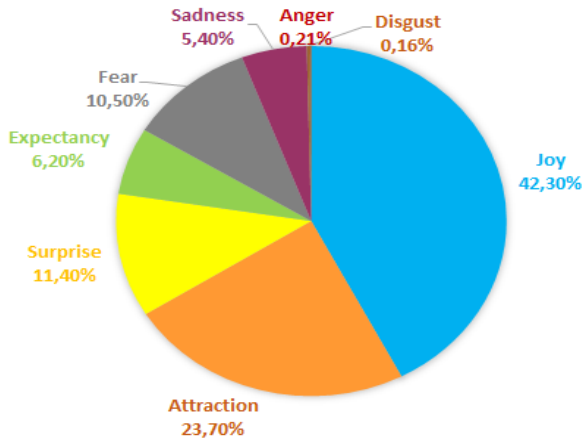


Figure 11. Percentage distribution of each primary emotion

Analysing properly the opinions on the experience of the visit to the Pompeii archaeological park, it is found that the words most widely used in the English language is represented by 'fun', followed by 'trip' and 'beautiful' which, together with 'illuminating', refer to feelings evoked by the beauty and the positive nature of the visit, as shown in Figure 12.

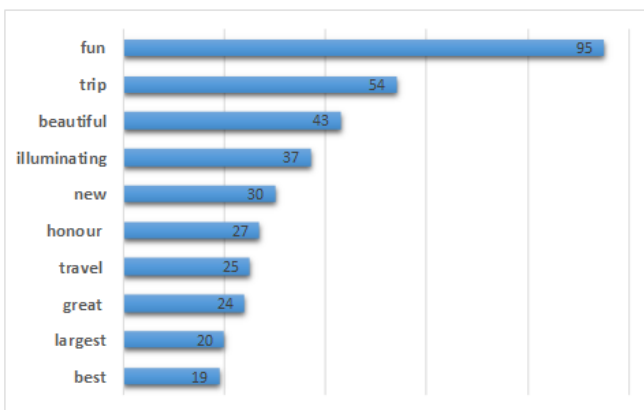


Figure 12. Ranking of the most mentioned positive words in English

In the Italian language instead, words like 'light', 'travel', 'seen' and 'alive' prevail, which define even better the sense of full satisfaction, as shown in Figure 13.

The negative words most widely used by English-language visitors instead is represented by 'damned' followed by 'eruption' which, in this case, are attributable to the history of Pompeii more than to the place itself, as shown in Figure 14.

Negative words in Italian language are focused on the eruption, in fact the second and third term we could judge them because of the first as 'terrible' and 'death' are a clear

reference to what the explosion of the Vesuvius volcano has entailed, as shown in Figure 15.

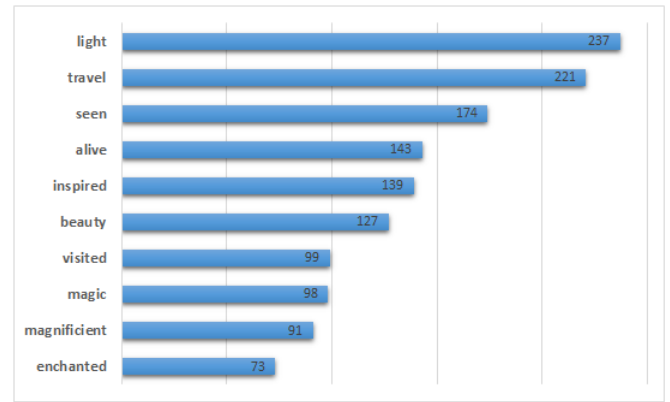


Figure 13. Ranking of the most mentioned positive words in Italian

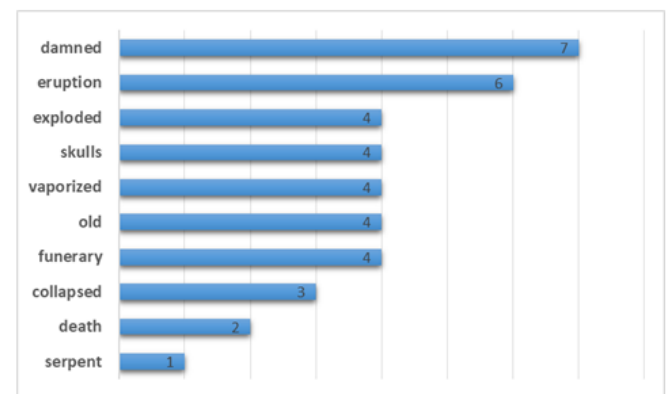


Figure 14. Ranking of the most mentioned negative words in English

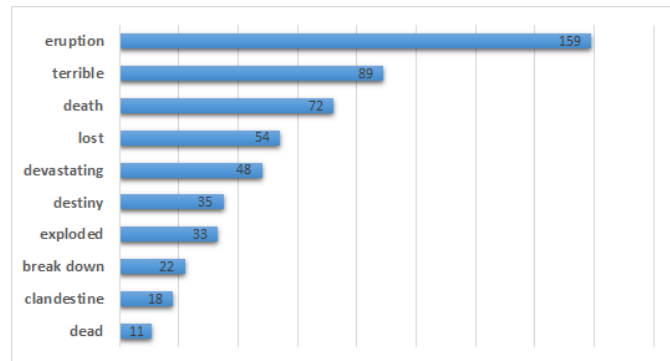


Figure 15. Ranking of the most mentioned negative words in Italian

Therefore, the term that is most often used in reference to Pompeii archaeological park is 'light'. This underscores the satisfaction with the amazement that visitors feel when they go to discover an ancient city that has been buried for centuries.

It is evident, from the obtained results, that the Archaeological Park of Pompeii, according to visitor experience, promoted a very satisfying experience. In fact, more than half of assessments regarding the site are related to experiences with generally positive value. Emotional experiences of a predominantly negative nature, on the other hand, are extremely limited: considering 3818 words, only 650

over 3818 words are characterized by this connotation and they are often referred to frescos, painted scenes or the history of Pompeii.

It follows that the perception of risk is low, since all the emotions considered prevalently positive can confirm the absence of perceived risk, while the negative ones can be considered as a demonstration of the fear of some adverse events. In fact, we know that the intensity and the value of the perceived risk are strongly correlated to the affective aspects. Starting from sensory stimuli, through emotions, one is led to the perception of security as feeling-need. It is possible to reach the total absence of risk perception when the meaning of the lived experience is in perfect harmony with the existential expectation of the person. So, if an individual who visits a place can ascertain the presence of adequate security measures, he/she perceives a condition of absolute risk-freeness.

Moreover, the examination of the obtained results allows to state that there is a very broad sharing of emotions, that is a not quite common result, and to state the existence of a general average emotion, confirming Pompeii archaeological park to be a very strong catalysing environment.

5. CONCLUSIONS

A method for the assessment of risk perception within the Pompeii Archaeological Park has been presented, giving emphasis to the emotional components, by means of the semantic analysis of the textual contents present in Twitter. It represents a useful tool since it allows to have constantly feedbacks about risk perception and when future activities aimed at increasing effective or perceived security is done, so that it is possible to know the effect on the perceived risk and security.

REFERENCES

- [1] Borghini, F., Garzia, F., Borghini, G., Borghini, A. (2016). *The Psychology of Security, Emergency and Risk*. WIT Press, Southampton, UK.
- [2] Garzia, F., Cusani, R., Borghini, F., Saltini, B., Lombardi, M., Ramalingam, S. (2018). Perceived risk assessment through open-source intelligent techniques for opinion mining and sentiment analysis: The case study of the papal basilica and sacred convent of saint francis in Assisi, Italy. *IEEE International Carnahan Conference on Security Technologies*, Montreal (Canada), pp. 11-15. <https://doi.org/10.1109/CCST.2018.8585519>
- [3] Medhat, W., Hassan, A., Korashy, H. (2014). Sentiment analysis algorithms and applications: A survey. *Ain Shams Engineering Journal*, 5(4): 1093-1113. <https://doi.org/10.1016/j.asej.2014.04.011>
- [4] Ramalingam, S. (2016). Metadata extraction and classification of YouTube videos using sentiment analysis. *IEEE International Carnahan Conference on Security Technology*, Orlando (USA). <https://doi.org/10.1109/CCST.2016.7815692>
- [5] Cambria, E., Schuller, B., Xia, Y., Havasi, C. (2013). New avenues in opinion mining and sentiment analysis. *IEEE Intelligent Systems*, 28(2): 15-21. <https://doi.org/10.1109/MIS.2013.30>
- [6] Borghini, F., Garzia, F., Lombardi, M., Mete, M., Perruzza, R., Tartaglia, R. (2018). Human factor analysis inside a peculiar job environment at the gran sasso mountain underground laboratory of Italian national institute for nuclear physics. *International Journal of Safety and Security Engineering*, 8(3): 390-405. <https://doi.org/10.2495/SAFE-V8-N3-390-405>
- [7] Park, S.M., Baik, D.K., Kim, Y.G. (2016). Sentiment user profile analysis based on forgetting curve in mobile environments. *IEEE 15th International Conference on Cognitive Informatics & Cognitive Computing*, pp. 207-211. <https://doi.org/10.1109/ICCI-CC.2016.7862036>
- [8] Anastasia, S., Budi, I. (2016). Twitter sentiment analysis of online transportation service providers. *International Conference on Advanced Computer Science and Information Systems*, pp. 359-365. <https://doi.org/10.1109/ICACISIS.2016.7872807>
- [9] Akter, S., Aziz, M. (2016), Sentiment analysis on Facebook group using lexicon based approach. *3rd International Conference on Electrical Engineering and Information Communication Technology*, pp. 1-4. <https://doi.org/10.1109/CEEICT.2016.7873080>
- [10] Shaikh, T., Deshpande, D. (2016). A review on opinion mining and sentiment analysis. *International Journal of Computer Applications (0975-8887)*, 6-9.
- [11] Garzia, F., Sammarco, E., Cusani, R. (2011). The integrated security system of the Vatican City State. *International Journal of Safety and Security Engineering*, 1(1): 1-17. <https://doi.org/10.2495/SAFE-V1-N1-1-17>
- [12] Contardi, G., Garzia, F., Cusani, R. (2011). The integrated security system of the Senate of the Italian Republic. *International Journal of Safety and Security Engineering*, 1(3): 219-246. <https://doi.org/10.2495/SAFE-V1-N3-219-247>
- [13] Garzia, F. (2018). Implementing an Internet of Everything system in the archaeological area of Quintili's Villa in the Ancient Appia route park in Rome. *WIT Transactions on the Built Environment*, 174: 261-272. <https://doi.org/10.2495/SAFE170241>
- [14] Garzia, F., Sant'Andrea, L. (2016). The Internet of Everything based integrated security system of the World War I commemorative museum of Fogliano Redipuglia in Italy. *IEEE International Carnahan Conference on Security Technologies*, Orlando (USA), pp. 56-63. <https://doi.org/10.1109/CCST.2016.7815683>
- [15] Garzia, F. (2016). An integrated multidisciplinary model for security management and related supporting integrated technological system. *IEEE International Carnahan Conference on Security Technologies*, Orlando (USA), pp. 107-11. <https://doi.org/10.1109/CCST.2016.7815690>
- [16] Garzia, F., Lombardi, M. (2017). Safety and security management through an integrated multidisciplinary model and related integrated technological framework. *WIT Transactions on The Built Environment*, 174: 285-296. <https://doi.org/10.2495/SAFE170261>