EMOTIONAL ANALYSIS OF SAFENESS AND RISK PERCEPTION OF DIFFERENT PAYMENT SYSTEMS IN ITALY AND THE UK DURING THE COVID-19 PANDEMIC

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ABSTRACT

Public safety, security and risk perception is an important aspect considered in opinion mining and sentiment analysis typically carried out on social networks. This involves considering each individual's opinion and determining a sense of what the public feels about an incident, event or place. In that sense, social networks play an important role in capturing the emotions of people. Security and safety managers can employ opinion mining and sentiment analysis as a tool to discover any unforeseen vulnerabilities in a precise manner and thereby plan and manage any associated risks. Furthermore, a continuous evaluation of risk perception can be carried out for timely and planned interventions in a seamless, effective manner to reduce or avoid any panic amongst communities. Without such advance techniques, safety and security of people, infrastructures and specific contexts can be easily compromised. Recent work in this direction has shown promising results in managing risks, especially during the COVID-19 pandemic. The purpose of the present work is to investigate the perception of risk associated with different payment systems, in Italy and the UK, during the COVID-19 pandemic, from 10 November 2020 to 13 May 2021, by means of the semantic analysis of the textual contents existing in Twitter.

Keywords: perceived risk assessment for security, open-source intelligent techniques for security, OSINT, opinion mining for security, sentiment analysis for security, payment systems risk perception.

1 INTRODUCTION

Public safety, security and risk perception is an important aspect considered in opinion mining and sentiment analysis typically carried out on social networks. This involves considering each individual's opinion and determining a sense of what the public feels about an incident, event or place. In that sense, social networks play an important role in capturing the emotions of people.

Security and safety managers can employ opinion mining and sentiment analysis [1]–[8] as a tool to discover any unforeseen vulnerabilities in a precise manner and thereby plan and manage any associated risks. Further, a continuous evaluation of risk perception can be carried out for timely and planned interventions in a seamless, effective manner to reduce or avoid any panic amongst communities. Without such advance techniques, safety and security of people, infrastructures and specific contexts can be easily compromised. Recent works in this direction has shown promising results in managing risks and especially during the COVID-19 pandemic [9]–[11].

The purpose of the present work is to investigate the perception of risk associated with different payment systems, in Italy and the UK, during the COVID-19 pandemic, from 10 November 2020 to 13 May 2021, by means of the semantic analysis of the textual contents existing in Twitter.

The set of opinions to be employed for this purpose involves seeking across several open sources (Open-Source INTelligence (OSINT)) and therefore the processing of huge volumes of data (Big Data) in digital form from which to obtain information and knowledge. In the present work, Twitter was employed as a source and a proper estimation of the keywords included in the different tweets was done.

The keywords have been selected taking into consideration that the estimation of perceived risk is greatly correlated to the psychological characteristics, through the emotional reactions aroused by a certain physical and logical context.

2 PAYMENTS SYSTEMS

Payment systems are instruments and procedures aimed at reproducing the material movements of money from one subject to another, in order to regulate established economic transactions [12]. Through payment systems, goods and services can be purchased, disbursing a sum of money on the basis of agreements made and delivering this amount to a creditor counterpart. The payment systems sector has become an important part of the exchange activities of each country: with the passage of time it has become increasingly complex, requiring an ever greater choice between tools and technological solutions, suitable for promoting speed and efficiency of the exchange procedures.

Cash (banknotes and coins) allows immediate transfer between two subjects and is immediately reusable. Cash is generally used to carry out transactions of limited amount between physically present subjects; it generally guarantees the anonymity of transactions. The "legal tender" of banknotes and coins involves the acceptance of cash, without prejudice to any limits set by law to regulate any type of transaction.

Monetary exchanges now take place largely through technological systems. The subjects that manage them are increasingly involved in the control of data networks and information technology (IT) systems [13]. The main types of electronic payment used are represented by: credit cards, debit cards, bank transfer, direct debits, money transfers, prepaid cards, digital payments (mobile payments, E-wallet payments, etc.), contactless payments.

2.1 Payments in Italy

Regarding Italy, based on the data collected by the European Central Bank (ECB) up to 2016, it was found that banknotes and coins are used by Italians in 85.9% of cases and cards are used only in 12.9% of transactions. If we consider the economic value of the transactions, the cards move 28.6% of the total, while the cash 68.4%, it can be deduced that cash is used for payments of a small amount on average.

Starting during the pandemic lockdown with an increase in e-commerce (eight out of ten Italians made use of it), the intensification of the use of credit cards continued in the post lockdown and is destined to continue. Today, the average frequency of electronic payments is around 2.9 times a month, compared to 2.6 in 2019 and 2.2 in 2018.

During the period corresponding to the medical lockdown, the use of electronic money by Italians increased with a jump comparable to that recorded in the eight years from 2011 to 2019. In the days of maximum emergency, the percentage of the value of the expenditure paid with credit, debit or loyalty cards, it went from 57%, an average figure recorded in 2019, to 68% [14].

2.2 Payments in the UK

Until a few years ago, in the UK it was still cash that moved the economy: in 2007, banknotes accounted for 60% of transactions, more than half. Ten years later there was overtaking: for the first time, debit cards exceeded cash. In 2019, the share of cash transactions carried out fell to 30% [15].

The trend of favouring cashless payments has been accelerated by the pandemic state, predicting that in the short term the percentage of the UK population who will still rely on cash will be 20%.

3 SEMANTIC ANALYSIS METHOD

Semantic analysis is somewhat diverse from the topic-based text classification where classification is carried out by means of predefined topics and the topic related words are crucial. Instead, opinion words such as positive, negative, or neutral are given importance in semantic analysis. In this work, we take into consideration a sentence-level classification as expressing a positive or negative opinion. We examine key tools followed by the method employed in this work:

1. Twitter: Twitter has been selected as the data source as it is one of the most popular microblogging and social networking site used by people today. Twitter revolves around the principle of followers. This tends to influence the opinion of others. From a Machine Learning perspective, Twitter messages are convenient to use as they are restricted to 280 characters/tweet and lends itself to a simple, structured way of analysing the sentence effectively. In this work, tweets in English and Italian were considered that relate to the considered context. Our aim is to assess the emotions of people and estimate their risk perception of different payment systems during COVID-19 pandemic.

2. OSINT tool: We consider the open-source intelligence (OSINT) software which relates to gathering data from open sources to produce actionable intelligence that is typically used by analysists using non-sensitive intelligence. As we use Twitter as our online source, we choose a set of keywords from Tweets that relate to perceived risk by people. These keywords correlate to an emotional experience of an individual for a specific context. The work is tested on Twitter as illustrated in the following, during COVID-19 pandemic, from 10 November 2020 to 13 May 2021.

3. Python, Twython, NLTK, Text2emotion [16]: Python is a high-level, interpreted, general-purpose programming language. Its design philosophy highlights code readability with the usage of considerable indentation. Python is dynamically-typed and garbage-collected. It supports multiple programming paradigms, together with structured (particularly procedural), object-oriented and functional programming. It is often defined as a "batteries included" language because of its comprehensive standard library. Twython is a Python library providing an easy way to access Twitter data, also allowing to determine the research area (Italy and the UK in our case). Natural Language Toolkit (NLTK) is a Python package for processing and analysing text, from basic functions to sentiment analysis powered by machine learning. Text2emotion is the python package to extract the emotions from the content, processing any textual message and recognize the emotions embedded in it, classifying them between the five emotions "Joy", "Anger", "Surprise", "Fear", "Sadness". These programming language/packages have been used to perform a part of the analysis which is compared with results obtained from a survey for word association illustrated in the following, where participants are asked to associate every selected words before to the hedonic valence (positive, negative, neutral) and then to one of the eight emotions "Joy", "Anger", "Surprise", "Fear",

"Sadness", "Anticipation", "Disgust", "Attraction". The keywords utilized as seek word are shown in Table 1. Table 2 provides typical categories of the one thousand more repeated words related to colleting period and the frequencies of occurrences of these words.

4. Procedure: First, a group of positive and negative words are defined. In addition, a group called "Neutral words" is included. It considers the words which do not have positive or negative valence. Next, a survey for word association with emotion is conducted. For the two languages considered, a group classification of the script sentences is carried out. For this purpose, a suitable survey was designed, and inputs collected from 40 evenly distributed male and female participants, aged between 17 and 75 for Italy and the same for the UK. This survey was later analysed which gave an insight into how people map words with hedonic valence (positive, negative, neutral and with the eight primary emotions before and with only five primary emotions, indicating the remaining ones as "others" to make these results comparable with results obtained by means of Python software packages. Such a mapping was obtained for every word considered in this work. They are also compared with results obtained by means of NLTK, Text2emotion.

Table 1: Summary of the English and Italian keywords used as search terms.

Country	Primary keyword	Secondary keywords 1	Secondary keywords 2
Italy	Italy-covid	money, credit cards, credit card, bancomat, coins, banknotes, cash, debit cards, debit card	virus, coronavirus, pandemic, covid, covid-19, covid 19, sars-cov-2
Italy	Italy	money, credit cards, credit card, bancomat, coins, banknotes, cash, bank, banks, post offices, current account, debit card, debit card	–
UK	UK-covid	money, credit card, atm card, coins, cash, banknotes, debit card	virus, coronavirus, covid, covid-19, covid 19, sars-cov-2
UK	UK	money, credit card, atm card, coins, cash, banknotes, bank, banks, bank account, debit card	–

Table 2: Total number of words collected over the one thousand more recurrent words.

Word	Count (English)	Count (Italian)
Positive words	66,690	16,160
Negative words	26,779	11,960
Neutral words	602,873	221,254
Total words	696,342	249,374

4 RESULTS OF SENTIMENT AND EMOTIONAL ANALYSIS FROM TWITTER

The survey started during the COVID-19 pandemic, from 10 November 2020 to 13 May 2021. The managing of the data involved generated a huge quantity of information associated to the studied collecting period (1,162,157 in Italy and 2,203,676 words in the UK, for a total

of 3,365,833 words). The total number of words collected over the one thousand more recurrent words are illustrated in Table 2.

The results of hedonic valence evaluated by means of NLTK are shown in Fig. 1, considering only the secondary keywords of "cards" and "cash". As it is possible to see from Fig. 1, with the exception of words collected with primary keywords "Italy-covid", there is a general positive hedonic valence for all the words collected with the other primary and secondary keywords.
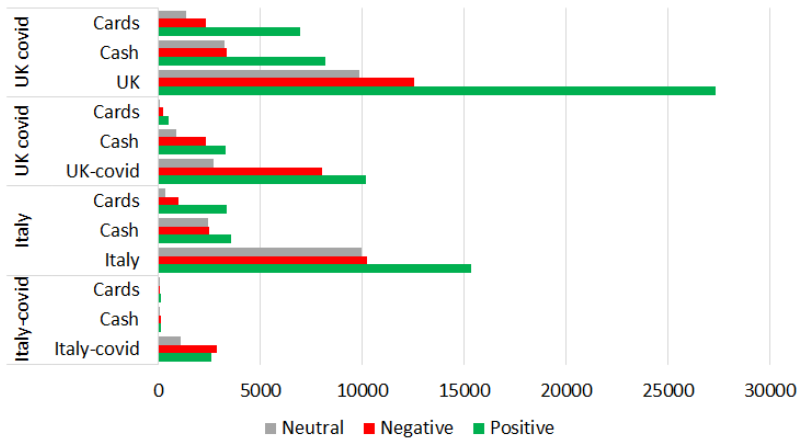

Figure 1:   Hedonic valence for primary keywords considering only the secondary keywords of "cards" and "cash" for Italy and the UK.

In order not to overburden the questionnaire to be administered to the sample of people considered, only the eight words regarding cash and eight words regarding cards, for Italy and the UK respectively, positive and/or negative, were considered, both for the English language and for the Italian language. The considered words, in English and Italian, are shown in Table 3.

Table 3: Considered English and Italian words considered for the survey.

| Word regarding "cash" in English	Word regarding "payment cards" in English	Word regarding "cash" in Italian	Word regarding "payment cards" in Italian
pandemic	pay	euro	alone
people	use	alone	euro
like	payment	pay	cashback
new	like	without	pay
need	new	home	debt
back	back	do	do
time	details	way	payment
UK	need	Italy	way

Fig. 2 illustrates the distribution of the number of tweets across the studied timeline of the four primary keywords (Italy-covid, Italy, UK-covid, UK) during the data collecting period.

We can see a descending/oscillating trend regarding the curves related to "Italy-covid" and "UK-covid", due to reduced restrictions in view of next summer season. We can also see a oscillating trend around a mean value regarding the curves related to "Italy" and "UK", as these curves are not directly related "covid" as primary keyword.
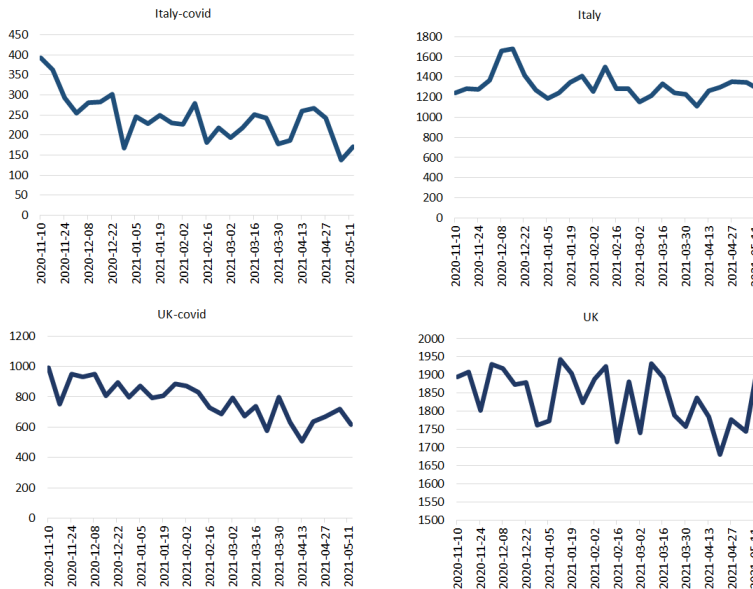
Figure 2:   Distribution of the number of tweets across the studied timeline of the four primary keywords (Italy-covid, Italy, UK-covid, UK) during the data collecting period.

Each of the four survey results related to "cash" and "cards", for Italy and the UK, respectively, are illustrated in the following, together with a comparison with results obtained by software analysis packages.

4.1 Survey results for "cash" in Italy

Regarding the survey results for "cash" in Italy and the related words used for the survey, we consider the hedonic valence and the distribution of each primary emotion (for eight and five+ others emotions survey) as shown in Figs 3 and 4, respectively. From Fig. 3 we can see that there is a general positive valence for all the survey words, except for "alone", "pay", and "without", as expectable. From Fig. 4, we can see that the predominant positive emotion is "Joy" for both surveys. Negative emotions represent a minority with respect to other positive emotions.

4.2 Survey results for "cards" in Italy

Regarding the survey results for "cards" in Italy and the related words used for the survey, we consider the hedonic valence and the distribution of each primary emotion (for eight and five+ others emotions survey) as shown in Figs 5 and 6, respectively. From Fig. 5 we can see
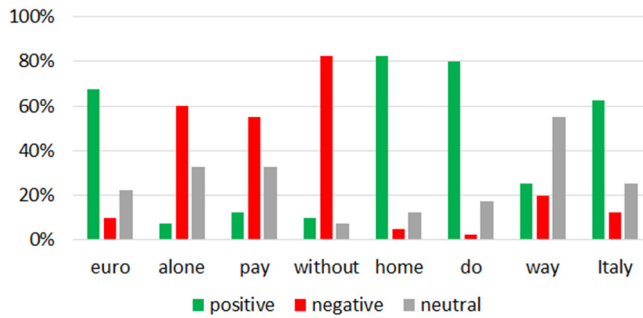
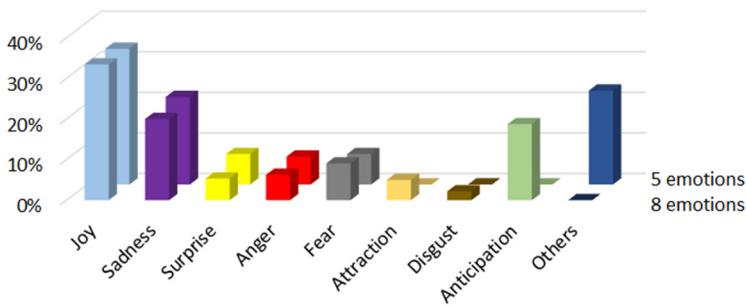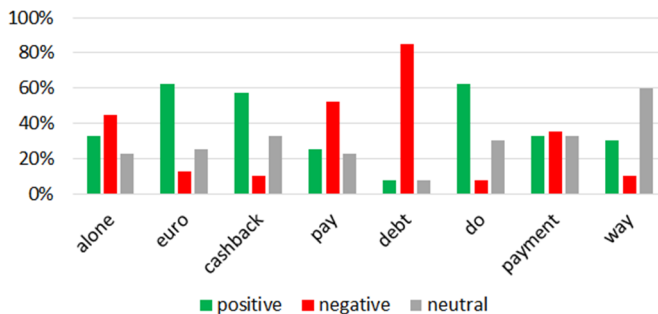Figure 3: Hedonic valence for the considered survey words regarding "cash" in Italy.

Figure 4:   Distribution of each primary emotion (for eight and five+ others emotions survey) for the considered survey words regarding "cash" in Italy.

that there is a general positive valence for all the survey words, except for "alone", "pay", and "debt", as expectable. From Fig. 6, we can see that the predominant positive emotion is "Joy" for both surveys. Negative emotions represent a minority with respect to other positive emotions.

Figure 5: Hedonic valence for the considered survey words regarding "cards" in Italy.
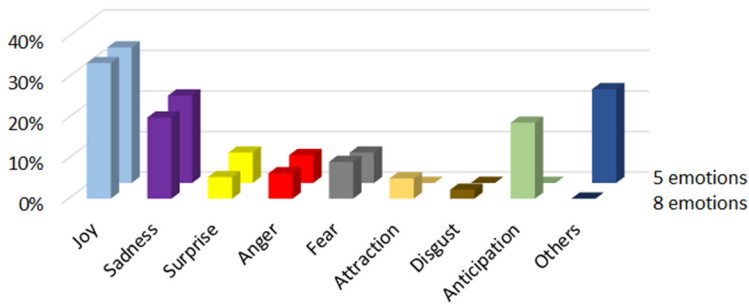
Figure 6:   Distribution of each primary emotion (for eight and five+ others emotions survey) for the considered survey words regarding "cards" in Italy.

4.3 Survey results for "cash" in the UK

Regarding the survey results for "cash" in the UK and the related words used for the survey, we consider the hedonic valence and the distribution of each primary emotion (for eight and five+ others emotions survey) as shown in Figs 7 and 8, respectively. From Fig. 7 we can see that there is a general positive valence for all the survey words, except for
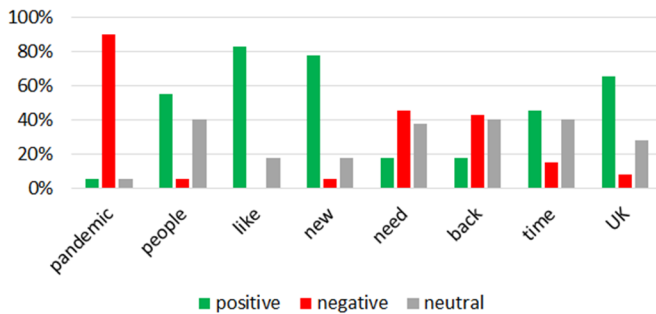

Figure 7: Hedonic valence for the considered survey words regarding "cash" in the UK.
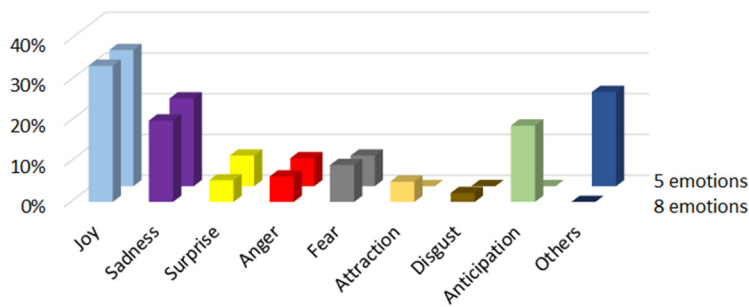

Figure 8:   Distribution of each primary emotion (for eight and five+ others emotions survey) for the considered survey words regarding "cash" in the UK.

"pandemic", "need", and "back", as expectable. From Fig. 8, we can see that the predominant positive emotion is "Joy" for both surveys. Negative emotions represent a minority with respect to other positive emotions.

4.4 Survey results for "cards" in the UK

Regarding the survey results for "cards" in the UK and the related words used for the survey, we consider the hedonic valence and the distribution of each primary emotion (for eight and five+ others emotions survey) as shown in Figs 9 and 10, respectively. From Fig. 9 we can see that there is a general positive valence for all the survey words, except for "payment", "back" and "need", as expectable. From Fig. 10, we can see that the predominant positive emotion is "Joy" for both surveys. Negative emotions represent a minority with respect to other positive emotions.
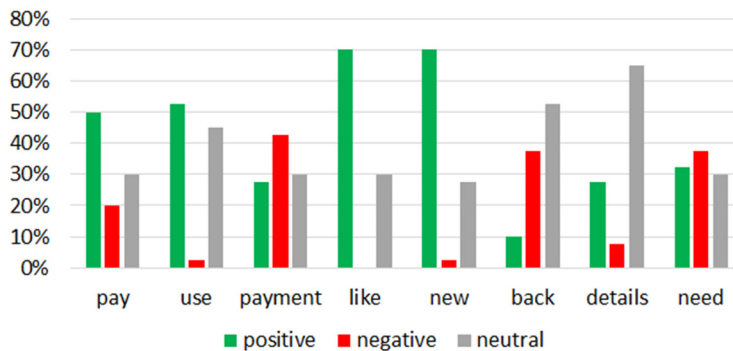

Figure 9: Hedonic valence for the considered survey words regarding "cash" in the UK.
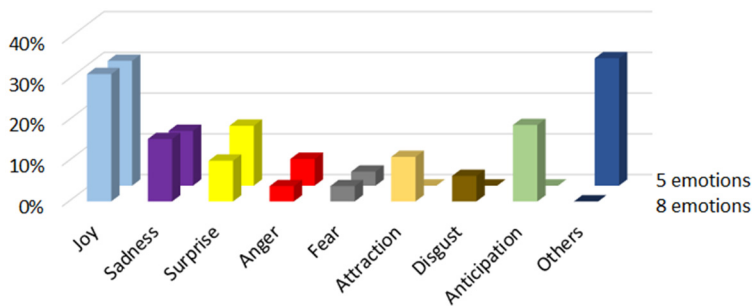

Figure 10: Distribution of each primary emotion (for eight and five+ others emotions survey) for the considered survey words regarding "cash" in the UK.

4.5 Survey results and comparison between survey and software analysis packages results

The comparison between survey and software analysis packages results are shown in Figs 11 and 12 for NLTK and Text2emotion respectively.
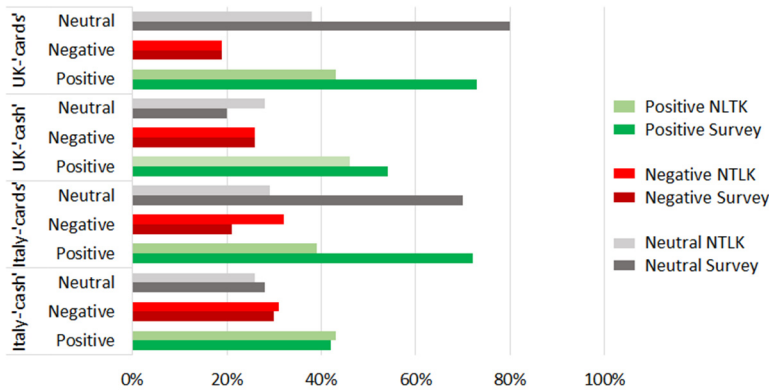
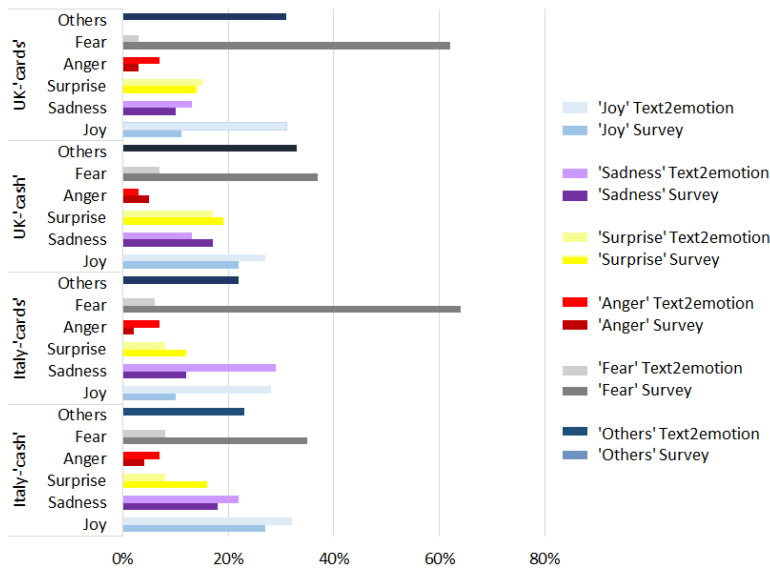Figure 11: Comparison between survey and NLTK analysis software results.

Figure 12: Comparison between survey and Text2emotion analysis software results.

Regarding only survey results shown in previous paragraphs, it is possible to state that:

1. For the analysis carried out on all the tweets collected in Italy and analysed through NLTK and Text2emotion, the hedonic value aroused both by the texts referring to cash and to cards and ATMs is positive and, although for both situations analysed the prevailing emotion is "Fear", for tweets referring to cash payment systems this is immediately followed by "Joy".

2. For the analysis carried out on all the tweets collected in the UK and analyzed through NLTK and Text2emotion, the hedonic value aroused both by the texts referring to cash payment systems and to those with cards and ATMs is positive and the prevailing emotion aroused is "Fear".

3. On the basis of the questionnaires administered in Italy, the prevailing sentiment for the most repeated words associated with cash is positive, arousing mainly "Joy". For the most repeated words in the tweets referring to the use of cards and ATMs, there was a negative feeling, represented by "Sadness". In both situations there was a continuity between the choice made with an available list of eight emotions and the one in which it was possible to choose only between five.

4. For the questionnaires administered in the UK, the hedonic value associated with the most repeated words, found both in the tweets referring to cash and cards, is positive. The emotions aroused turn out to be "Joy" and "Anticipation" in the first case and only "Joy" in the second. We want to highlight that there was no continuity in the responses detected when the available choice was only between five emotions instead of eight. It can be hypothesized that this is possible both for the ambivalent emotion aroused by some words, and because even the list of the eight primary emotions, despite being more complete, may not contain the nuances of emotions that can be experienced by the user in relation to a specific word, or, more likely, for the common use of complex emotions to replace the primary components that determine them.

Regarding the results of comparison between survey and software analysis packages shown in Figs 11 and 12, it is possible to state, for all four considered cases, that:

5. The trend of the hedonic valence shows a similar behavior both for the results obtained by the software packages and by the questionnaires administered, with a predisposition to positive sentiment.

6.   a discrepancy can be observed between the results obtained through the analysis carried out using software, in which the predominant emotion was found to be "Fear", and the results obtained from the questionnaires, where the most encountered emotion turns out to be "Joy". It is important to highlight how often the most used choice in the proposed survey was "Others", probably because, as already pointed out, it is more common to use complex emotions to replace the primary components that determine them.

The results show how the selected samples, respectively representative of the perception of users in Italy and the UK, present a tendency for the most part to a positive value, which is reflected in the propensity to "Joy", except for the perception identified in the section corresponding to perception of the use of cards and ATMs by Italian users. This propensity could depend on resilience memory. In psychology, resilience is a word that indicates the ability to deal positively with traumatic events, adapting to individual situations and constantly changing. This phenomenon explains the optimism found in the texts analyzed, despite following a difficult and stressful situation such as that of the COVID-19 pandemic and the resulting changes and restrictions. A difference that can be found between the samples of Italy and the UK is that in the second case analyzed an adequate match was not found between some of the words and the emotions selected and proposed in the questionnaires, both in the eight and in the five emotions model. There are no other particular differences in the perception of the risk found for the use of the different payment systems in the two countries considered, probably because the course of the emergency situation, albeit with some different nuances, does not show obvious discrepancies.

These results confirm the existence of an underlying optimism that causes emotions not justified by the circumstances, to underline an inconsistency between the perception of reality and reality itself. In fact, although the studies in this regard have not been properly defined, the objective risk from the point of view of safety and security linked to the use of the various

payment systems is not negligible and therefore one would expect, contrary to the results obtained, a negative hedonic value, associated with a negative emotion.

5 CONCLUSIONS

A methodology for the assessment of the perception of risk associated with different payment systems, in Italy and the UK, during COVID-19 pandemic, from 10 November 2020 to 13 May 2021, by means of the semantic analysis of the textual contents existing in Twitter has been illustrated.

It represents a valuable means when it is necessary to evaluate the perceived risk vs. the objective risk, in particular when we deal with critical contexts such as the considered one.

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