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Définition de la problématique, revue de littérature et stratégie de réalisation
(Livrable 2)

Travail présenté à
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Dans le cadre du cours
Projet de fin d'études en gestion stratégique de projets
MNG-6521

Faculté des sciences de l'administration
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Université Laval
26 avril 2021

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Sentiment Analysis for project success

Abstract

Nowadays, many business operations have adopted the use of social media to track customers' opinion and mood which is known as Sentiment Analysis (SA); however, evidence suggests that the usage of SA for project management activities have barely been a subject of study. This research seeks to present some background, highlight the importance of this new research, and give an overview of the principal reasons for the limited use of sentiment analysis in project management. A literature review was performed to analyze the benefits of using sentiment analysis in project management along with different type of business and/or situations in which it is used, the threats, barriers, and enablers of sentiment analysis adoption. Key areas where sentiment analysis is used include elections campaigns, business collaboration and communication and for marketing purposes. The use of sentiment analysis on social media as communication tool has shown to improve information sharing, engagement, and relationships among stakeholders. The most considerable threat includes a negative impact on reputation and the misleading of information – fake news. The reviewed literature highlights that the lack of a social media adoption strategy is the principal reason for the limited use of sentiment analysis in project management. This study contributes to the project management practice by introducing a model for social media adoption in project management.

1.Introduction

During the past years, many authors have presented different research or surveys focused on project success criteria and factors (Westerveld, 2003). Project success is a widely subject of concern in project management. In addition to the traditional project performance indicators, the measurement of the project success is somewhat subjectively defined by the value delivered to the project stakeholders (Bolin, A. U., 2012). Project management researchers are already aware of the duality that exists between the success of a project and the project participant's sense of satisfaction with the same projects (Usher & Whitty, 2017). A project can apparently be a success;

however, the clients can claim it as a failure due to the inability of the project teams to deal with stakeholders' issues (Rad, 2003). The success of a project is, as well the result of contributing cultural values through the implementation of social dimensions. Success factors encompass micro (individuals) and macro (group) levels where project-related activities are performed by the project manager and project teams (Kendra & Taplin 2004).

As a further matter, the project manager and project team contribute to the project success by developing positive emotions and positive relationships among other project participants (Sankaran et al, 2014). The importance of this relationship resides in understanding people's emotions as a new dimension to measure satisfaction, which is currently essential for businesses. Sentiment analysis has recently been recognized for its application to almost every business domain like election campaigning, large infrastructure projects, consumer products and services (Tarnowska, 2019; Ceron et al, 2014; Garcia-Crespo, 2010; Roberts et al, 2019; Jiang et al. 2016). Analyzing stakeholders' feedback, such as opinions in social media conversations, will allow project managers to listen attentively to their stakeholders, and tailor products and services to meet their needs (Grljević & Bošnjak, (2018).

This study aims to provide a synthesis of the previously published studies about the use of social media in project management. This research has focused, therefore, to reveal whether the application of sentiment analysis (SA) on stakeholders' opinions/emotions data published in social media have contributed to the success of the projects. The ultimate aim of this research is to increase the possibility of project to succeed by the adoption of sentiment analysis approach as a new tool for assessing and monitoring stakeholders' satisfaction and engagement throughout the execution of a project. The application cases demonstrate how effective sentiment analysis could be throughout the project life cycle. For example, analysing what Montrealer and residents of the surrounding towns think about the REM project.

Despite the use of social media for measuring business performance, little is known about how social media can influence the success of public megaprojects (Arash, D et al, 2020). Taking this into consideration, the research question leading my study is: How can project managers use sentiment analysis to improve project success?

2. Methodology

The focus is on the identification of research outcomes, theories and practices or applications, which show the possibilities of project success in different types of projects using sentiment analysis and assessing project stakeholders' opinions. The organization of the literature review is conceptual due to the lack of research in Natural Processing Language (NPL) application, particularly in the project management field. The examination and evaluation of various project success criteria, especially stakeholders' satisfaction and engagement, used in different projects, determine the first step undertaken in this study. The identification of study cases is based on their consideration in publications and practical application. Articles references were chosen and are explained along the literature review. In order to obtain highly relevant papers within reasonable time, we selected the key search terms, namely project success criteria, project performance criteria, stakeholder engagement, stakeholder satisfaction, sentiment analysis, social media, opinion mining allowing to limit the number of potentially relevant articles to a manageable level. From the practical perspective, an analysis will be conducted on four large public projects:

- Phoenix Pay System.
- Tramway of Quebec City.
- Réseau Express Métropolitain (REM)
- O-Train of Ottawa.

In this paper Sentiment Analysis is done based on Lexical based mechanism. First, citizen's opinion will be extracted from the Twitter platform. Then, opinion will be classified - as positive and negative and finally a conclusion will be drawn about the satisfaction and engagement from the citizen.

2.1. Process to collect and analyze data

In Figure 1, a general workflow of the sentiment analysis (SA) process is illustrated which was applied to evaluate the four projects of this research. The tasks included within the process are described as follows:

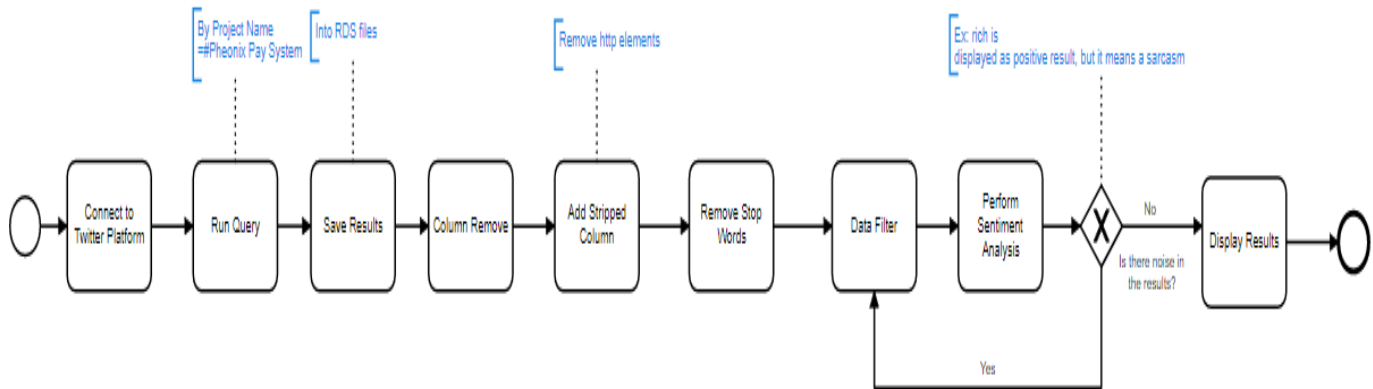


Figure 1. Sentiment Analysis Applied Process

Task 1 – Connect to Twitter Platform: For this purpose, an access token needs to be manually created to authenticate to Twitter’s API from where existing twitter data are retrieved and downloaded. This includes:

- Create twitter application.
- Twitter packages act as an interface to the Twitter API.
- An authentication package is used.
- Authentication IDs like consumer key, consumer key secret, access token, access token secret is generated.

Task 2 - Run query or search tweets on the studied project: Narrow the number of tweets, it was decided not to include retweets, so as to avoid duplicate tweets impacting the evaluation.

Task 3 - Save results: The collected data was saved in RDS files for each project to avoid rerunning the task 2 for a large period of time.

Task 4 - Pre-processing: To clean up the tweets and to convert the data to the format required by the input of the sentiment analysis algorithms. Data processing is a great challenge in our task due to the historical data size. The extracted data is raw tweets. It contains unnecessary data that is not required for analysis. This includes:

- Column Remove to eliminate the meaningless columns.
- Add Stripped Column to convert all words to lower-case, removing links to web pages, deleting punctuation and stemming words.

- Remove English and French stop-words that are not helpful to determining the sentiment of a tweet.

Task 5 - Data filtering: Consists in eliminate word that are false-positive. “Noisy” tweets are unavoidable in query results. These are tweets which contains the movie keyword but they are unrelated with the projects. Noisy tweets are filtered by removing duplicates.

Task 6 - Classifying and display sentiment: The pre-processed tweets are scored and classified by polarity (positive or negative) and categorized into eight different types of emotions (anger, anticipation, disgust, fear, joy, sadness, surprise, trust). This task includes:

- Find the most commonly used words from the collected tweets for each project. This will give an overall picture of what the stakeholders are mostly concerned about.
- Perform sentiment analysis consists in classifying and plotting polarity works (“positive” and “negative” sentiments)

3.Literature Review

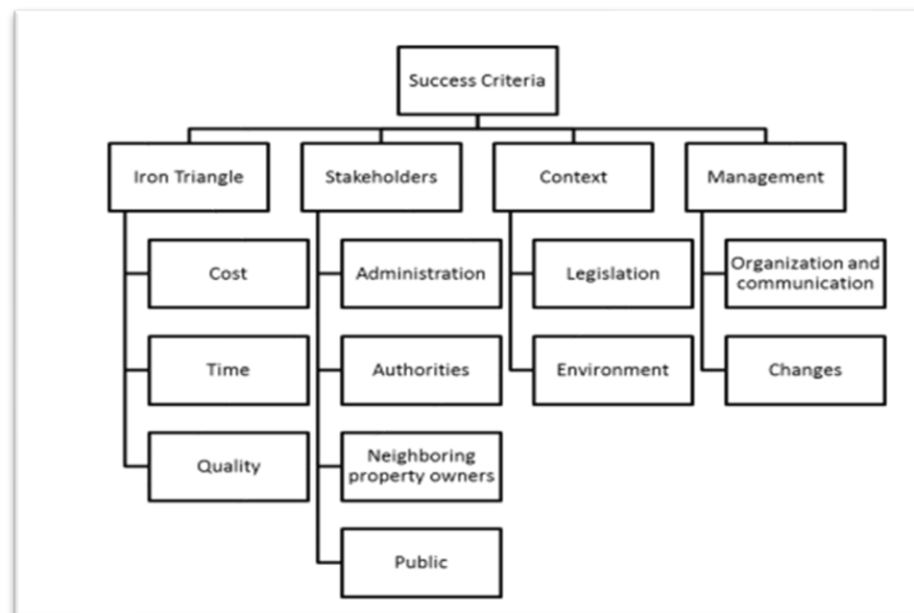
The remainder of this paper is structured as follows. An overview of project success and failure is given in Section 3.1, further emphasizing the role of the stakeholders on megaprojects. The importance of the stakeholder management and satisfaction is then presented in detail in Section 3.2. Subsequently, an introduction of sentiment analysis is presented in Section 3.3. Four case studies from various domains are showcased in Section 3.3.3 demonstrating the business applicability of this technology. Finally, the paper closes with a short conclusion of its contents and some proposals for future work.

3.1. General information on project success and failure

3.1.1. Project success – A human factor

Project success is defined as the ability of the project manager not only to comply with the “iron triangle”, but also with emphasis on the people’s side by meeting the stakeholders’ objectives (Mazur et al, 2014). Westerveld, E. (2003) mentions that judgement is majorly made by a variety of stakeholders. A project is, therefore,

considered a successful endeavor when all the stakeholders perceive their needs as satisfied. Having competent project managers, teams, managers, and an adequate organization structure in combination with a highly use of project management methodologies, tools and techniques can increase the project management success; as a result of it, enabling project success (Radujković & Sjekavicab, 2017). For instance, Prostějovská & Tománková (2017) present 4 project success criteria as shown in figure 1. for construction projects where stakeholders group criteria (administration, authorities, neighboring, property owners and public) influenced more than 50% of the projects studied. Regardless of the size of the project and apart from the basic constraints, stakeholder groups are significant factors that can influence the initiation, execution, and the successful completion of construction projects.



*Figure 2. Project success criteria in construction project
Source: (Prostějovská & Tománková, 2017, p. 5)*

3.1.2. Project failure – Diversity of interest and expectations

Insights gathered from 150 contractors and managers in construction projects undertaken in Malaysia, Gomarn & Pongpeng (2018) found six main factors that influence the failure of the projects including time overruns, cost overruns, disputes, arbitration, litigation, and total abandonment. In addition, they suggested considering a new measure of performance indicator on large construction projects, such as satisfaction of stakeholders due to the impossibility of the traditional performance

indicators (on-time, under-budget, and according to specifications) for measuring project performance. Sutterfield et al., (2006) highlight that many projects experience cost overruns and fail, as it is the case of lighter amphibian heavy-lift (LAMP-H) project performed within the Department of Defense – DOD due to the ineffectiveness at identifying and managing the hidden and conflicting agendas of project stakeholders early in the project management process. The Project Stakeholder Management (PSM) strategy framework suggests that project managers elicit project stakeholder feedback on a continuous basis to minimize the potential conflicts while capitalizing on the strengths of the project team and the opportunities brought by the stakeholders. In the context of megaprojects, risk management is subject to great attention because of the higher number of stakeholders involved, translating that into a larger number of interests and expectations that need to be fulfilled, increasing the complexity of the project. Megaproject failure is linked to public stakeholder resistance due to cultural or political interest (Sanchez-Cazorla, 2016).

3.2. Stakeholders and their roles on project performance

3.2.1. Stakeholder management

Managing individuals or groups has been identified as one of the major tasks within the project management activities. The main objective of doing project stakeholder analysis is to increase the possibilities to foresee and tackle problems and opportunities related to the project by the project team in a timely manner and thereby increasing the likelihood for project success by creating value from the stakeholders' perception (Eskerod et al,2015). For example, the integration of sustainability and stakeholders' concerns into key strategic processes has emerged as one of the most powerful indicators of organizational performance (Sloan, P., 2009). The organization's strategic success relies on the stakeholders' active participation. To this end, the context of environmental sustainability has been pointed out as fundamental to promote the stakeholder involvement (Waligo et al, 2014).

Moreover, some studies have observed and concluded the existence of a direct link between the stakeholder relationship and a successful project outcome. Bourne & Walker (2008) propose the development of The Stakeholder Circle tool in which the

project success and failure are directly related to stakeholders' perceptions of the value created by the project and the nature of their relationship with the project team. The methodology implemented by this tool provides a way for evaluating the influence of the stakeholders in a project, understanding their expectations, and defining the right mechanism of engagement to handle project key participants' expectations and perceptions for the sake of the project.

3.2.2. Stakeholder engagement

Stakeholder engagement has become an intrinsic part of the organizational strategy contributing to the sustainability of the corporation. Organizations that lean from their stakeholders, as social sources of opportunities, can attain benefits from them. A fundamental question concerns that stakeholder engagement is by seizing opportunities and managing risk – threats. Organizations that monitor and assess corporate responsibility and sustainability place more emphasis on stakeholder engagement processes. Hypothetically speaking, the more organizations interact with their stakeholders, the better organizations will understand their concerns and interests (Sloan, 2009; Stocker et al, 2020).

Waligo et al (2014) underline the importance of the decision-making process, as an interactive process, which is the result of the engagement between the organization and the stakeholders. This interactive and joint process has been distinguished as an effective mechanism for problem or conflict solving strategy, business performance and business opportunities through the establishment of trust. Nevertheless, this collaboration, between organizations and stakeholders, is perceived as a complicated alliance due to, firstly, the multiple and diverse stakeholders who often hold multiple viewpoints. Consequently, an effective management of stakeholders' involvement is indispensable. Waligo et al, (2014) recognized two forces that have significantly influenced the stakeholder involvement: leadership quality and stakeholder involvement capacity as shown in Figure 2.

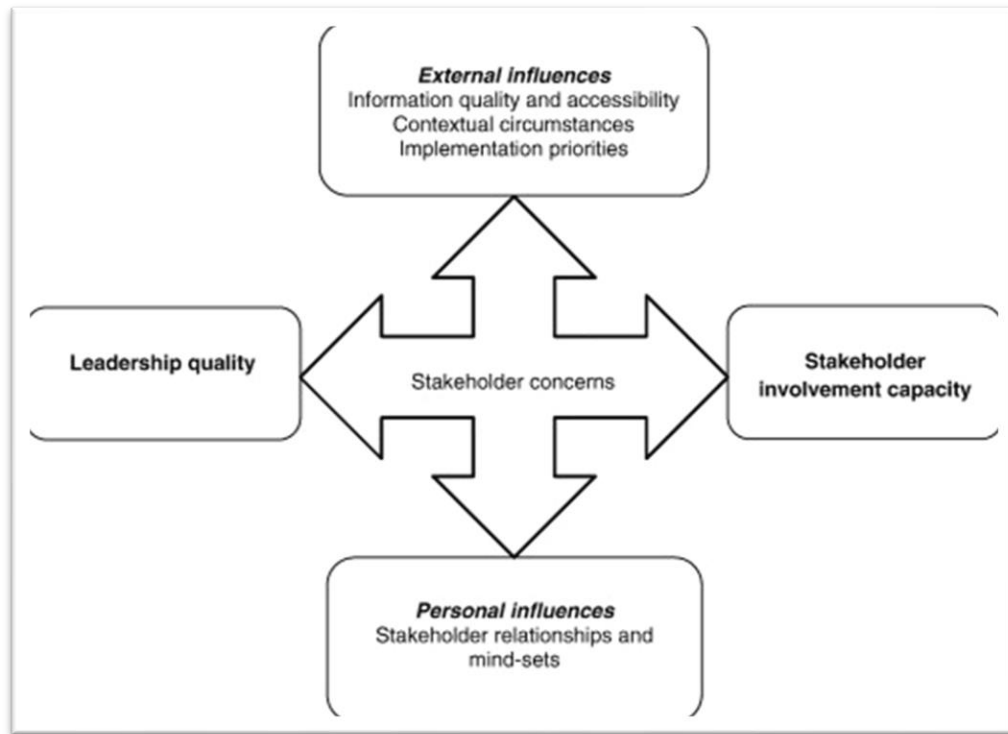


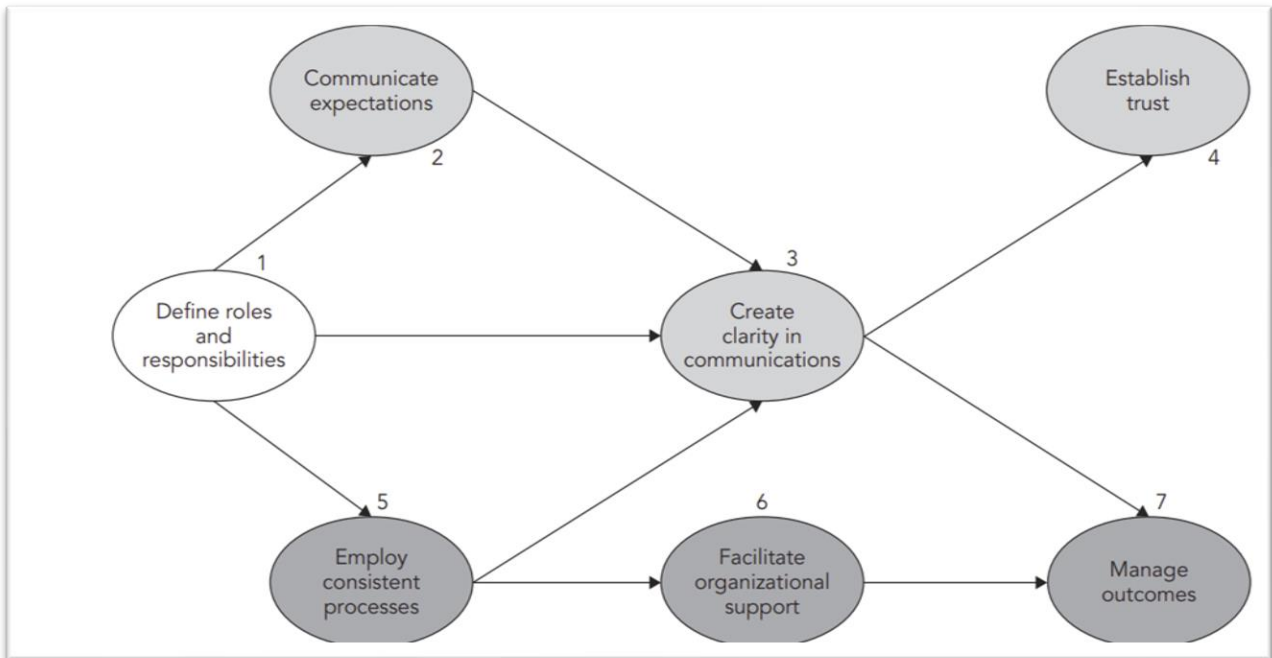
Figure 3. The Leadership–Stakeholder Involvement Capacity (LSIC) nexus
Source: (Waligo et al, 2014, p. 6)

Within the context of infrastructure construction projects, paying less attention to stakeholders is a reason for the project failure. Therefore, strengthening an effective and interactive communication enhances the stakeholder involvement and leadership. Effective communication results in a better development of the stakeholder engagement and trust which in return enhances the decision-making process. On the other hand, lack of effective communication strikes the stakeholder's engagement contributing to an unsupportive project environment (Butt et al 2016).

3.2.3. Project manager competencies – Managing emotions.

Since project management has globally been recognized as a profession, a variety of skills and behaviours has been identified as required of project managers across different industry types (Sutherland et al,2020). In addition to technical competencies, developing soft skills is part of the core competences to reach effectiveness; consequently, project managers depend on their abilities to understand people to succeed (Ibid). Thus, project managers need to make proof of great empathy which facilitates the understanding of others' emotions. Consequently, managing stakeholders'

emotions (joy or grief) improve the decision-making process toward the desired outcome (Leandro et al., 2009; G C Maheshwari et al., 2004). Communication is one of the most challenging and required competencies that promotes a better decision-making process by establishing an environment of collaboration and trust (Figure 3.) (Anantatmula 2008).



*Figure 4. Project manager performances model
Source: (Anantatmula 2008, p. 42)*

3.2.4. Project manager competencies – Use of technology.

The use of technological tools is a key component of project management activities in assisting project managers to create formal communication channels with other project participants, promote learning capacities, knowledge sharing, improvement of productivity and decision-making process along with establishing positive sentiment among the project stakeholders (Ibid). The authors, also, consider that project managers of the future will need the skills to build trust to successfully collaborate.

On the other hand, organizations have been using social media like Facebook and Twitter as communication strategy which has increased the stakeholder engagement (Ponte et al., 2015). Project managers could benefit from social media use in documenting decisions, managing communication, reporting project progress and outcomes, engaging project participants. Social media enables project managers to

connect with diverse project stakeholders improving productivity. For instance, government projects are generally complex due to the engagement of numerous participants which represent a major risk to the project success. Therefore, policymaking has become the bridge between governments and citizens enhancing communication and collaboration through the analysis of social media content and the monitoring of social opinions and emotions (Arash et al., 2020).

Despite the variety of opportunities and benefits that social media could bring to the project management area, there are some concerns regarding its effective utilization and potential threats (i.e., negative emotions) that could negatively impact the success of the project (Arash et al., 2020).

3.3. Sentiment analysis

3.3.1. Microblogs – Social media a descendent of blogs

With the advent of Web 2.0, it has been much easier for both users and consumers to publish any type of information (Martinez et al., 2014). Microblog sentiment analysis has recently become a demanding topic of research. The name of “microblog” originated due to 140-character limitation per post. Microblogs appeared around 2006 descending from blogs and have grown up exponentially exerting a powerful influence as social media since then. One of the most famous and largest microblogs is Twitter, having over 288 million users and generating more than 55 billion posts per day, based on a report at the end of April 2015. Microblogs’ major characteristics can be summarized as follows:

- Shorted length messages which are easier to produce and consume.
- Highly accessible from different devices.
- Users can share their opinions at any moment.
- Following-follower model which promotes faster message diffusion.

Microblogs have turned into a great source of gathering and understanding customers' opinions and emotions in real time on products/services provided by any kind of businesses because of the tremendous number of posts that are produced every second. Microblogging sites such as Twitter have become the preferred places where individuals state their opinions. (Li & Li, 2013; Akcura et al., 2018).

3.3.2. Microblogs - Twitter overview

The initial idea behind Twitter was to share users' daily activities. However, over time, it has converted into a powerful tool for disseminating powerful information. The first publication in the Twitter service happened on 16 July 2006, and since then its popularity has grown in such way that it is even being subject of study in various fields of science. Twitter has become one of the most popular platforms in the world having in average eleven million of comments per day. The great advantage of Twitter is its limited size of the messages which makes the information shared by the users to be more relevant. The real success of Twitter is due to the fact of having become an emerging and powerful communication tool not only for business, but also for political purposes where politician have been able to reach as many voters as possible. Twitter now represents a real time, large and valuable source of information that should be studied carefully and deeply. For instance, applying a variety of Natural Language Processing (NLP) techniques for opinions analysis, information retrieval, data mining, prediction opens up an excellent opportunity to analyse people's interests, engagement and satisfaction regarding a product or service (Martinez et al., 2014).

3.3.3. Sentiment Analysis - General context

The exponential growth and the rapid adoption of social media have brought a new paradigm in the manner how consumers communicate with organizations. Nowadays, people participate more freely and openly on the web, resulting in a high volume of information, which can transform into valuable knowledge, available online. This situation has created the opportunity for a new field of study known as sentiment analysis (SA) (Kazmaier, 2020).

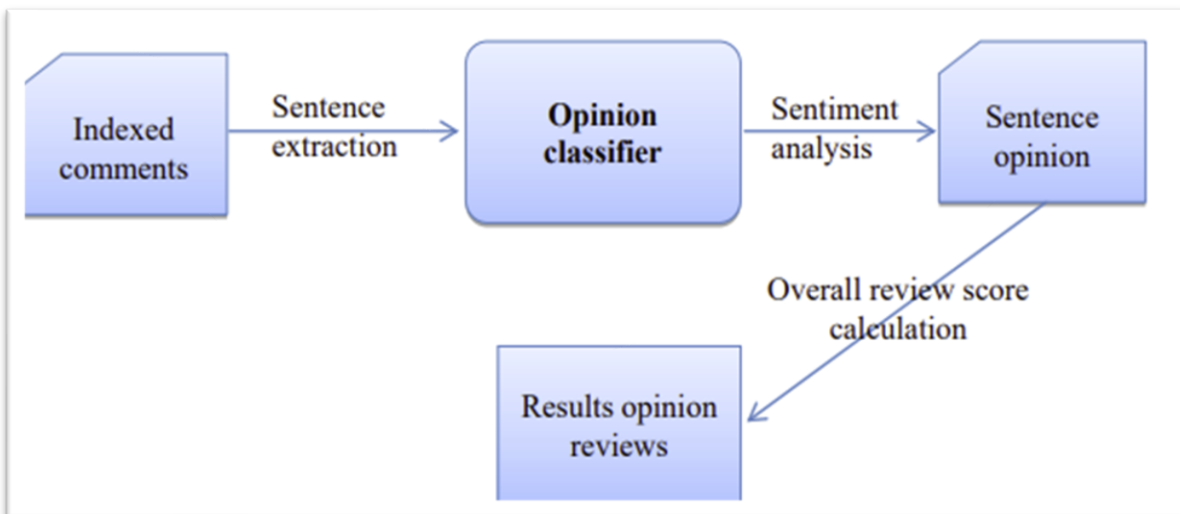
Sentiment Analysis has enjoyed a lot of research attention over the last years, especially in topics such as classifying sentences as positive, negative, or neutral; and more recently, detecting the target of the sentiment. Much of this work focused on customer reviews of products and services, but tweets and other social media data are now increasingly being explored making the application of sentiment analysis research to grow in different industries. Later, with the development of social media, sentiment analysis in Twitter became a very eminent research topic. Yet, there was a lack of

suitable datasets for training, evaluating, and comparing different systems (Nakov et al., 2016).

Sentiment Analysis (SA), that belongs to the Natural Language Processing (NLP) field, is a process which consists in extracting and classifying people's feelings and emotions. Sentiment analysis deals with detecting polarity of the text mostly from social networks; specifically, whether a text represents a positive, negative, or neutral opinion converting this into a powerful source of new opportunities, monitor and manage reputation (Devika et al., 2016; Olivera & Zita, 2018; Shu, 2014).

The sentiment analysis of a text could be summarized in 4 steps (Ion et al., 2012) as shown in figure 4:

- Data collection and preprocessing: gather of datasets and elimination of “noise” – irrelevant opinion.
- Classification: polarity is identified.
- Aggregation
- Presentation of results: textual or graphical presentation of results.



*Figure 5. The overall opinion mining process
Source: (Ion et al., 2012, p. 84)*

The measurement of people's emotions is quite a complicated task due to the non-standard or the lack of formalism regarding people's expression in social media. Additionally, the evaluation of users' opinion is very challenging because of the texts' limitation (i.e., in Twitter) as well as the informal writing that can contain grammar and mis-spelling issues. Yet, Sentiment Analysis is composed of two applications: opinion

mining and affective analysis. Opinion mining focuses more on mining opinions that are classified mostly as positive, negative, and occasionally as neutral while affective analysis concerns people's emotions such as anger, happiness, and disagreements. This classification of opinion based on emotions is also known as polarity (Chatzakou & Vakali, 2015; Junior et al., 2021).

3.3.4. Sentiment Analysis - Tasks

With an adequate analysis of the online content that users generate and especially by analyzing the emotions hidden in it, companies can acquire critical information for improving their business. In overall, the sentiment analysis consists of three major tasks (Olivera & Zita, 2018; Nakov et al., 2016):

1. **Creating resources for sentiment analysis:** at this stage, pre-processed training is required. Raw text data which is collected from social media (i.e., Twitter) platform is cleaned. The tweets that express sentiment about popular topics is gathered using the Twitter API. Then, messages that contain no sentiment-bearing words are removed. The pre-processing also includes sub-steps such as tokenization, stemming, lemmatization, stop-word removal and tagging, most processes also apply some kind of Twitter-specific processing such as substitution/removal of URLs, substitution of emoticons, spelling correction, word normalization, abbreviation lookup, and punctuation removal.
2. **Classification of text according to the polarity of the expressed opinion:** first is to determine the sentiment (positive, negative, or neutral) towards an event instance, while the second one requires to identify both event instantiations and their associated polarity values.
3. **Application of sentiment analysis:** this task can be a stand-alone task, combined with other tasks of natural language processing (summing up opinions, finding opinions, etc.), or a part of a complex application (for example, ranking the product according to the expressed opinion of users in intelligent recommendations or trend detection systems).

3.3.5. Sentiment Analysis - Methods and techniques.

In Figure 6, (Olivera & Zita, 2018) shows the most popular used techniques of classification for sentiment analysis. Machine learning techniques are divided into supervised and unsupervised learning. Supervised learning methods require a large amount of preprocessed (tagged) training data, while unsupervised learning methods do not impose such a requirement. It may be easier to collect a large data source from websites; however, it is difficult to prepare labeled documents that contain explicitly positive and negative comments. For this reason, it is more common to implement unsupervised learning methods which are based on sentiment words or lexicons.

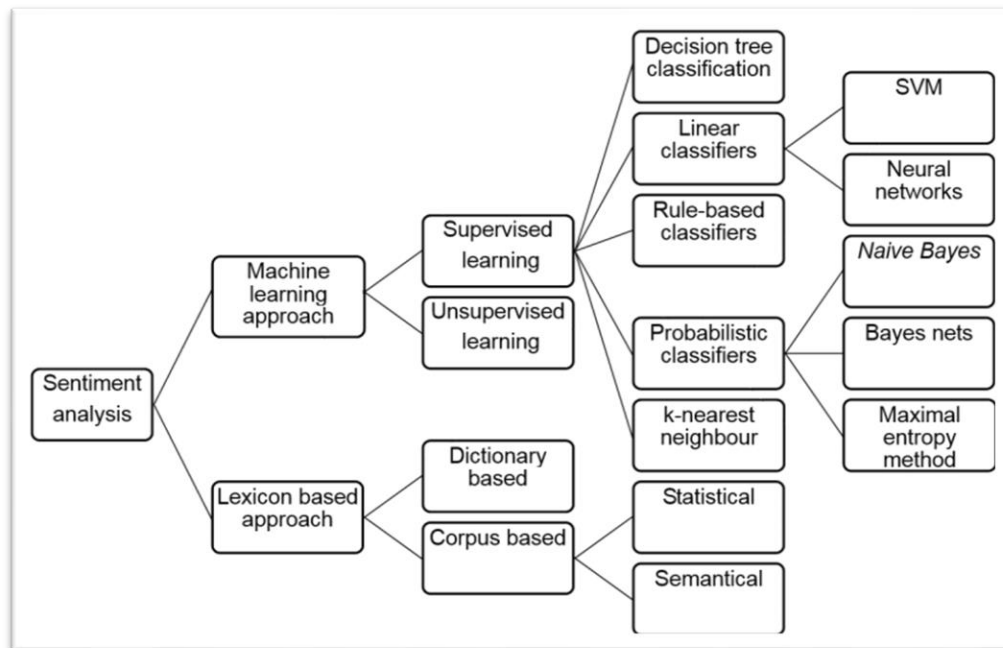


Figure 6. Sentiment classification techniques
Source: (Olivera & Zita., 2018, p. 42)

The categorization model, used on Supervised learning, is created during the learning phase, on representative sets of training texts focused on the topics of interest. The Bayesian method is used as the learning method: the probabilistic classification model is normally built on around 100 documents for each thematic category. Contrary, documents in unsupervised learning are represented by a sparse matrix, where the text is normalized to give more weight to uncommon terms. Similarity is measured by a implementing some mathematical calculation between document vectors, while

clustering is based on the K-Means algorithm, which is a robust algorithm for Web Mining interactive applications (T. By et al, 2012)

On the other hand, Lexicon based approaches use a sentiment dictionary of to recognize sentiment words in texts. There is three mechanisms of gathering and making a sentiment lexicon:

1. Manual access based which requires a lot work and time-consuming
2. Dictionary based which compares words within the collected texts with a dictionary of sentiment words.
3. Corpus based which compares a list of sentiment words related to a specific domain that is concerned of analysis.

Most of the study on sentiment analysis has focused on text written in English and consequently most of the resources developed, such as lexicons with sentiment labels, are in English. Some unsupervised learning approaches depend on the creation of a sentiment lexicon in an unsupervised way that is used to determine the degree of sentiment polarity of a text. The important aspect is, therefore, the creation of the lexicon via the unsupervised labelling of words or phrases with their sentiment (Cambria E. & Hussain A. 2012).

3.3.6. Sentiment analysis - Applications

3.3.6.1. Application Case 1: Monitor electoral campaigns.

This application case of sentimental analysis was based on the literature presented by Ceron et al (2014) in which the authors presented two empirical real cases using social media to compute citizen preferences during elections. Twitter as a social network has brought the possibility of utilizing the web as a data source to monitor people's political and electoral preference during political campaigns. Moreover, social media has been seen as a complement to the traditional mechanism of gathering citizens' political preference data collected by off-line polls. Some researchers have presented evidence of reliable forecasting or predictions of final results. For instance, some sentiment analysis has shown correlations between Obama's approval rate and the sentiment expressed by the number of followers or "likes" or tweets. The 2012 U.S. Presidential election was the first political environment in which sentiment analysis was

successfully applied. Twitter users were monitored regarding their voting intentions toward the four main candidates: Obama, Romney, Johnson, and Stein from September 28 to November 6 as summarized in Figure 5.

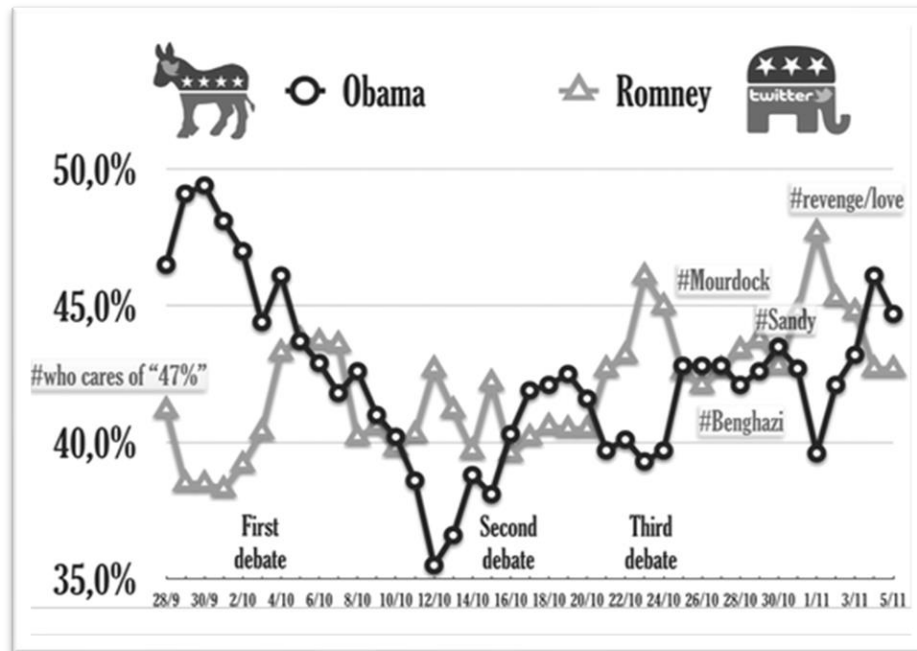


Figure 7. U.S. Presidential 2012: The trend of Twitter votes for Obama and Romney
Source: Source: (Ceron et al, 2014, p. 9)

Similarly, sentiment analysis on social media came with better estimations, compared to traditional polls, predicting the results of the 2010 U.K. Elections. It is interesting to mention that data collected and analysed from Twitter revealed the actual sentiment of people during the electoral campaign which was afterwards confirmed by traditional survey pools. Then, conclusions drew that sentiment analysis and survey polls predicted the same winner.

In a similar fashion with the American case, the sentiment analysis was performed to the primary elections in Italy from October 25 to November 25, 2012. Around 500,000 tweets were collected during different points in time to evaluate the people's voting preferences towards the five candidates: Bersani, Renzi, Vendola, Puppato, and Tabacci, as shown in figure 6.

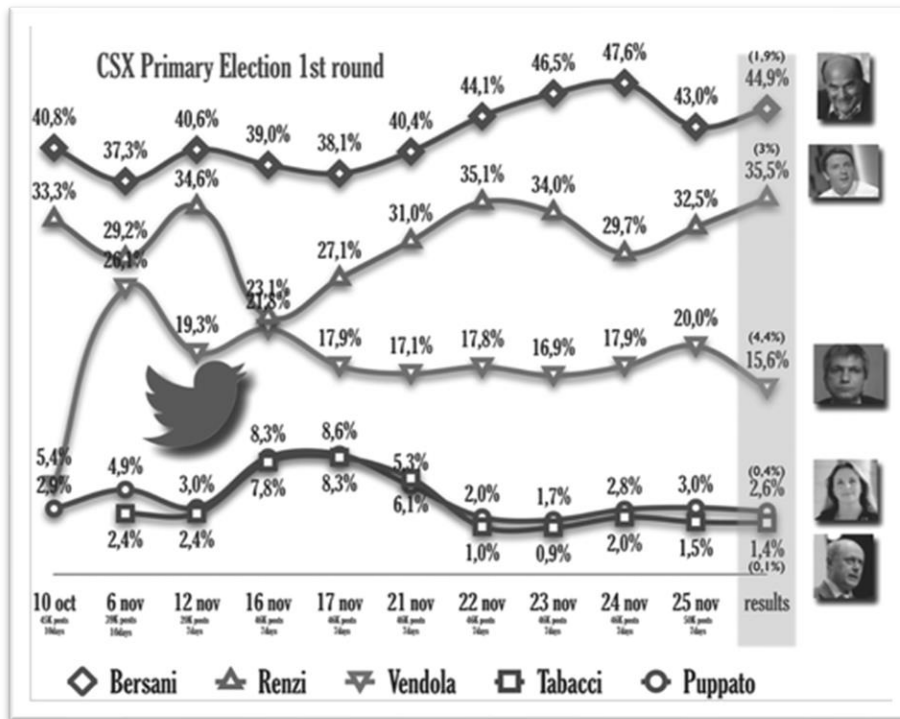


Figure 8. Candidates share votes according to Twitter forecasts. Comparison with actual results

Source: (Ceron et al, 2014, p. 12)

The results of the sentiment analysis on Twitter users for the Italy election show similar trends compared to several traditional polls. Actually, the gap between estimates, using sentiment analysis, and the results is very tight being on average 2%. The conclusion drawn from these cases is that electoral campaigns can be forecasted analyzing social media data using sentiment analysis with excellent outstanding outcomes.

3.3.6.2. Application Case 2: SEMO – an experimental framework for customer social networks analysis.

With this case study, Garcia-Crespo et al. (2010) present a promising use of sentiment analysis in the context of Customer Relationship Management (CRM) applications. Creating a long-term relationship with customer's implies understanding and satisfying their needs which is key to a business' success or failure. Therefore, CRM applications play a determining role in acquiring and retaining profitable customers. For this reason, CRM systems are focusing on the use of social networks as a channel of communication within the clients. The intention of the SEMO framework is

to extract customers' emotions from social networks to maximize satisfaction. Customers' emotions data is collected from the open social network dataset (OSND) by using the OpenSocial which is an application programming interface (API) developed by Google to build social applications across the Web. OSND is, essentially, focused on "opinions" related to products. The role of the sentiment analysis within the framework is to relate the information contained in the OSND to the Customer Emotion Ontology (CEO) terms as presented in figure 7.

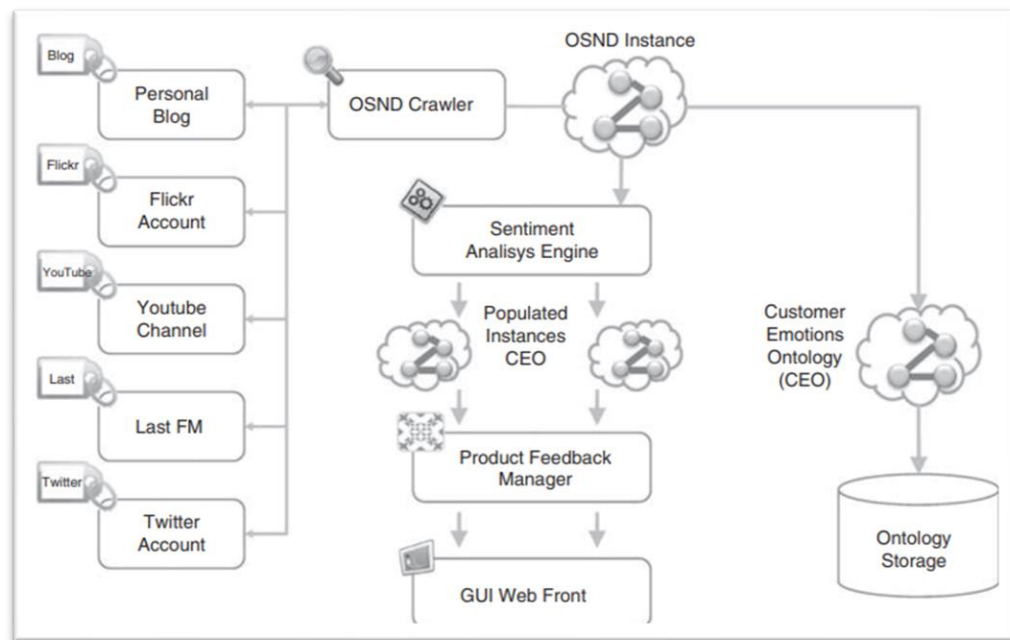


Figure 9. SEMO system architecture
Source: (Garcia-Crespo, 2010, p. 183)

The empirical test of SEMO has concluded with promising results by identifying basic emotions from social networks, such as: happiness, pleasing, optimism, contentedness, frustration, anger, and so forth. Considering this case study, the application of sentiment analysis on CRM systems is promising a great future to the marketing domain.

3.3.6.3. Application Case 3: Twitter for determining the emotional responses of people to urban green spaces.

This application case of sentimental analysis was based on the literature presented by Roberts et al (2019) in which the authors presented the outcomes of a polarity study on social media computing citizen's emotions for 60 urban projects in Birmingham. For

this case of study, sentiment analysis was conducted on 10,000 tweets to assess the polarity (positivity/negativity) of users' Twitter over a 12-month period. After conducting the sentiment analysis on the collected data, the findings assigned 68.4% to the neutral category, 24.6% and 7% to the positive and negative groups, respectively. For instance, the feeling of happiness, as the main response, was present in the highest frequencies on the results which was aligned with previous off-line studies. For example, happiness was linked to activities and events taking place in the parks. In general, the positive and negative emotions were mainly associated with events happening within the green space. It was concluded that emotional information gathered through Twitter dataset could be applied as a monitoring tool for events occurring in green areas as shown in picture 8.

Theme/cause of positivity	Associated emotion
Socialising and enjoying time with friends	Love/Happiness
Enjoyment of nature and the landscape	Beauty/Happiness/Calmnes
Enjoyment of a music event	Happiness/Love/Surprise
Enjoyment of a sports event or exercise	Happiness/Love/Calmness

Figure 10. Themes causing a positive response
Source: (Roberts et al, 2019, p. 829)

3.3.6.4. Application Case 4: Large hydro projects

Jiang et al. (2016) recognize the complexity of construction types of project due to the implication of many stakeholders who have different agendas. Additionally, this study case is presented as a solution to the inconveniences from questionnaire-based surveys for large construction projects. Sentiment analysis was applied to monitor public concerns and participation making improvements in the decision-making process. For this reason, public opinion has become a key component to monitor during the execution of a project that has a big impact in society. For this case study, a sentiment analysis (PSA) was proposed with the main objective to collect and process online citizen's opinion particularly for hydro projects. The implementation of PSA would benefit mostly from the reliability of the collected data on Twitter, Weibo, or other social media platforms. The PSA system proposed in this case is the first attempt to use

sentiment analysis as part of the project management activities. Figure 9 summarizes the steps conducted by the PSA system to run sentiment analysis on hydro projects.

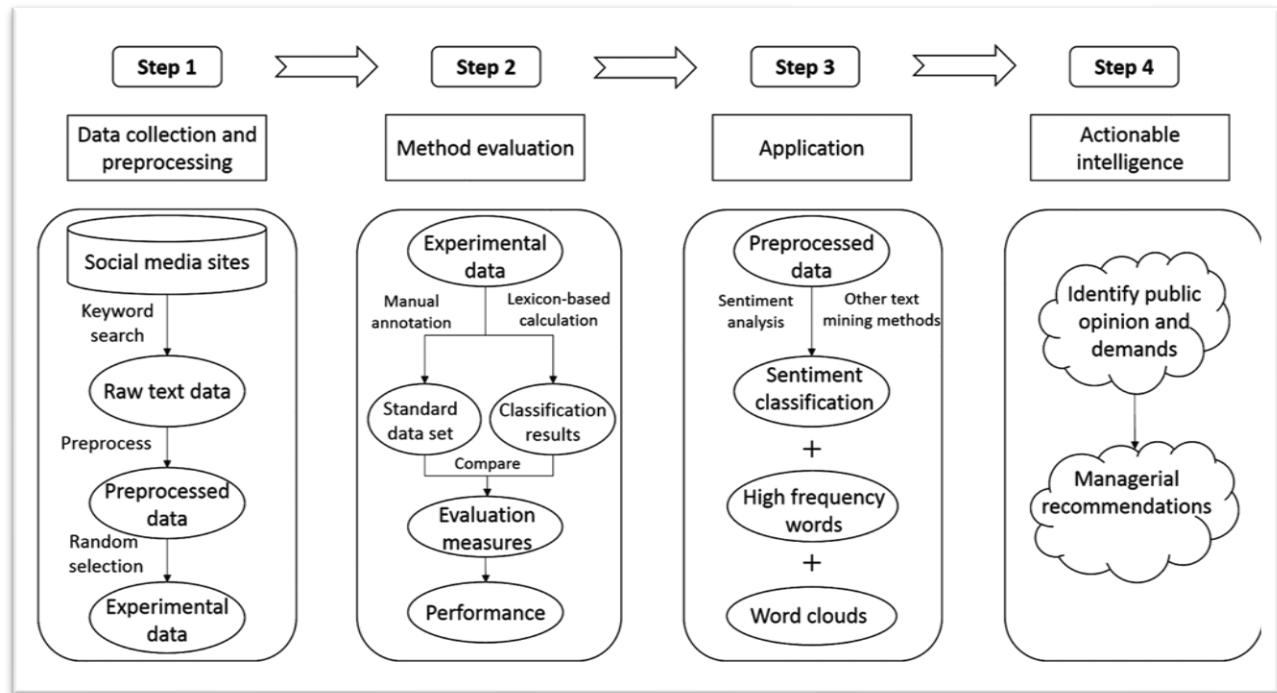


Figure 11. PSA system architecture
Source: (Jiang et al. 2016, p. 3)

The PSA system was applied on The Three Gorges projects (TGP) demonstrating effective and accurate outcomes. The results drawn from this study show that 47.7% of messages represent negative sentiments and the 52.3% is divided between neutral and positive opinions. One of the major blockers during this study is related to the Chinese culture where people are reluctant to express their opinions freely since public projects are developed by the government. Additionally, this study reveals that the project management team needs to develop the capability to manage data in the new context of opinion mining. It was also concluded that using the PSA system could be a tool for project teams to monitor people's emotions published in social media concerning infrastructure projects.

4. Empirical Application

In this section, a high level overview of the process implemented to collect and classify sentiment of citizen regarding the projects in study is described. Then, the

analysis of four large Canadian projects is presented. For each project, the particular features are described and compared to non empirical results. Next, the challenges encountered during the implementation of the algorithms will be also presented.

4.1. Approach and process

The sentiment analysis process to collect and visualize data from Twitter was implement in R. Lexicon based approach was the technique applied where the sentiment of texts is considered the text as a combination of individual words as shown in Figure 12. The process implemented as the empirical part of the research consists in, first the existing tweets are downloaded via Twitter API by using keywords (i.e., #PhoenixPaySystem). The collected data is stored in RDS files for each project to avoid re-running the algorithm every time to reduce the duplication of data. Then, a series of sub-tasks are executed to clean the data sets by removing noisy characters, duplicate data, sarcasm, French and English stops words.

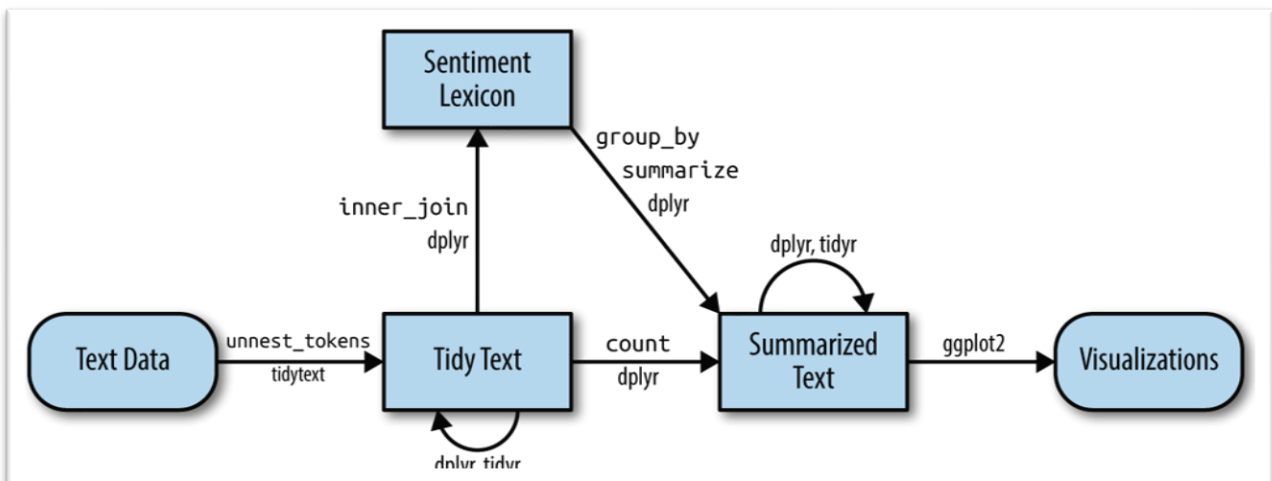


Figure 12. implement sentiment analysis using tidy data principles

Source: (Silge & Robinson, 2017, p. 13)

Next, the three general-purpose (AFINN, Bing, NRC) lexicons are applied which are based on unigrams or single words. The AFINN lexicon assigns words with a score that goes between -5 and 5 where negative scores correspond to negative sentiments and positive values mean positive sentiment. Bing lexicon classifies words into negative and positive categories. The NRC lexicon classifies words as Yes/No into categories of positive, negative, anger, anticipation, disgust, fear, joy, sadness, surprise, and trust (Silge & Robinson 2017).

4.2. Overview of the projects

In the Table 1 shows an overview of the different projects selected for the empirical studies. Phoenix Pay System was a software development project conducted by the Federal Government along with IBM as contractor, O-Train represents a large transport system in Ottawa that is currently implemented the phase II of the project. Tramway of Quebec City is also a large transport initiative that is currently at the early phase of adequation. REM is a major transport project leading by Montreal City to connect Montreal to the suburbs areas.

Project	Status	Started year	Budget	Tweets analyzed
Phoenix	Closed	2009	Original budget was \$309 million. Extra cost of \$905 million	263
O-Train	Phase I – Closed. Delayed for 2 years	2013	\$2.1 billion	470
	Phase II – In progress	2019	\$3 billion	
Tramway of Quebec	In progress	2018	Environ \$2.2 billion	633
REM	In progress	2020	\$7.5 billion	923

Table 1. Four projects selected for the empirical study – Overview

4.2.1. Phoenix – public service pay system

In 2009, the Government of Canada started an initiative to replace the 40-year-old system it used to pay 290,000 employees in 101 departments and agencies. This Transformation of Pay Administration Initiative would also centralize pay services for nearly half of the departments and agencies, which had previously processed pay for their own employees. The initiative's goal was to decrease the costs of and improve the efficiency of processing the government's payroll, which is about \$22 billion a year. (Assistant Auditor General of Canada, 2018)

4.2.2. O-Train -Ottawa trainway system

The O-Train Confederation Line transit project is Ottawa's largest single infrastructure project since the building of the Rideau Canal. This project – which replaces existing diesel-powered buses with electric light rail trains – is the first stage in the City's future rail network. It runs 12.5 kilometers from Blair Station in the east to Tunney's Pasture in the west, with a 2.5-kilometre underground tunnel through the downtown. In total, there will be 13 stations on the line, and this project also includes a state-of-the-art maintenance and storage facility at Belfast Yard (O-Train Confederation Line | City of Ottawa, n.d.).

4.2.3. City of Quebec tramway

The City of Quebec has been concerned about the mobility issues in the territory since 2009. After several consultations with citizens, the public transport network (RSTC) project now appears to be the solution to meet current and future mobility challenges. Planned to be ready for 2026, the RSTC will promote better traffic flow and ensure harmonious cohabitation for all users whether motorists, transporters, cyclists or pedestrians. Also, the city's landscape will be transformed and the quality of life of citizens will be improved (Les grandes étapes Tramway, n.d.).

4.2.4. REM – Réseau Express de Montréal.

The Réseau Express Métropolitain (REM) is a new automated light rail network. It will include 26 stations and span the greater Montréal area with 67 km of tracks—by comparison, the current metro network is 71 km long. The REM is the largest public transit project undertaken in Québec in the last fifty years. The first trains are expected to start running in 2022 from the South Shore to Bonaventure-Central Station. Then, the other branches of the network will be gradually put into service in 2023-2024 (Presentation of the REM project, n.d.).

4.3. Sentiment analysis – polarity results

4.3.1. Phoenix Pay System

The major challenge analyzing the tweet data for this project concerns with the fact that the project was already delivered when the first tweet was posted. Consequently, the results obtained from sentiment analysis reflects mostly the public servant

employees' satisfaction with the outcomes of project. Bing was the first approach applied that classified the words into positive and negative category. For example, the Figure 13. shows the results of the algorithms before eliminating “noise” in data set. The words sounded positive (green bars), but they actually represents, in some cases, sarcasm or words that was having more a negative meaning within the text. Yet, after the removal of these words from the analyzed data set, the algorithms detected only negative ratings as shown in Figure 14.

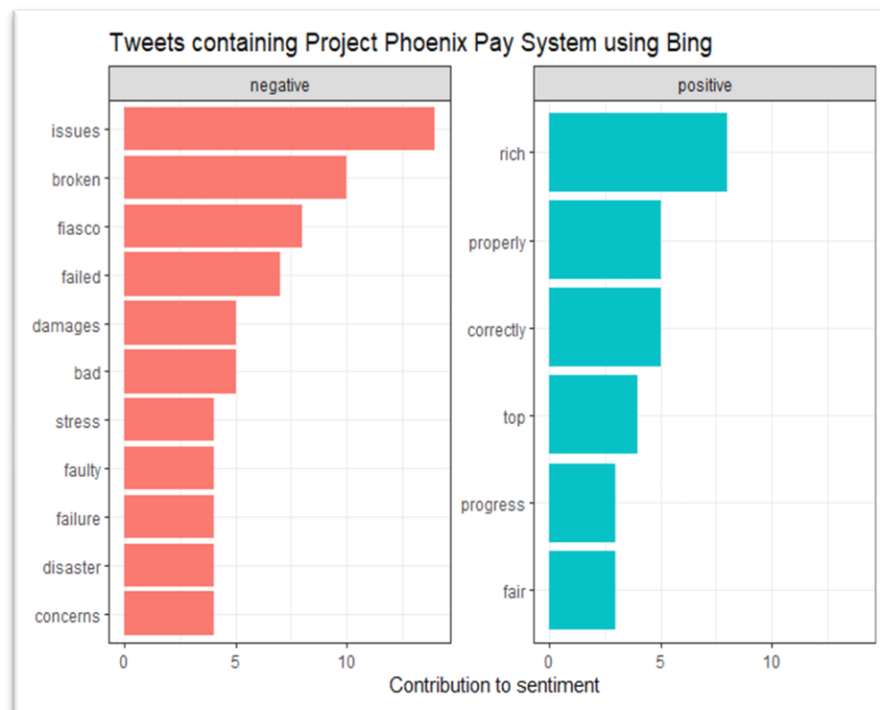


Figure 13. Results before applying noise reduction - Phoenix Pay System

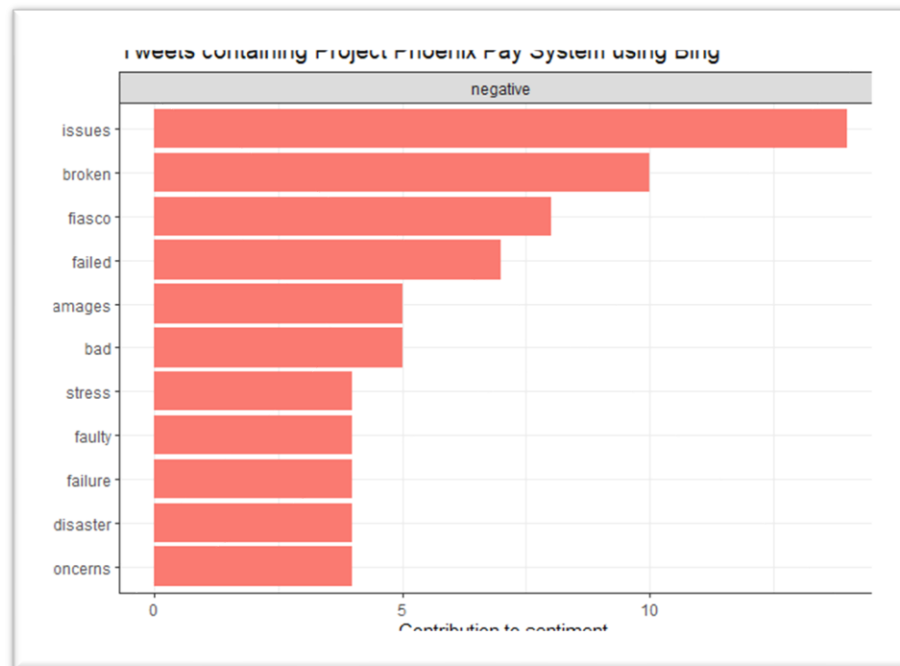


Figure 14. Results after applying noise reduction - Phoenix Pay System

In Figure 14 shows the employees' dissatisfaction with the project. Phoenix Pay System is an excellent example of project failure giving as result that over 200,000 federal public service workers have been impacted by the launch of this project according to the Public Service Alliance of Canada (Phoenix, 2018). This project represents a great illustration of how sentiment analysis could support or guide the project managers during the execution of the project to understand the stakeholders' opinion and engagement about the project and undertake the corresponding measures to avoid the failure.

The results obtained from the sentiment analysis algorithms matches the audit conducted by the Government of Canada. This audit has revealed that the Phoenix pay system is less efficient and less cost-effective than the old system, and thousands of employees have not been accurately paid or paid on time. In our fall 2017 audit of Phoenix pay problems, we found that the problems were having serious financial impacts on the federal government and its employees. In that audit, it was estimated that it will take many millions of dollars and years to fix the Phoenix pay problems. It is important that the government learn from the mistakes made in the Phoenix project to

properly manage future large information technology projects. (Assistant Auditor General of Canada, 2018).

Assistant Auditor General of Canada conducted surveys during the fall 2017 to audit Phoenix pay problems and understand the causes of the projects. It was a survey of pay staff in Miramichi as well as in the satellite centres, which were set up by Public Services and Procurement Canada to increase the Department's pay processing capacity. The survey's purpose was to understand the impact on pay advisors of pay problems after Phoenix was first implemented. 740 questionnaires and received responses from 480 employees, for a total response rate of approximately 65%.

The result from the questionnaires concluded that the Phoenix project was an incomprehensible failure of project management and oversight. Phoenix executives prioritized certain aspects, such as schedule and budget, over other critical ones, such as functionality and security. Phoenix executives did not understand the importance of warnings that the Miramichi Pay Centre, departments and agencies, and the new system were not ready. Similar conclusions could be obtained from running sentiment analysis as shown in Figure 15. This is an evidence that project managers could make use of sentiment analysis to measure stakeholders' opinions.

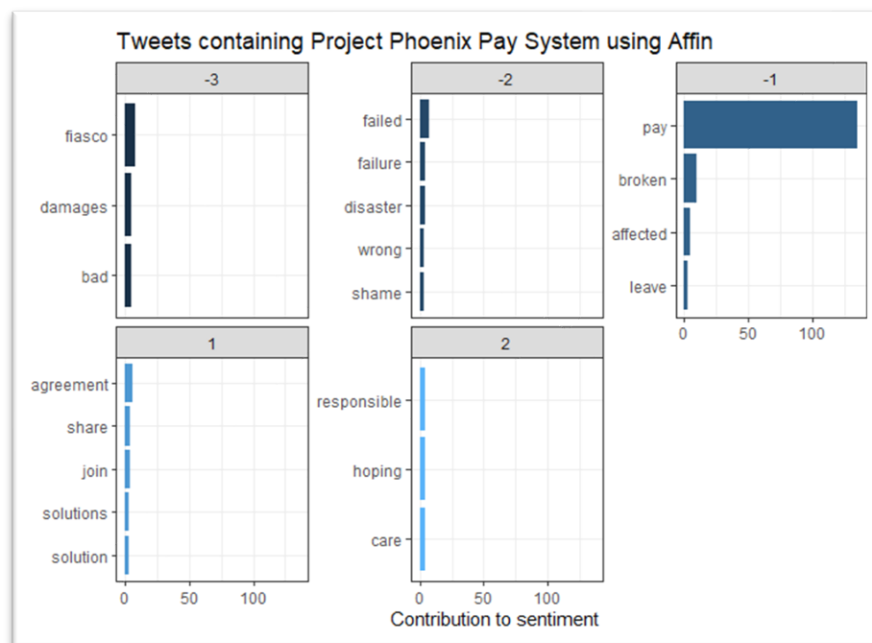


Figure 15. Results obtained from the AFINN approach – Phoenix Pay System

In (Assistant Auditor General of Canada, 2018) was mentioned that project managers did not provide complete and accurate information to deputy ministers and associate deputy ministers of departments and agencies, including the Deputy Minister of Public Services and Procurement, when briefing them on Phoenix readiness for implementation. The Figure 16. shows users' concerns about Phoenix project which is undoubtedly a representation of the conclusion drawn by Assistant Auditor General of Canada office: *"the decision by Phoenix executives to implement Phoenix was unreasonable according to the information available at the time. As a result, Phoenix has not met user needs, has cost the federal government hundreds of millions of dollars, and has financially affected tens of thousands of its employees"*.

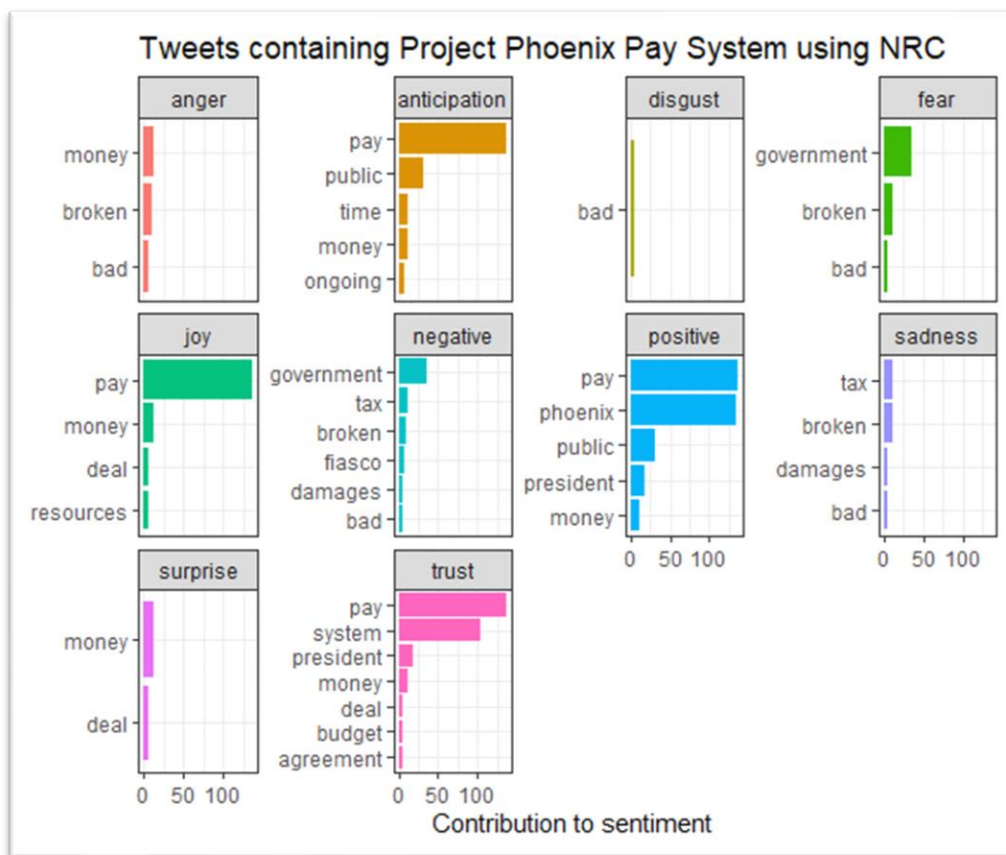


Figure 16. Results obtained from the NRC approach – Phoenix Pay System

4.3.2. O-Train – Ottawa train system

This project has two phases (one already implemented and the other one which is currently underway) which makes the results of the application of sentiment analysis an interesting measurement of the people's sentiments regarding this

project. The Figure 17. shows the results obtained from the first run of the algorithm. Some misclassifications were detected and corrected as shown in Figure 18. For example, the word patience had a positive rating, but it was actually in a more negative sense.

The results shows in Figure 17 and 18 of the Bing classification matched the experience during the execution of the phase I. Most citizen were expressing more negative sentiments than positive ones concerning the project. This was obviously as results of the 2 years delays of the project. Still, the sentiment analysis algorithm presented some optimism from Ottawa people.

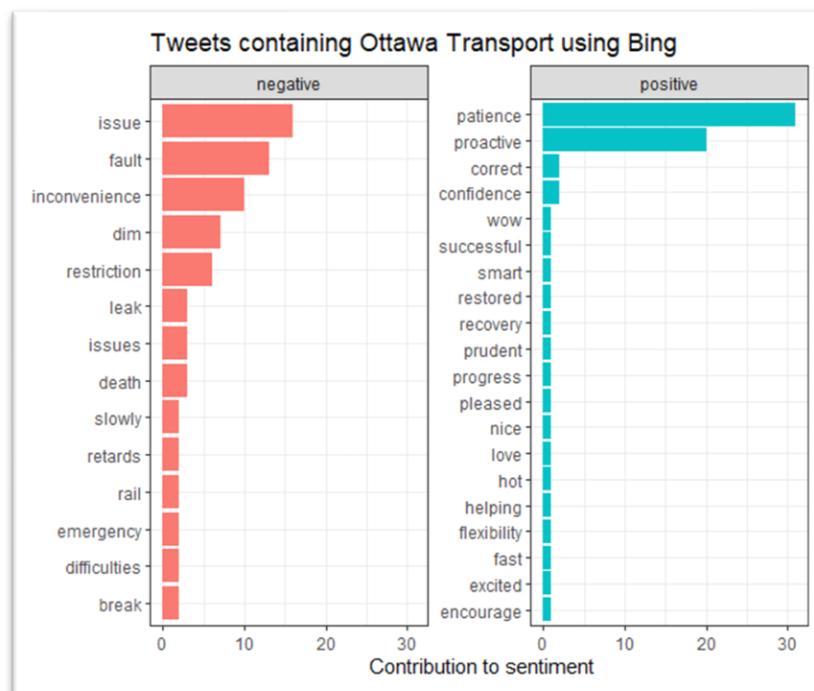


Figure 17. Figure 13. Results before applying noise reduction - OTrain.

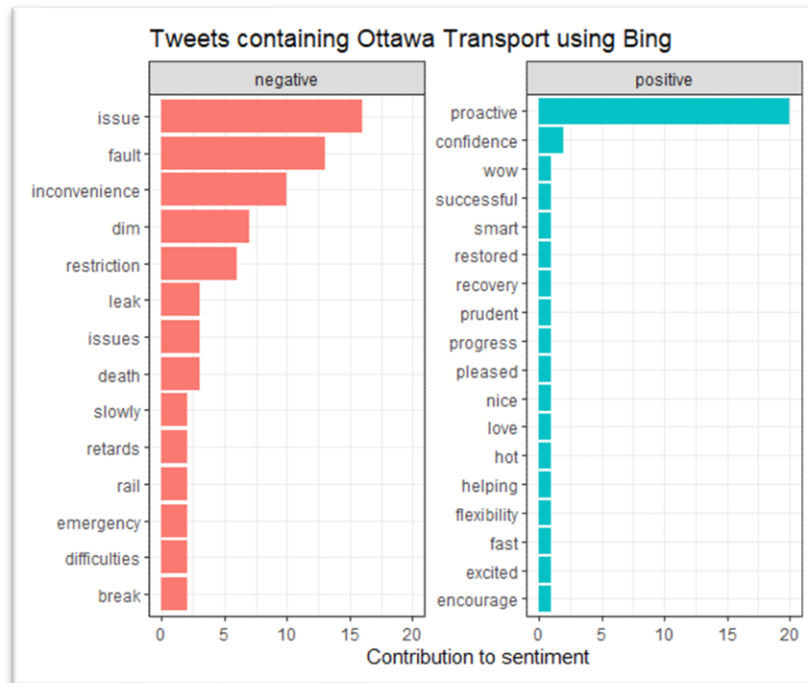


Figure 18. . Results after applying noise reduction -OTrain

For example, the word “Issue” has obtained a high rating due to the problems (interruptions) that the project encountered during the first days of being in service. The negative polarity detected by the sentiment analysis algorithms matched perfectly the situation of the project. Consequently, this is an evidence that the adoption of sentiment analysis approach can benefit the project to succeed.

In the Figure 19, it shows the sentiment classification using AFINN approach where negative polarity has a negative value while positive has a positive numerical value. It is evident that the classification obtained by AFINN approach reflects the people's sentiment regarding the service delivered by the project as reported by some News channels. For example, CBC news reported people's concerns: “not everyone can get away with getting to work late and telling your boss, '**Sorry**, it was the LRT.' I think it's really important we have a reliable transit system”. CTV News reported: “There were several issues that were experienced along the Confederation Line impacting customers across the system,” Manconi wrote. Around 4:20 p.m., an eastbound train experienced a fault near Rideau Station. Manconi says approximately 30 minutes later, the same train experienced another fault just outside Blair station.”

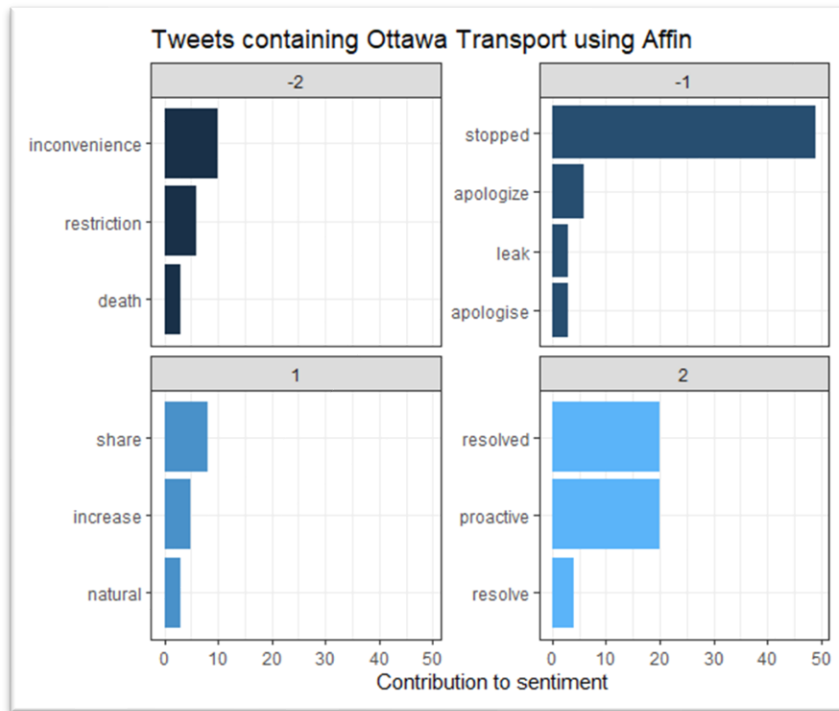


Figure 19. Results obtained from the AFINN approach - OTrain

The Figure 20 shows the words or lexicon associated to different emotions (i.e., fear) which provides a deeper understanding of the sentiment expressed by O-Train users. This information could be of great importance for project managers since knowing people's sentiment about the project can improve relation with customers, identify what evokes strong (negatives) emotions and undertake corrective measures. As results, better understanding of people's emotion can be an important consideration for the success of the project.

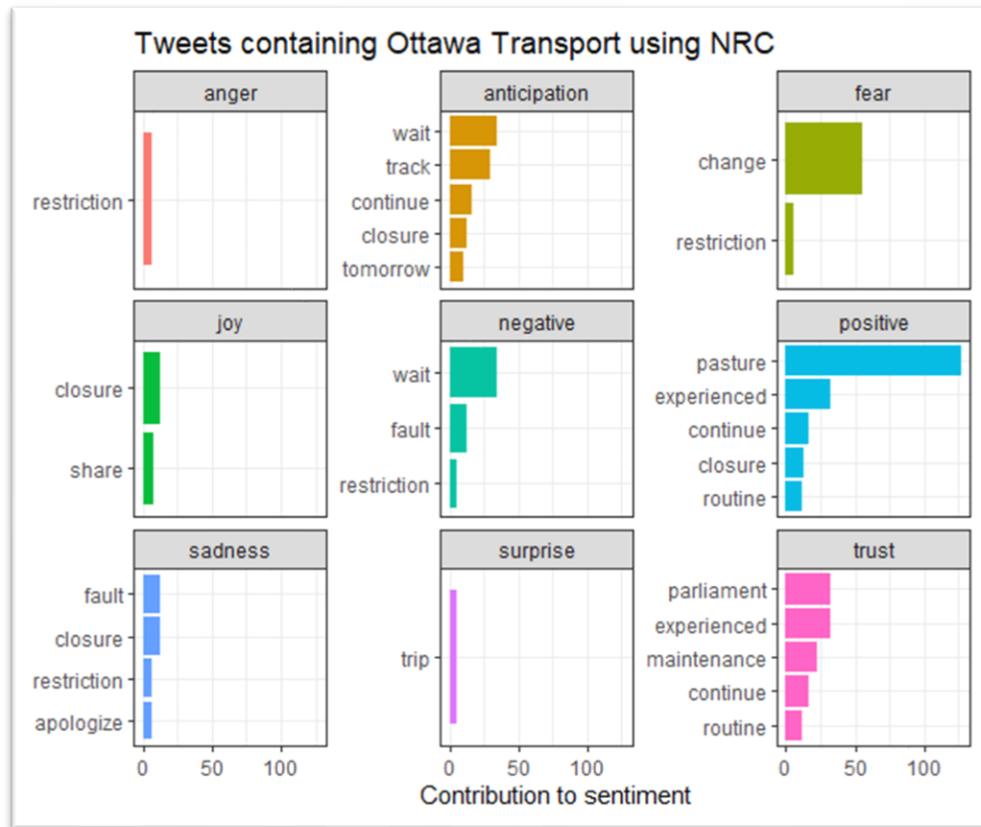


Figure 20. Results obtained from the NRC approach - OTrain

4.3.3. Quebec City train

This project differs from the two previous projects by the stage where the projects is currently at. As presented in the portal of the project

<https://www.reseaustructurant.info/projet/grandes-etapes/>, this project is at the adequation work stage. Therefore, the opinions and sentiments collected at this stage represent the people's engagement and expectation towards the project. For example, in the Figure 21, the negative sentiments expressed in Twitter are mostly associated to the same type of project executed in other countries. Some people feel uncertain about the benefit of this project because some similar projects have failed abroad.

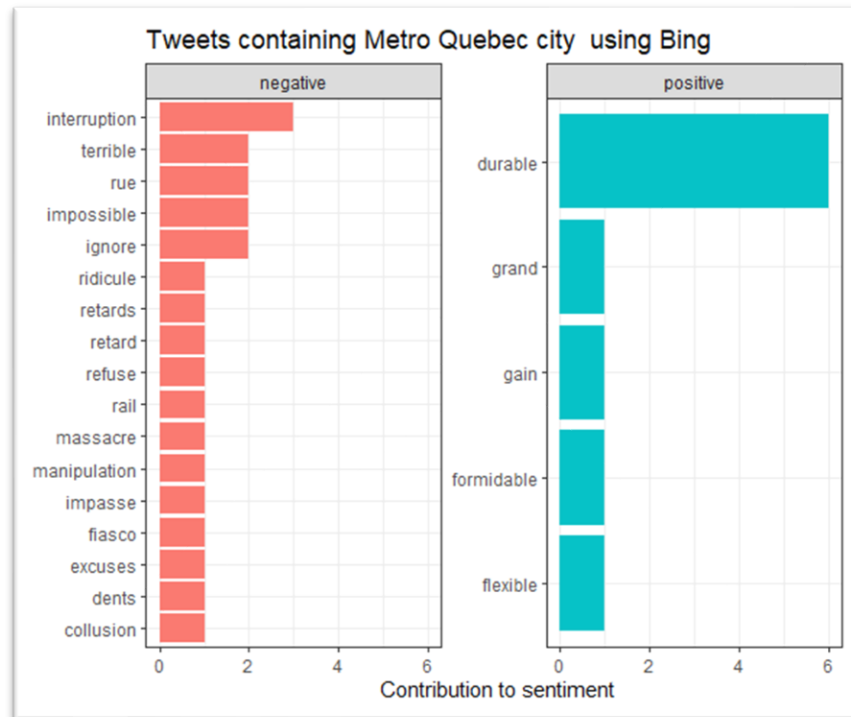


Figure 21. Results after applying noise reduction – Quebec city tramway

Example of Negative tweets reported by users

- Bonne nouvelle! Le BAPE rejette le de Québec. Adieu le tram Labeaume!
- L'administration a choisi le sans faire l'analyse complète des solutions. Un manque de rigueur et de transparence. Labeaume a imposé son choix contre l'intérêt des citoyens de Québec. C'est irresponsable.
- Le #tramway arrive dernier sur un trajet 14km à Québec en 46 minutes! C'est moins rapide qu'un #Metrobus. Le #métro léger arrive premier avec 25 minutes
- Transport est en charge du projet de RSTC de Québec. Une priorité ministérielle et gouvernementale\n\nLe bureau de projet du RSTC ne contrôle plus son projet ?\nQuel sera le rôle de M. Genest le directeur actuel ?\nLe maire est exclu du projet ?\n\nAjouter vos questions et PARTAGEZ svp
- Bordeaux réalise l'échec du tramway: G€ englouti et aucune amélioration du transport. e ville la plus embouteillée. Québec commet la même erreur avec le tramway. Un étoVAL est plus performant et durable.

Example of Positive tweets reported by users

- Il est temps de débarquer du #tramway pour construire un véritable transport collectif plus rapide, plus durable, plus sécuritaire, sans impacts négatifs pour les citoyens
- Un métro VAL serait formidable pour la ville de Québec. Beaucoup mieux adapté à notre climat et moins cher qu'un tram. La ville de Rennes est très inspirante.
- L'automatisation du #MétroVAL permet de pousser la fréquence à 1 minute! 3 fois plus qu'un tramway. Une solution flexible qui s'ajuste à la demande.
#MétroVAL le meilleur investissement pour un transport durable et sécuritaire.

From the tweets reported, it is evident that people are concerned about the quality functionality of the product. Yet, it is important to highlight the positive comments which are also important to the project succeed. This also becomes an opportunity for the project owner to promote the benefit of the project for the city of Quebec.

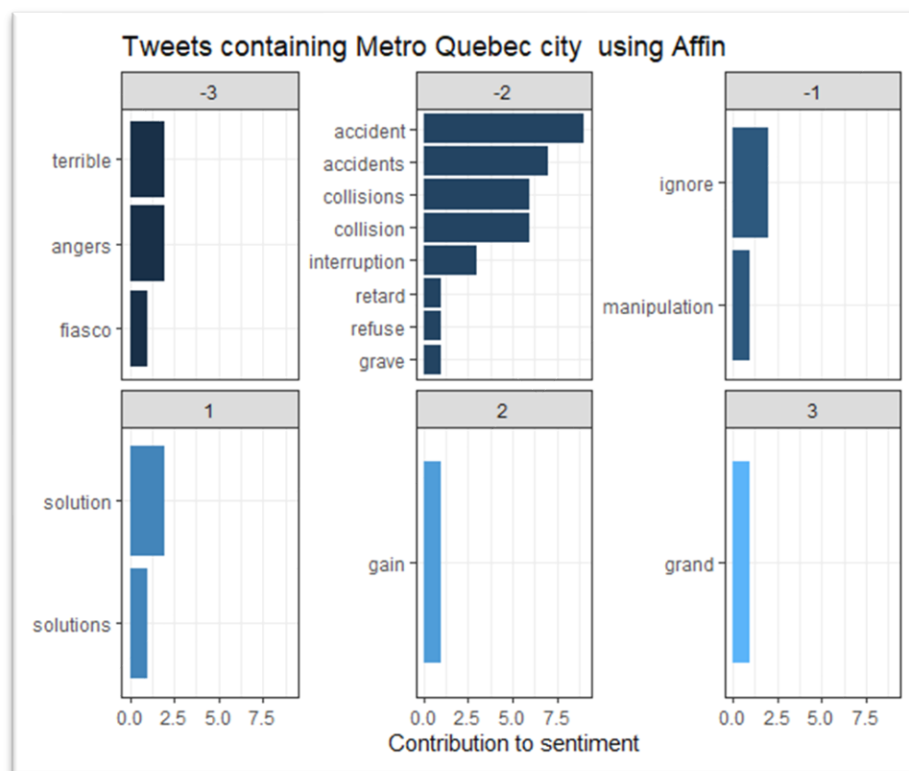


Figure 22. Results obtained from the AFINN approach Quebec city tramway

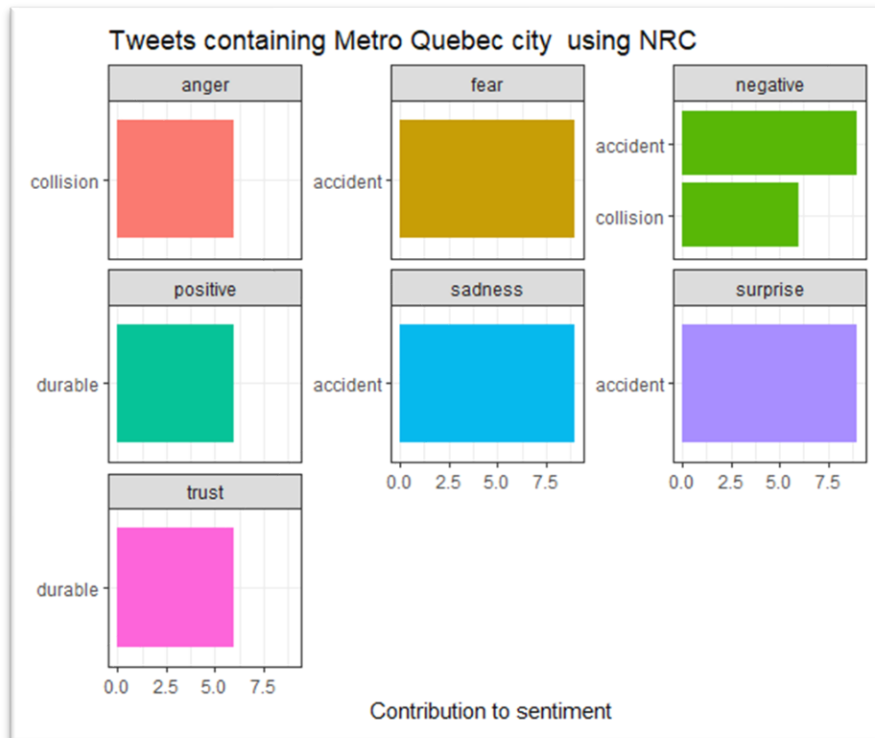


Figure 23. Results obtained from the NRC approach - Quebec city tramway

The sentiments displayed in the Figure 22 and 23 represent the citizen's concerns about the security issues of the solution delivered by the project. Yet, at the same time this is an opportunity for the stakeholders (from the government side) to measure the people's satisfaction and engagement for the project. Therefore, reading and analyzing reviews can help develop the project and lead it to a successful termination.

4.3.4. REM – Réseau Express de Montreal.

Figure 24 shows the results of the sentiment analysis for the REM project. The observations show that the distribution of the polarity are different from the other three project. In this case, users ratings bar plot shows that people tend to feel more positive faced to the project. Since major construction works are currently in progress, it is normal that the algorithm captures and classifies “congestion” as a negative word. But, the most important to highlight in the Figure 24 is the number lexicon classified as positive. This means that Montrealers are satisfied and engaged with this project.

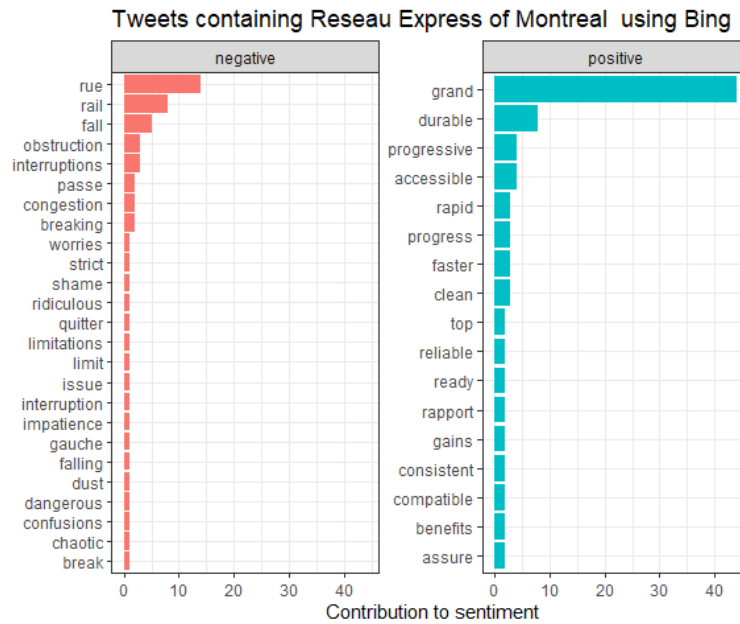


Figure 24. Results after applying noise reduction – REM

In Figure 25, the AFINN approach shows that most of the Tweets are classified positively which confirms the results obtained from applying the Bing approach. This measures the uses positive satisfaction which is very important for the project success.

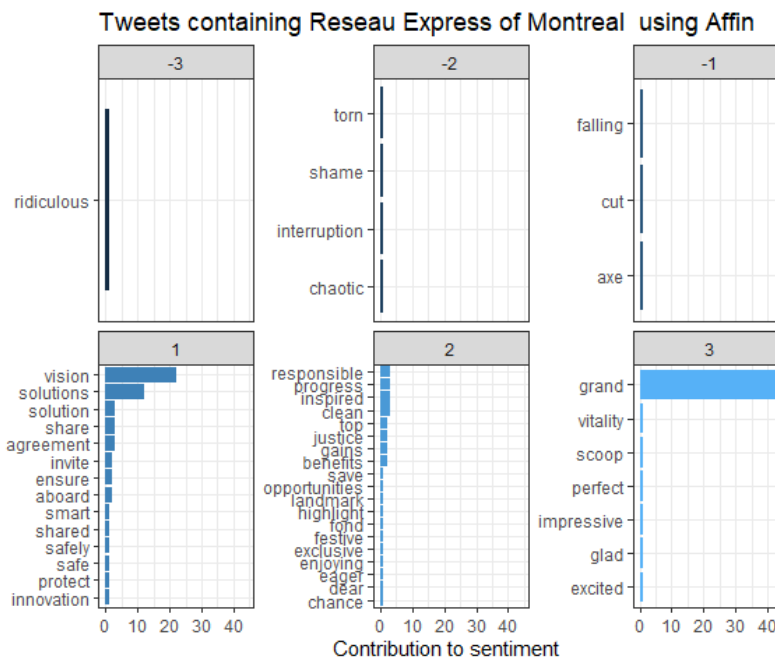


Figure 25. Results obtained from the AFINN approach – REM

The NRC approach, as shown in the Figure 26, displays some negative emotions. This might be linked to the problems caused by the construction sites. For example, Globalnews reported that people's dissatisfaction regarding the parking spots where the constructions are taking place (Haines, 2021)

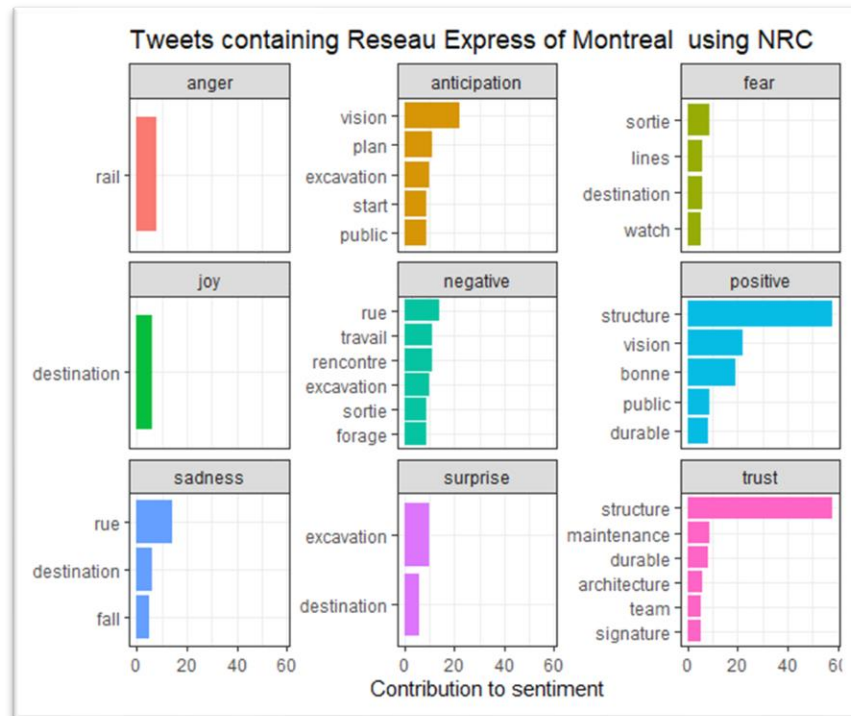


Figure 26. Results obtained from the NRC approach - REM

4.4. Gaps and challenges

The detection of irony and sarcasm is a complex sentiment analysis task. The detection of ironic expressions in the reviews is an open problem that could help to extract more valuable information about the study's subject. Spam is another sentiment analysis-related concern. Through Web platforms such as Twitter, people can openly describe their experiences and thus affect a project's success. Therefore, the implementation of sentiment analysis techniques to mine user opinions and sentiments is crucial to understanding the faults and benefits of a product resulting from the execution of a project. Given the large and number of applications of sentiment

analysis, it offers a great potential to directly influence quality improvement in project management.

Because of inconsistencies found between user ratings and the results obtained from the algorithms implemented as part of this research where users often writing negative sentences in positive opinions and vice versa, a new approaches is required to fix the positive, negative, and neutrality problem to make the process more simple and less manual.

5. Discussion

Sentiment analysis is an new research field. It is difficult to determine how it will evolve in the future, although the sentiment analysis could go beyond a simple classification of texts on a positive and negative scale. This research has uncovered multiple opportunities to advance research in Sentiment Analysis related to project and stakeholder management. Social media sites, such as Twitter, confirm themselves as sources of valuable information that can be exploited to carry out users' sentiment forecasts to obtain knowledge on people's preferences and polarity about a service, product, or event. However, the performance of such forecasts seems to depend on the technique adopted, and in many cases, sentiment analysis frameworks are still under experimental studies. The results of the predictions presented in the application cases, provide good reasons to be optimistic about the capability of sentiment analysis to become a useful complement to the traditional tools and techniques to deal with stakeholders' management. Another example that shows how sentiment analysis could be implemented into the project activities is the idea of how customers' emotions are extracted from social networks to maximize satisfaction and subsequently help business' success. Stakeholder's management within the context of large construction projects, by basically using a volume of tweets to capture public opinions, the algorithms were able to make better predictions and with outstanding accuracy than old-fashioned way of collecting information from people as off-line surveys. Based on the real-world applications presented in this paper, sentiment analysis is a promising tool for project managers and project teams to monitor people's emotions published in social media concerning public projects.

6. Conclusions

The findings of this research open a great possibility to adopt Sentiment Analysis as a tool to assess project performance. The results from the empirical cases show evidences that project managers could take advantage of Sentiment Analysis approach to measure the stakeholders' satisfaction towards a project, take corrective action, if required, which may lead the project to a successful closing. This study opens a path for performing sentiment analysis tasks for large projects. For example, project managers can take advantage that people are more open to severe criticisms about public topics on social medias.

In this paper, the stakeholders' emotions are analyzed by utilizing Lexicon based approach that finds sentiment associated with sentence (in this case Tweets) and then classify these emotions according to its polarity (negative or positive). Future research could explore the application of a predictive model (i.e. implementing a supervised machine learning algorithm) which may forecast the success or the failure of a project based on the sentiments or emotions collected from platforms like Twitter.

References

- Akcura, T., Altinkemer, K., & Chen, H. (2018). Noninfluentials and information dissemination in the microblogging community. *Information Technology and Management*, 19(2), 89–106. <https://doi.org/10.1007/s10799-017-0274-z>
- Anantatmula, V. S. (2008). The Role of Technology in the Project Manager Performance Model. *Project Management Journal*, 39(1), 34–48. <https://doi.org/10.1002/pmj.20038>
- Arash, D., Ritesh, C., & Muralitheran, V. K. (2020). Social media in project management: a systematic narrative literature review. *International Journal of Information Systems and Project Management*, 08(04), 5–21. <https://doi.org/10.12821/ijispm080401>
- Assistant Auditor General of Canada. (2018). Report 1—Building and Implementing the Phoenix Pay System. https://www.oag-bvg.gc.ca/internet/English/parl_oag_201805_01_e_43033.html
- Bhadane, C., Dalal, H., & Doshi, H. (2015). Sentiment analysis: measuring opinions. *Procedia Computer Science*, 45, 808–814. <https://doi.org/10.1016/j.procs.2015.03.159>

- Bolin, A. U. (2012). Salvaging value from project failure. *Performance Improvement*, 51(5), 12–16. <https://doi.org/10.1002/pfi.21262>
- Bonsón Ponte, E., Carvajal-Trujillo, E., & Escobar-Rodríguez, T. (2015). Corporate facebook and stakeholder engagement. *Kybernetes*, 44(5), 771–787. <https://doi.org/10.1108/K-07-2014-0136>
- Bourne, L., & Walker, D. H. T. (2008). Project relationship management and the stakeholder circle™. *International Journal of Managing Projects in Business*, 1(1), 125–130. <https://doi.org/10.1108/17538370810846450>
- Butt, A., Naaranoja, M., & Savolainen, J. (2016). Project change stakeholder communication. *International Journal of Project Management*, 34(8), 1579–1595. <https://doi.org/10.1016/j.ijproman.2016.08.010>
- Cambria E., Hussain A. (2012) Techniques. In: *Sentic Computing*. SpringerBriefs in Cognitive Computation, vol 2. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-5070-8_3
- Ceron, A., Curini, L., & Iacus, S. M. (2014). Using Sentiment Analysis to Monitor Electoral Campaigns. *Social Science Computer Review*, 33(1), 3–20. <https://doi.org/10.1177/0894439314521983>
- Chatzakou, D., & Vakali, A. (2015). Harvesting opinions and emotions from social media textual resources. *Ieee Internet Computing*, 19(4), 46–50. <https://doi.org/10.1109/MIC.2015.28>
- Eskerod, P., Huemann, M., & Savage, G. (2015). Project stakeholder management—past and present. *Project Management Journal*, 46(6), 6–14. <https://doi.org/10.1002/pmj.21555>
- Garcia-Crespo, A., Colomo-Palacios, R., Gomez-Berbis, J. M., & Ruiz-Mezcua, B. (2010). Semo: a framework for customer social networks analysis based on semantics. *Journal of Information Technology*, 25(2), 178–188. <https://doi.org/10.1057/jit.2010.1>
- Gomarn, P., & Pongpeng, J. (2018). Project failure Indicators: perceptions of Thai and Malaysian engineers. *MATEC Web of Conferences*, 192, 02021. <https://doi.org/10.1051/mateconf/201819202021>
- Grljević Olivera, & Bošnjak Zita. (2018). Sentiment analysis of customer data. *Strategic Management*, 23(3), 38–49. <https://ulaval.on.worldcat.org/oclc/8682578527>
- Haines, B. J. (2021, April 22). Construction continues on future West Island REM stations without parking plan. *Global News*. <https://globalnews.ca/news/7779986/construction-west-island-rem-stations-without-parking-plan/>

- Ion, S. M. E. U. R. E. A. N. U., & Cristian, B. U. C. U. R. (2012). Applying supervised opinion mining techniques on online user reviews. *Informatică Economică*, 2, 81–91. <https://ulaval.on.worldcat.org/oclc/8521511286>
- Jiang, H., Lin, P., & Qiang, M. (2016). Public-opinion sentiment analysis for large hydro projects. *Journal of Construction Engineering and Management*, 142(2). [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001039](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001039)
- Junior, A. B., da Silva Nádia Félix F, Rosa, T. C., & Junior, C. G. C. (2021). Sentiment analysis with genetic programming. *Information Sciences*, 562, 116–135. <https://doi.org/10.1016/j.ins.2021.01.025>
- Kendra, K., & Taplin, L. J. (2004). Project success: a cultural framework. *Project Management Journal*, 35(1), 30–45. <https://doi.org/10.1177/875697280403500104>
- Leandro, B. de R., & Paul, B. (2019). Project management competency framework. *Iberoamerican Journal of Project Management*, 1, 34–59. <https://ulaval.on.worldcat.org/oclc/8772659206>
- Les grandes étapes Tramway. (n.d.). Ville de Québec. Retrieved April 15, 2021, from <https://www.reseauturant.info/projet/grandes-etapes/>
- Li, Y.-M., & Li, T.-Y. (2013). Deriving market intelligence from microblogs. *Decision Support Systems*, 55(1), 206–217. <https://doi.org/10.1016/j.dss.2013.01.023>
- Martinez-Camara, E., Martin-Valdivia, M. T., Urena-Lopez, L. A., & Montejo-Raez, A. R. (2014). Sentiment analysis in twitter. *Natural Language Engineering*, 20(1), 1–28. <https://doi.org/10.1017/S1351324912000332>
- Mazur, A., Pisarski, A., Chang, A., & Ashkanasy, N. M. (2014). Rating defence major project success: the role of personal attributes and stakeholder relationships. *International Journal of Project Management*, 32(6), 944–957. <https://doi.org/10.1016/j.ijproman.2013.10.018>
- Nakov, P., Rosenthal, S., Kiritchenko, S. et al. Developing a successful SemEval task in sentiment analysis of Twitter and other social media texts. *Lang Resources & Evaluation* 50, 35–65 (2016). <https://doi-org.acces.bibl.ulaval.ca/10.1007/s10579-015-9328-1>
- O-Train Confederation Line | City of Ottawa. (n.d.). Ottawa City. Retrieved July 5, 2021, from <https://ottawa.ca/en/parking-roads-and-travel/oc-transpo-and-public-transit/o-train-confederation-line>
- Phoenix. (2018, September 24). Public Service Alliance of Canada. <https://psacunion-test.psac.com/phoenix>

- Presentation of the REM project. (n.d.). REM. Retrieved April 15, 2021, from <https://rem.info/en/reseau-express-metropolitain>
- Project Management Institute (PMI®). (1996). A guide to the project management body of knowledge (PMBOK® Guide). Newtown Square, PA: Project Management Institute.
- Prostějovská Zita, & Tománková Jaroslava. (2017). Project management: how to assess a project's success. *Business & It*, Vii(1), 2–7. <https://doi.org/10.14311/bit.2017.01.01>
- Rad, P. F. (2003). Project success attributes. *Cost Engineering - Morgantown*, 45(4), 23. <https://ulaval.on.worldcat.org/oclc/98042749>
- Radujković Mladen, & Sjekavica, M. (2017). Project management success factors. *Procedia Engineering*, 196, 607–615. <https://doi.org/10.1016/j.proeng.2017.08.048>
- Roberts, H., Sadler, J., & Chapman, L. (2019). The value of twitter data for determining the emotional responses of people to urban green spaces: a case study and critical evaluation. *Urban Studies*, 56(4), 818–835. <https://doi.org/10.1177/0042098017748544>
- Sanchez-Cazorla, A., Alfalla-Luque, R., & Irimia-Diequez, A. I. (2016). Risk Identification in Megaprojects as a Crucial Phase of Risk Management: A Literature Review. *Project Management Journal*, 47(6), 75–93. <https://doi.org/10.1177/875697281604700606>
- Sankaran Nilgün Okay and Gerhard Chroust, Shankar, Emil Berg, M., & Terje Karlsen, J. (2014). How project managers can encourage and develop positive emotions in project teams. *International Journal of Managing Projects in Business*, 7(3), 449–472. <https://doi.org/10.1108/IJMPB-01-2013-0003>
- Shu, W. (2014). Continual use of microblogs. *Behaviour & Information Technology*, 33(7), 666–677. <https://doi.org/10.1080/0144929X.2013.816774>
- Silge, J., & Robinson, D. (2017). *Text mining with r : a tidy approach* (First). O'Reilly Media. <https://ulaval.on.worldcat.org/oclc/990182937>
- Sloan, P. (2009). Redefining stakeholder engagement. *Journal of Corporate Citizenship*, 2009(36), 25–40. <https://doi.org/10.9774/GLEAF.4700.2009.wi.00005>
- Stocker, F., Arruda, M. P., Mascena, K. M. C., & Boaventura, J. M. G. (2020). Stakeholder engagement in sustainability reporting: A classification model. *Corporate Social Responsibility & Environmental Management*, 27(5), 2071–2080. <https://doi-org.acces.bibl.ulaval.ca/10.1002/csr.1947>

- Sutherland, M., Birkhead, M., & Maxwell, T. (2000). Core competencies required of project managers. *South African Journal of Business Management*, 31(3), 99–105. <https://ulaval.on.worldcat.org/oclc/7211656387>
- Sutterfield, J. S., Friday-Stroud, S. S., & Shivers-Blackwell, S. L. (2006). A Case Study of Project and Stakeholder Management Failures: Lessons Learned. *Project Management Journal*, 37(5), 26–35. <https://doi.org/10.1177/875697280603700504>
- T. By, C. Aliprandi, M. Cuadros, F. Capeci and F. Neri, "Sentiment Analysis on Social Media," in 2012 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining, Istanbul Turkey, 2012 pp. 919-926. <https://doi.ieeecomputersociety.org/10.1109/ASONAM.2012.164>
- Tarnowska, K. A., & Ras, Z. W. (2019). Sentiment analysis of customer data. *Web Intelligence*, 17(4), 343–363. <https://doi.org/10.3233/WEB-190423>
- Usher, G. S., & Whitty, S. J. (2017). Project Management Yinyang: Coupling project success and client satisfaction. *Project Management Research and Practice*, 4, 5523. <https://doi.org/10.5130/pmrp.v4i0.5523>
- Waligo, V. M., Clarke, J., & Hawkins, R. (2014). The 'leadership-stakeholder involvement capacity' nexus in stakeholder management. *Journal of Business Research*, 67(7), 1342–1352. <https://doi.org/10.1016/j.jbusres.2013.08.019>
- Westerveld, E. (2003). The project excellence model®: linking success criteria and critical success factors. *International Journal of Project Management*, 21(6), 411–418. [https://doi.org/10.1016/S0263-7863\(02\)00112-6](https://doi.org/10.1016/S0263-7863(02)00112-6)