

Original Research Article

Sentiment Analysis Model for Public Participation Forums in County Governments

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Received: 19.08.2022

Accepted: 24.09.2022

Published: 29.09.2022

Journal homepage:<https://www.easpublisher.com>**Quick Response Code**

Abstract: Public participation is important because it helps to close the gap between the public, private sector and the government. However, a successful devolution process in Kenya is hampered by a lack of/inadequate public participation in county governments. Communications gaps are one of the arguments made for this development. The main objective of the study was to develop a sentiment analysis model for use in public participation forums in County Governments in Kenya. The study was conducted through the design thinking process. The population of interest of this study comprised of county management and staff also area residents in Nakuru, Busia and Baringo counties who have participated in public participation forums before. The Bidirectional Encoder Representations from Transformers (BERT) approach was used to create the cloud NLP package and obtain user sentiment magnitudes for the sentiment analysis model. Following that, cross validation was utilized to assess the performance indicators during the design stage, and users took part in the model's assessment. The overall conclusion of validation is that the model performed as expected and recorded instrumental results in increasing effective public participation in county governments in Kenya and strengthen the devolution process. This study recommends that the model can be cascaded to all the counties in Kenya to improve the efficiency of public participation.

Keywords: Public participation, (BERT), Sentiment Analysis Model.

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INTRODUCTION

Technology is viewed as a solution to social issues. Public participation is not an exception. Every county government in Kenya has an official website which is often used to access information. The requisite documents for public participation are posted on the website (Transparency International Kenya, 2018). Effective participation needs transparency (Daudi, 2016). Transparency in public' actions and transparency in leadership and administration. Openness is affected through access to information. Inadequate access leads to difficulty in interpreting the policies, services and programs. Public apathy is the indifference, lack of concern in development. When there is apathy among the public means that there are disinterested leading to them withdrawing from participation (Obora, 2016).

Sentiment Analysis

Sentiment analysis (SA) which is also referred to as emotion AI or opinion mining can be defined as

the process of automating mining of opinions, views, attitudes, emotions and phrases through Natural Language Processing (Beigi, Hu, Maciejewski & Liu, 2016). It is the application of text analysis, computational linguistics, and biometrics to systematically identify, extract, quantify, and study affective states and subjective information.

Sentiment analysis is widely applied to the voice of the customer materials such as reviews and survey responses, online and social media, and healthcare materials for applications that range from marketing to customer service to clinical medicine. Sentiment Analysis is extremely useful in social media monitoring as it allows us to gain an overview of the wider public opinion behind certain topics. The applications of sentiment analysis are broad and powerful. The ability to extract insights from social data is a practice that is being widely adopted by organizations across the world.

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Surprisingly, despite Kenyans' undeniable involvement in public issues online, there aren't many online tools dedicated to public engagement, which the constitution recognizes as a crucial element of governance. The goal of the current study was to address this gap by creating a tool for Sentiment Analysis that county governments might utilize to encourage public engagement.

Statement of the Problem

The significance of public participation in the nation's governance system has been seen when effective court petitions have been utilized to block significant policy implementations and government initiatives because of a lack of or insufficient level of public participation in the process. In spite of this, citizen involvement in governance matters is incredibly low. One main obstacle to effective citizen input was especially mentioned as the absence of quorum during public engagement. Inadequate communications, a lack of county legal requirements for public participation, fear of victimization, venues, and logistics are a few of the arguments put out for this development.

Carrying out the discussions online could improve the quality of the debates and bring out other salient issues. Therefore, an online PP tool with embedded sentiment analysis algorithms specifically designed for the counties can be quite resourceful under the circumstances. Already, there are several applications in the market such as Brand watch

Analytics which use algorithms to capture and analyse users' sentiments though most are used commercially by marketers and not for public policy. Locally, such tools are not available for public participation and citizens' views on governance have had to be captured and analysed using traditional means like physical surveys which interestingly also fail in their accuracy of SA. The present study, therefore, endeavours to design, implement and evaluate the performance of a local PP sentiment analysis model for county governments in Kenya.

Sentiment Analysis Algorithms

Several algorithms and methods for implementing sentiment analysis systems have been developed and are mostly classified as Rule-based systems that perform sentiment analysis based on a set of manually crafted rules; Automatic systems that rely on machine learning techniques to learn from data, and; Hybrid systems that combine both rule-based and automatic approaches. Both the rule-based and automatic approaches have lower levels of precisions which can be improved through hybridization. The concept of hybrid methods is very intuitive it just requires the combination of the best of worlds, the rule-based and the automatic ones. Usually, by combining both approaches, the methods can improve accuracy and precision (Devlin and Chang, 2018).

Conceptual Framework

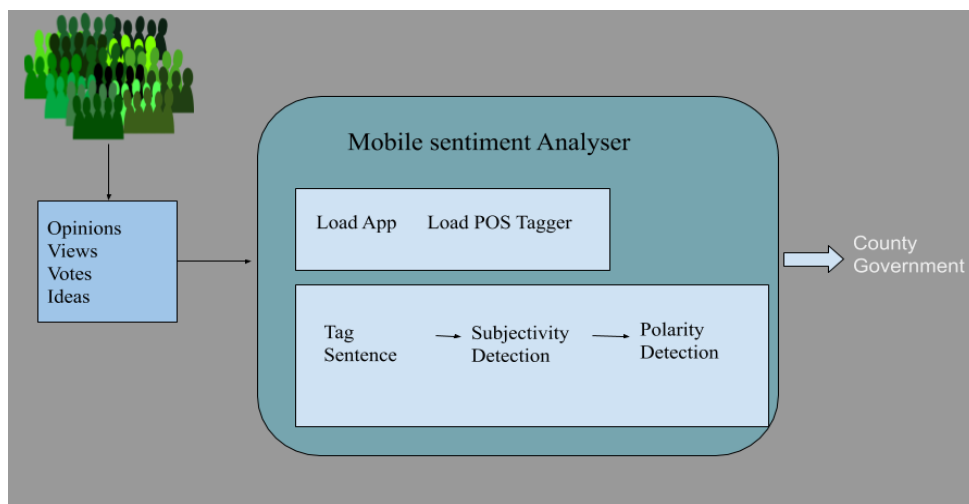


Figure 1: Conceptual Framework

The conceptual framework has the following concepts:

1. Users

These are the parties who are going to utilize the online participation forums. The participants of the system include:

- i. **Public**- These are the individuals giving their opinions, views or ideas about a particular subject.
- ii. **System Administrator** – This is the entity that is in charge of the system, updating

information and ensuring the system is running efficiently.

- iii. **County Government** – It is an entity that utilises the system by checking on the analysis results to gauge the citizen's response.

2. Mobile Sentiment Analyser

This incorporates a mobile application where the public can give their opinions on a subject matter provided by the county government and a sentiment

analyser. The sentiment analyser includes the following components:

- i. **Text pre-processing** -A text might contain different paragraphs which have to be cut into sentences based on English symbols. Using the position of speech tagging to identify the types of words in the sentence.
- ii. **Subjectivity Detection** –This involves using the POS tags to identify opinion lexicons in the

sentence, whether the sentence is subjective or objective.

- iii. **Polarity Detection** –This stage also utilizes the POS tags to indicate positive or negative expressions.

Model Workflow

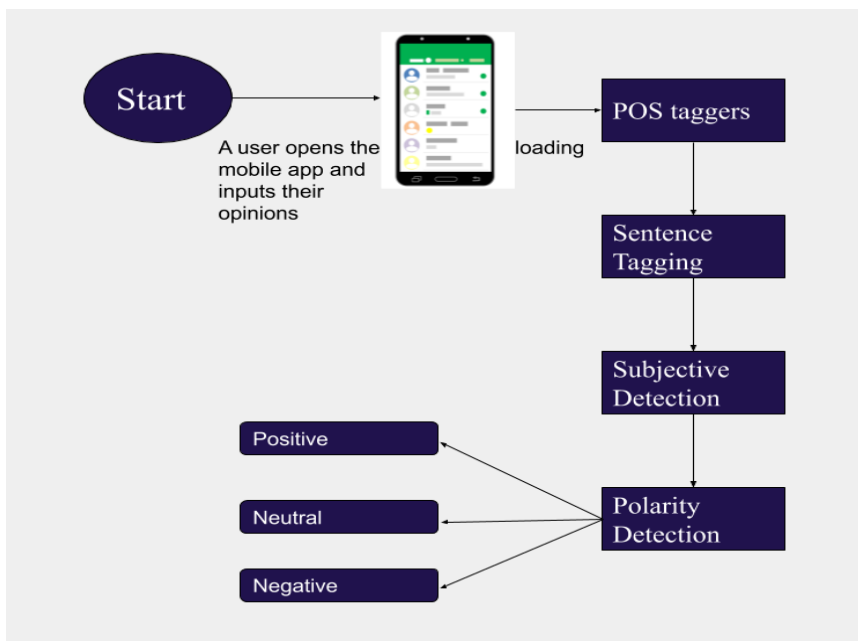


Figure 2: Model Workflow

Research Design

The study was conducted through the design thinking process approach. It is the process by which the core principles of design are used to solve problems and identify innovative solutions that enhance user experience (Adams & Nash, 2016). The three elements

to design thinking approach include; understanding the need and the user experience, brainstorming and coming up with a range of possibilities and ideas, and building and testing out the concepts to select a solution that fit the user’s problem.

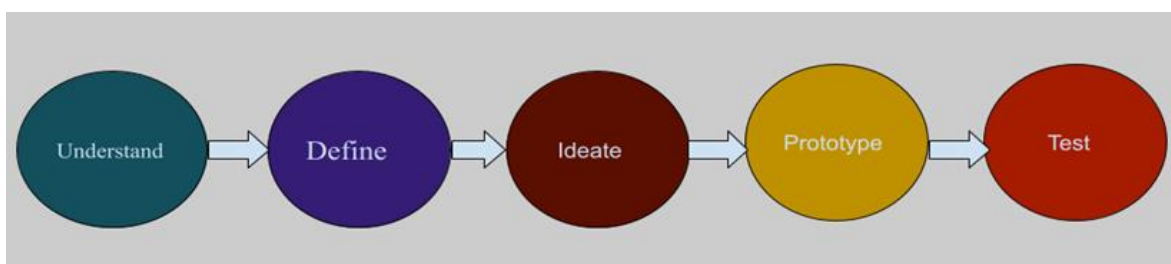


Figure 3: Design Thinking Process Approach

- 1) **Understand:** It involves using the empathic process to get the user’s needs and experiences. The objective of empathy is to understand the other person. There are four phases to the empathic discovery process, which include; discovery, immersion, connection and detachment (Kouprie & Visser, 2009). Discovery is the decision to leave one’s comfort zone to understand the client’s world. Immersion is the action of stepping into the

client’s world. This may include acts such as observations, interviews or site visiting. It is a way to collect baseline data. Collection phase includes sharing of the feelings from the previous phase with the client. Detachment involves stepping out of the client’s world and using professional expertise to enhance the client’s life (Kouprie & Visser, 2009).

- 2) **Define:** This involves creating a point of view that is based on the insights and needs of the

user. It includes redefining and focusing questions based on the insights gathered from the first stage. It analyses collected data and identifying which users' needs to be addressed with the design solution.

- 3) **Ideate:** This is the exploration phase. It is diverging on large quantities of possible ideas that could evolve into solutions.

- 4) **Prototype:** It is putting the ideas to the test. It includes developing some of the ideas into tangible objects. It is building the design.

- 5) **Test:** This involves the interaction of the prototype with the users, earning how they interact with it, allowing for refinement of the ideas.

The design thinking process was employed as follows:

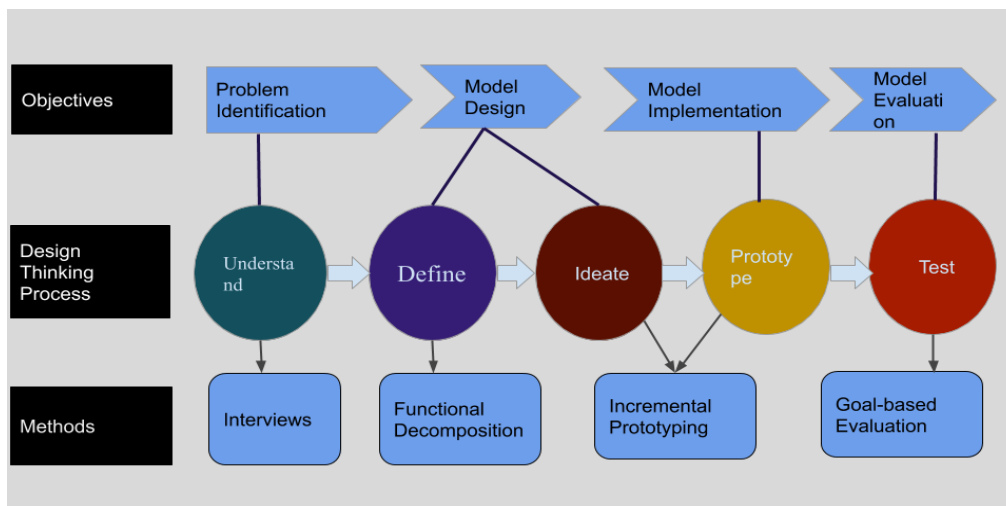


Figure 4: Design thinking process in this study

Target Population

The population of interest of this study comprised of county management and area residents in the three counties who have participated in public participation forums before. Therefore, the project targeted 218 persons in Nakuru, 174 persons in Busia and 122 persons in Baringo counties respectively.

Model Development

The primary purpose of the study was to develop a sentiment analysis model for use in public participation forums in County Governments in Kenya. As such, this model aimed at easing the otherwise difficult process of obtaining sentiments from the public about county government projects as required by the law.

System Architecture

The sentiment analysis model contains several modules that are integrated, namely, user registration, login and roles management module, forum management module, participation management module, sentiment analysis module. The following section presents a summary discussion of the different modules that form sentiment analysis model;

- (a) **Registration Module:** The users of the system (admins and public users) are first registered either through self- registration as is the case with public users or by admins through user management module. The registered users can therefore access other modules of the system based on their roles.

The bio data that the user fills in during registration becomes vital in authenticating the users.

- (b) **Login Module:** This module authenticates users who are registered and authorizes them to explore other modules based on their roles by setting up sessions for them. This module therefore acts as an entry point to the sentiment analysis system for registered users.
- (c) **User Management Module:** This module allows the admin users to add other uses to the system, drop users, update user details and assign roles to the system users.
- (d) **Forum Management Module:** The forum management module allows the system admins to create new forums where other users can engage, edit existing forums or drop forums.
- (e) **Participation Management Module:** The primary aim of this study was to develop a model that would assist in automating public participation on projects that county governments wish to implement. This module therefore is fundamental such that it allows the public users to post their comments about various topical issues that require participation and the admins to read general feeling of the public about the projects in discussion. To do so, the admin can read the comments (raw as well as translated).
- (f) **System Navigation:** This module allows the users to traverse the system easily by based on their roles. To achieve this, system has a side menu that contains different menu items that guide the user in exploring different system features.

- (g) **Sentiment Analysis module:** This module computes the average sentiment and magnitude scores then display the average feeling from participations ranging from positive to negative. This will guide the decisions by the county governments regarding implementation of projects for which public participation was sought.
- (h) **System Dashboard:** This component displays quick view of system statistics regarding the number of comments made by participants, the number of participations that users can engage in, the number of forums created and the number of public user or citizens registered.

Model Validation

Expert survey was conducted to establish the validity of the model. The expert survey involved thirty-three (33) participants of whom 78.8% (26 Participants) were county residents and 21.2% (7 Participants) county administrators as shown in figure 28 below. A set of variables were used derived from one issue in Nakuru County, namely; “Nakuru Airport”. All the thirty-three respondents were expected to give their comments about the singular issue using the model and also give their feedback through a form provided during validation process. The responses were captured and analysed for validity of the model as far as sentiment analysis is concerned. The validation results are provided in the sections below.

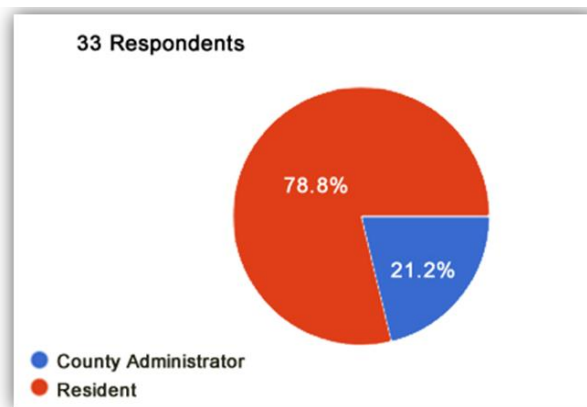


Figure 5: Expert Survey Participants
Source: Researcher (2021)

Validation Metrics

The model was further evaluated for four software metrics, namely; usability, reliability, efficiency, and functionality. As such, Six (6) expert

survey questions were structured to help obtain corresponding data (responses) for the four validations metrics. The data for validation of the four metrics were captured as summarised in Table 1 below;

Table 1: Validation Metrics Questions and Responses

Metrics	Question	SD	D	N	A	SA	TOTAL Responses
Usability	Q1 I like the overall experience I had with the public participation application	0	0	0	7	26	33
	Q2 I was able to navigate through the application without any challenge	0	0	3	11	19	33
	Usability Means	0	0	2	9	23	33
Efficiency	Q3 I could not use the application without registering and logging in.	2	0	2	13	16	33
	Q4 The system allowed me to register and take part in public participation for my county	0	0	0	9	24	33
	Efficiency Means	1	0	1	11	20	33
Reliability	Q5 I managed to complete the assessment without a challenge	0	0	0	10	23	33
Functionality	Q6 I think my opinions were captured well and will count on the overall.	0	0	2	14	17	33

Mean of responses for questions capturing the same metrics were obtained and analysis for specific metrics described. The results indicated that all the experts (100%; SA=26, A=7) considered that the sentiment analysis model was usable based on the

overall experience they got using the application while a majority of them (90.9%; SA=19, A=11) considered it usable based on their ability to navigate through the application without challenge. An average of 94% (SA=20, A=11) further agreed that the application was

efficient based on authentication and authorization. All the experts (100%; SA=23, A=10) agreed that the application was reliable while 94% (SA=17, A=14) considered the system to be functional. The analysis, as indicated in Figure 6 below, showed that all the

responses for all the four metrics were skewed towards Agreed and Strongly Agreed. This means that the model was Usable, Functional, Reliable and its Efficiency was valid.

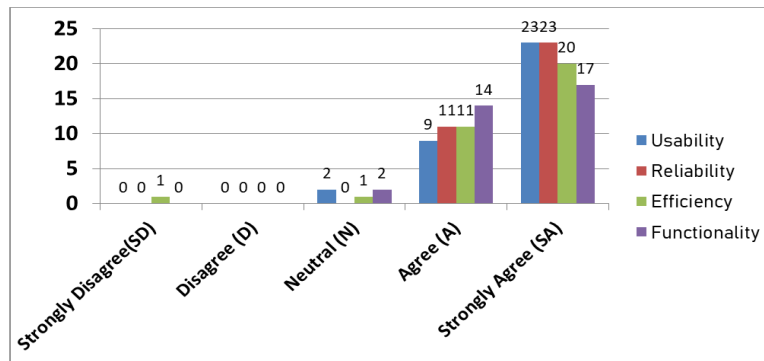


Figure 6: Validation metrics
Source: Researcher (2021)

Sentiment Translation and Analysis

The general objective of the study was to develop a sentiment analysis model. It was therefore prudent to assess if this overall objective had been obtained. As such, observation was done upon the comments posted by the respondents, particularly those that were given in either Swahili or sheng languages. It was observed that the model could actually translate the

comments given from Swahili (or sheng) accurately, obtain sentiment and magnitude scores and gives the overall feeling of the comment in both text and emojis using BERT Algorithm. The screenshot presented in figure 7 below shows the translation and sentiment analysis for comments 116 and 115 given by respondents.

116	Anonymous	Inawezekana "It is possible"	Neutral	Sentiment Score: 0.1, Magnitude: 0.1	😐
115	Anonymous	Jambo la busara sana kwa uchukuzi mji wa Nakuru.nina kubaliana. "A very wise thing for transportation in the city of Nakuru. I agree."	Positive	Sentiment Score: 0.8, Magnitude: 1.6	😊

Figure 7: Sentiment Translation and Analysis
Source: Researcher (2021)

Validation Variables

(a) Validation Variable 1: Nakuru County Needs an Airport

From the responses, 90.9% (30 respondents, SA=23 and A=7) commented that having an airport in Nakuru county would be a good idea. Less than 10% of

the respondents were either neutral or disagreed to having the airport in the county. As such, the model may be considered as valid basing on the rule of majority. Figure 8 below shows the distribution of responses for validation variable 1.

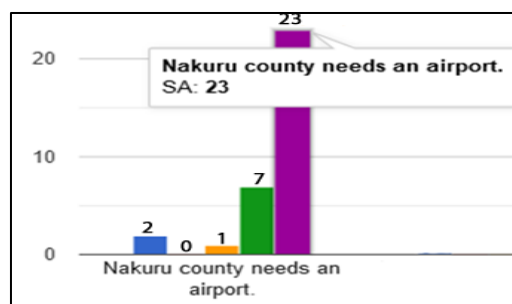


Figure 8: Validation Variable 1 Results
Source: Researcher (2021)

Paired Sample T-Test Validation

A paired sample t test was run to determine if there was a statistically significant differences between two issues that were analysed via Jumuika application and from the survey responses. In analysing the means

of sentiments, data was collected from 33 respondents using Jumuika app. Similarly, the same respondents were given questionnaire with the same issues raised in the Jumuika application. The results are presented in Table 2.

Table 2: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Nakuru Airport Sentiment Index	4.2348	33	.93737	.16318
	Data from Jumuika App On opinion concerning construction of the Nakuru Airport	4.1212	33	.99240	.17275

Table 3: Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Nakuru Airport Sentiment Index & Data from Jumuika App On opinion concerning construction of the Nakuru Airport	33	.170	.344

The paired samples correlations indicates that the two variables are not significantly correlated to each other ($r=0.170$; $p=0.344$).

Table 4: Paired Samples Test

		Paired Differences					t	Df	Sig. (2-tailed)
		Mean	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Nakuru Airport Sentiment Index - Data from Jumuika App On opinion on construction of the Nakuru Airport	.11364	1.24388	.21653	-.32742	.55470	.525	32	.603

There was no significant difference between the sentiment questionnaire and the results from Jumuika application ($t_{32}=0.525$, $p>0.05$). This implies that the solution developed captures the sentiments in the same way as the alternative approaches.

CONCLUSION

The primary focus of this study to develop a sentiment analysis model to aid county governments in the jurisdiction of Kenya to automate public participations on projects and issues they wish to undertake. The study finally delivered web-based as well as mobile-based integrated applications to enable citizens to actively participate in goings on within the county and shape the progress of development within their areas of concern. With Jumuika application, the county government administration can read public views from the citizens and make informed decisions thereof based on population’s general feeling. The Jumuika solution can manage users, roles, participations, and forums and compute magnitude scores, sentiment scores, polarity and general feelings.

The sentiment analysis model was implemented as an integrated platform of mobile

application and web application. The mobile application was developed using android and hosted on Google play store to enable citizens to easily access and install. The citizens use the mobile application to register, login, and participate in county development projects. The web application enables the admins to login manage participations, users, roles, forums and review scores and sentiments from participation forums

RECOMMENDATIONS

As such, these county governments should implement automated mechanisms to gather the general feelings of the public on projects they plan to undertake before they do so. Uptake of ICT by the devolved units is paramount because it reaches more people faster. Counties should therefore deploy sentiment analysis applications for their public participations fora during this information age.

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Cite This Article: Malachi Omela Manases, Moses Thiga, Nelson Masese (2022). Sentiment Analysis Model for Public Participation Forums in County Governments. *East African Scholars J Eng Comput Sci*, 5(5), 69-76.