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Cleaning Services Website with Sentiment Analysis

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Abstract
This study is about the creation of the business website for Cleaning Services and the incorporation of sentiment analysis using Naïve Bayes classifier to customer feedbacks. The accuracy of the system's sentiment analysis was measured using F-Measure from 42 sample customer feedbacks and the result had shown that the system's precision was at 90.5%, denoted as Excellent while its accuracy was at 95% and considered Excellent. Meanwhile, the functionality of the business website was evaluated by 10 respondents consisting of Software Developers and faculty members from the Information and Communications Technology (ICT) sector. Using ISO 20510 Software Quality Standards, the respondents rated the system in each of the eight categories as Very Satisfactory while the overall mean rating of the system was likewise Very Satisfactory. The Sentiment Analysis of the system is a vital tool which could be incorporated in any business website that needs an automated analysis of their customer sentiments so as to make strategic, data-driven decisions and promote customer satisfaction.

Keywords: customer feedback, sentiment analysis, business website

Introduction

Nowadays, more people spend on goods and services online and the reason could vary from convenience, competitive price to simply keeping up with the current trend. Indeed, nothing could be better from getting goods or services at the comfort of one's own home.With more customers moving online, more businesses realize the importance of online presence and the opportunity it creates. Consequently, business entities are shifting their focus on internet marketing as it will enable them to target more customers at the most inexpensive way.

According to Linton [1], Internet marketing is important because it aligns business strategy to how the way consumers make purchasing decisions. Internet marketing is one of the best methods of promoting a product and service in front of target audiences [2]. It enables companies to build relations with customers using a regular, low-cost and efficient means of personalized communication. Through it, a business could update or inform their customers of the latest and upcoming products and services.

Internet marketing poses several benefits for businesses. According to Kothiyal [2], it increases the visibility of the business by reaching more people online. Statistics shows that 57% of Millennial say that social media has made the ads they see more relevant to them and 48% of people say they made their last online purchase as the direct result of an internet marketing advertisement [3] Thus, it is important to note the role of internet marketing in increasing business profitability

Getting to reach potential customers requires online presence. It only makes sense as in today's time, where everything from grocery to money-transfer is done online, each time a user needs a particular service, the primary instinct is to search online. Online presence entails those current customers could always reach you online or potential customers could search and find your type of business over the internet.

While studies have shown that most consumers prefer to use social media and other platforms to look for and order products, a business website is the de-facto form of establishing online presence. A business website is important in establishing a strong credibility as a business because it is synonymous to an established and unique address on the internet and which today's customers expect of a serious business. By having a website, a business is able to showcase not just the products and services it offers, but also as a marketing strategy to reach

more potential customers or connect to potential business partners.

However, much like the traditional form of marketing, online competition is tough as similar businesses has its own marketing strategy. It is therefore vital that a website is designed not just to improve user experience or showcase a product or a service. A website should also be used as a tool to understand the sentiment of customers about the business product or service so as to adjust certain aspects of the business, address customer needs and ultimately attain customer satisfaction.

One of the businesses which used the internet as a marketing platform is the Cleaning or Janitorial Services. Most of these cleaning services offer professional janitorial services to commercial and residential clients. The issue of maintaining credibility and quality service are at the forefront of every Cleaning Services business. Through it, a business is able to retain customers, establish a name and more importantly, get referrals from current customers to their network of friends who are in need of cleaning service.

When a cleaning service does not have a business website, the primary mechanism of getting new customers is through the referral system. But with the rising number of competitors, it is hard to find new customers by relying merely on referral system.

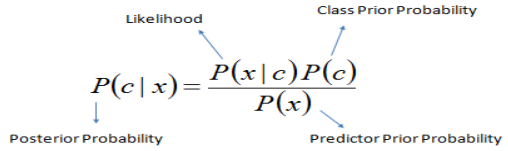
Therefore, an online presence through a business website is necessary to supplement the referral system and more importantly, to reach more potential customers. In order to address the issue of customers terminating the janitorial service without the prior knowledge of possible reasons, the business entity may collect customer feedback through their website.

Using customer feedbacks, the business may perform sentiment analysis in order to determine the opinion of customers about their service. The result of analysis maybe used to develop strategies to improve the service, promote customer satisfaction and minimize service cancellation.

Sentiment analysis is a Natural Language Processing (NLP) technique of classifying textual data as positive, negative or neutral [4]. Currently, most cleaning services websites merely collects customer feedbacks and sentiment analysis is not an integral part of their websites. The lack of online dataset of customer feedbacks for cleaning services is not readily available, limiting the sentiment analysis processing to certain machine learning algorithms.

Considering the foregoing circumstances, the researchers proposed the design of a cleaning services website with an integrated sentiment analysis using client feedback. Unlike other businesses like hotels, restaurants or airlines, there is no available dataset for cleaning services that can be applied to customer feedbacks, so the researcher will use Naïve Bayes classifier to perform sentiment analysis.

Naïve Bayes is a conditional probability model where the classifier is some function which assigns a class label to a given feature or data. Bayes theorem provides a way of calculating the posterior probability, $P(c|x)$, from $P(c)$, $P(x)$, and $P(x|c)$. Naive Bayes classifier assumes that the effect of the value of a predictor (x) on a given class (c) is independent of the values of other predictors. This assumption is called class conditional independence [5].



$$P(c \mid \mathbf{X}) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

Where:

- c is the class variable and could be positive, negative neural
- x is the dependent feature vector of size *n* and represents the feedback words
- P(c|x) is the posterior probability of class c (pos, neg or neu) given the predictor x (attribute or feature)
- P(c) is the prior probability of the class(pos = 0.333, neg = 0.333, neu = 0.334)
- P(x|c) is the likelihood which is the probability of predictor given class
- P(x) is the prior probability of predictor

The dictionary of words classed as positive, negative or neutral will be used in the classification process. Each customer may provide one or more feedbacks and the system will be able to classify feedbacks by customer and the overall sentiment of all the customer feedbacks. Such concept and processing maybe integrated in other business websites in order to help businesses monitor customer sentiment about their products and/or services and respond to customer needs.

Objectives Of the Study

The purpose of this study is to create the business website for Cleaning Services as a marketing strategy, gather customer feedback and perform Sentimental Analysis to determine customer sentiment.

Specifically, this study will:

a. allow potential customers to send queries to the system;
b. allow the site administrator to view sent queries,
c. allow the site administrator to manage customer records;
d. allow the site administrator to manage service invoice to customers and add relevant services rendered by invoice,
e. allow customers to send service feedback,
f. allow the site administrator to conduct sentiment analysis on submitted customer feedbacks.
g. test the web application using ISO 25010 in terms of the application's Functional suitability, Performance efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability,
h. validate the precision and the accuracy of the sentiment analysis using F-Measure.

Methodology

The study will employ Naive Bayes classifier to perform sentiment analysis of customer feedback using a lexicon of positive, negative, neutral, ignore and prefix words for the sentiment classification process. As a developmental research, a web application was developed using prototyping in the client-server architecture. As a quantitative research, the system's output will be measured using F-measure. Figure 1 shows the conceptual framework of the system.

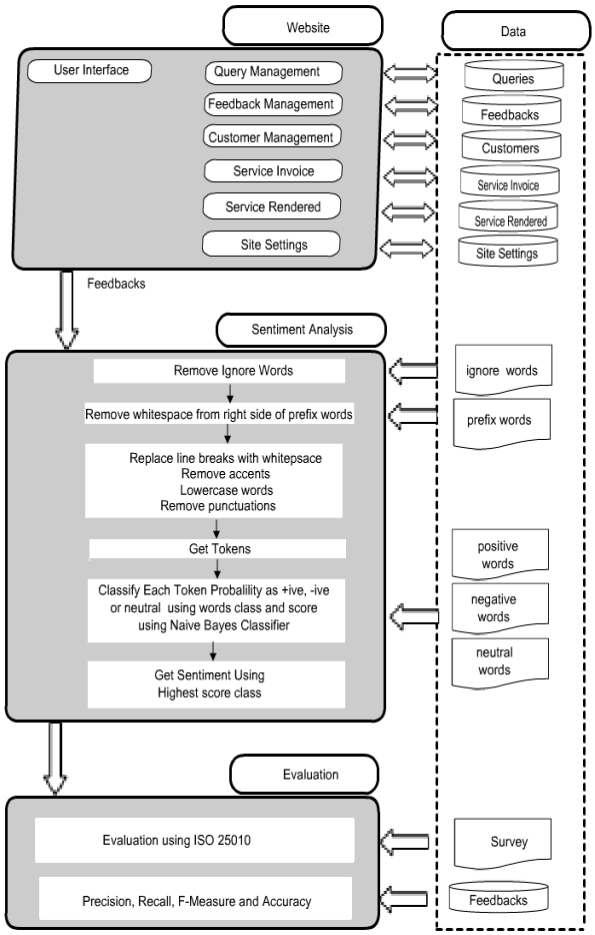


Fig. 1: Conceptual Model

1. Website Component

The Website component is at the top of the chronological steps undertaken. The User Interface components are the designed HTML pages and Javascript codes where users will interact with the system. Other sub-components under Website directly use the User Interface component. The Query Management component is designed to handle customer queries and save it to the Queries table. Likewise, the component reads the data from the Queries table and presents it to the site Administrator each time the user needs to view all customer queries.

The purpose of the Feedback Management component is to accept feedback entered by customers and save it to the Feedbacks table. Each time the site Administrator wants to view customer feedback or perform sentiment analysis, the Feedback component reads the data from the same table.

The Customer component is designed to handle entry and update of customer records to the Customers table. For each customer record, the system allowed the user to add service invoice using the Service Invoice component. Each rendered service and corresponding service fee by Service Invoice is handled by the Service Rendered component using the ServiceRendered table.

2. Sentiment Analysis Component

This component is designed to perform the sentiment analysis process. Figure 2 shows the block diagram of the sentiment analysis process.

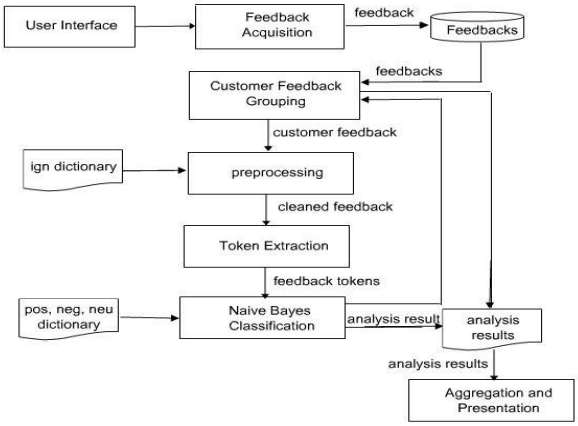


Fig. 2: Block Diagram of Customer Feedback Sentiment Analysis

All the feedbacks that were collected using the UI component are retrieved from the Feedbacks table and grouped by customer.

Before each feedback could be analyzed, the following preprocessing steps are done to ensure that the algorithm gets the right data format:

- using PHP's preg_split and implode, each feedback is normalized by setting a single space separating each word in customer feedback;
- words that appear in the ignore words dictionary are removed:
- whitespaces after prefix words are removed thereby combining prefix with next word ("very good" becomes "verygood");

In the token extraction stage, the following processing steps are performed:

- line breaks are replaced with spaces
- accents are removed
- everything is converted to lowercase for matching with lowercased dictionary
- punctuations are removed
- tokens/individual words are extracted

Classification Steps

The system was designed using an object-oriented approached. The class diagram of sentiment analysis is shown below:

Feedback_analyzer
ignore_words : array negative_prefix_words:array dictionary: array minTokenLength: integer(1) maxTokenLength :integer(15) classes : array('pos', 'neg', 'neu') classTokenCount : array('pos' = 0, 'neg' = 0, 'neu' =0) classDocCount : array('pos'=0, 'neg' = 0, 'neu'=0) tokCount : integer(0) docCount: integer(0) prior : array('pos'=0.333,'neg'=0.333,'neu'=0.334)

+Feedback
-LoadDictionary(void):void
+SetDictionary (class:string):void
-AnalyzeFeedback(void):void
+GetSentiment(void):void
+SetNewFeedback(customer_id:integer, customer_name:string)
+Score(void):array
+ResetTokenCollection(void):void
+GetTokens (customer_feedbacks:string):array
+GetAnalyzedTokens(void):array
+GetAnalysisDetails(void):array
+GetAnalysisSummary(void):array

Prior Probabilities
In order to compute for the posterior probability, the class' prior probability (***prior*** in the class attribute) are set with the following value:

- prior['pos'] =0.333
- prior['neg'] = 0.333
- prior['neu']= 0.334

For each iteration in the class dictionary, the **scores** array indexed by class name are initialized to 1:

- scores['pos'] = 1;
- scores['neg'] = 1;
- scores['neu'] = 1;

If a feature/word occurs in the class dictionary, **count** is set to 1, otherwise 0. Because each feature will be evaluated, 1 (one) is added to the **count** variable to ensure that an absence of feature in a class will not affect the outcome of other features. This process is called Laplace smoothing. The score for each feature was computed as the product of the occurrence of each word in the class dictionary:

scores[class] *= (count + 1) //expanded below
scores['pos']*= (1+1);
scores['pos'] = 1 * (1+1) // on first iteration
scores['pos'] = 2;

To compute for the posterior probability of each class, the score for each class, P(c|x), is multiplied by the score for this class divided by the total score of all classes:

$$score[class] = \frac{prior[class] * score[class]}{score['pos']+score['neg']+score['neu]}$$

In the above sample computation for prior probability of **pos** class, scores['pos'] = 2, the scoring formula would translate to:

$$score['pos'] = \frac{0.333 * 2}{score['pos']+score['neg']+score['neu']}$$

The following pseudocodes are the bases of the Sentiment Analysis component which were formally converted to PHP code:

Feedback_analyzer class

```
initialize customers to empty array
initialize customer_feedbacks to empty string
initialize customer_id to -1
initialize temp to empty array
initialize feedback_records to empty array
initialize customer_tokens to empty array
initialize ignore_words to empty array
initialize negative_prefix_words to empty array
initialize dictionary to empty array
initialize minTokenLength to 1
initialize maxTokenLength to 15
initialize classes to array('pos', 'neg','neu')
initialize classTokenCount to
   array('pos' = 0, 'neg' = 0,'neu' =0)
initialize classDocCount to
   array('pos'=0, 'neg' = 0,'neu'=0)
initialize tokCount to zero
initialize docCount to 0
initialize prior to
   array('pos'=0.333,'neg'=0.333,'neu'=0.334)
End Feedback_analyzer class
```

The class constructor is automatically invoked when the class is instantiated. It loads all dictionaries, customer feedbacks and starts the sentiment analysis process:

```
Feecback_analyzer constructor:
        CALL LoadDictionary
        LET feedback_records = LOAD customer
          feedbacks by customer
        CALL AnalyzeFeedback
END Feecback_analyzer
```

The pseudocode for LoadDictionary calls a private method to load all the words from dictionary file of their respective class. It also loads prefix and ignore words into memory:

```
Function LoadDictionary
   FOREACH classes as class
         CALL SetDictionary(arguments:class)
   END FOREACH
   SET ignore_words = LOAD ignore words from
     file
   SET negative_prefix_words = LOAD prefix
     words from file
END LoadDictionary
```

The function SetDictionary pseudocode for loading the lexicon of positive, negative, neutral, ignore and prefix words:

```
Function SetDictionary(parameters:class)
//class is one of 'pos', 'neg', 'neu'
   SET words = LOAD class contents from class
     dictionary file
   FOREACH words as word
      increment docCount by 1
      increment classDocCount[class] by 1
      remove spaces around word
      IF dictionary[word][class] is empty
         SET  dictionary[word][class] = 1
      END IF
      increment classTokCounts[class] by 1
      increment tokCount by 1
```

```
   END FOREACH
END SetDictionary
```

The pseudocode of function AnalyzeFeedback reads each feedback record and pass it to a separate function to do the actual sentiment classification:

```
Function AnayzeFeedback
   SET x = 1
   FOREACH feedback records as feedback
      IF x = 1 THEN
         SET customer_id = feedback:customer id
         CALL SetNewFeedback(arguments:customer_id,
           feedback:customer name)
         SET customer_feedbacks to empty string
      ELSE IF customer_id <> feedback:customer id
         CALL GetSentiment
         CALL SetNewFeedback(arguments:customer_id,
            feedback:customer name)
         SET customer_feedbacks to empty string
       END IF
       Split feedback into words
       combine words with single space separator
       append combined words to customer_feedbacks
       increment x by one
   END FOR
   IF customer_feedbacks is not empty
      CALL GetSentiment
   END IF
END AnalyzeFeedback
```

The pseudocode for SetNewFeedback is invoked for each new feedback. It initializes the customers array with details of the new customer feedback. The customers array holds the posterior probabilities and actual feedback words:

```
Function SetNewFeedback (parameters:customer_id,
customer_name)

   SET customers[customer_id] to empty array
   assign customer_name to
      customers[customer_id][‘customer’]
   SET customers[customer_id[‘pos’] = 0
   SET customers[customer_id][‘neg’] = 0
   SET customers[customer_id][‘neu’] = 0
   SET customers[customer_id][‘words’[‘pos’]
     to empty array
   SET customers[customer_id][‘words’[‘pos’]
     to empty array
   SET customers[customer_id][‘words’[‘neu’]
     to empty array
END SetNewFeedback
```

The GetSentiment function call the Score function to get the sentiment of customer feedback and set the highest class sentiment of each feedback. It also adds the feedback words processed by the system:

```
Function GetSentiment
   current_score = CALL Score //score returns an
      array type
   initialize idx to zero
   FOREACH current_score as (key, value)
      set customers[customer_id][key] = value
      IF idx = 0
         CASE key = "pos"
            SET customers[customer_id][‘highest’]
               = "Positive"
          CASE key = "neg"
            SET customers[customer_id][‘highest’]
               = "Negative"
         CASE key = "neu"
            SET customers[customer_id][‘highest’]
               = "Neutral"
      END IF
      increment idx by 1
   END FOREACH
   FOREACH customer_tokens as (key, value)
      APPEND value to
         customers[customer_id][‘words’][key]
   END FOREACH
END GetSentiment
```

The pseudocode for Score function implements the Naïve Bayes probabilistic classifier on customer feedback:

```
Function Score
   CALL ResetTokenCollection
   FOREACH ignore_words as ignore_word
      IF customer_feedbacks contains ignore_word
         remove ignore_word from customer_feedbacks
      END IF
   END FOREACH
   FOREACH negative_prefix_words as prefix
      IF customer_feedbacks contains prefix
         remove whitespace characters after prefix
            from customer_feedbacks
      END IF
    END FOREACH
    tokens = CALL GetTokens
      (arguments:customer_feedbacks) //returns an array
   initialize $total_score to zero
   initialize scores to empty array
   FOREACH classes as class
      SET scores[class] = 1
      FOREACH tokens as token
         IF length of token > minTokenLength
           AND length of  token < maxTokenLength
            AND token not in ignore_words
            IF dictionary[token][class] not empty
               SET count = dictionary[token][class]
               APPEND token to customer_tokens[class]
            ELSE
               SET count = 0
            END IF
            SET scores[class] *= (count + 1)
         END IF
         scores[class] = prior[class] * scores[class]
      END FOREACH
      FOREACH classes as class
         total_score = total_score + scores[class]
      END FOREACH
      FOREACH classes
      // round off result to 3 decimal places
         scores[class] = scores[class] / total_score
```

```
        END FOREACH
    END FOREACH
    sort scores in reversed order
    RETURN scores
END Score
```

The pseudocode for ResetTokenCollection which adds an entry to the customer_tokens array and initializes for the current customer's sentiment analysis:

```
Function ResetTokenCollection
    SET customer_tokens['pos'] to empty array
    SET customer_tokens['neg'] to empty array
    SET customer_tokens['neu'] to empty array
END ResetTokenCollection
```

The pseudocode for GetTokens function which performs preprocessing on and normalizes customer feedback:

```
Function GetTokens (parameters:customer_feedbacks)
    replace line endings in customer_feedbacks with
        spaces
    remove accents from customer_feedbacks
    convert customer_feedbacks to lowercase characters
    remove punctuations from customer_feedbacks
    break customer_feedbacks into individual words
    assign individual words into matches as array
    RETURN matches
END GetTokens
```

The psuedocode for GetAnalyzedTokens function which returns all the processed feedback tokens/features for display of the analyzed feedback words:

```
Function GetAnalyzedTokens
    RETURN customer_tokens
END GetAnalyzedTokens
```

The peudocode for GetAnalysisSummary function which returns the result of sentiment analysis for display purposes:

```
Function GetAnalysisSummary:
    initialize summary to empty array
    SET summary['post'] = 0
    SET summary['neg'] = 0
    SET summary['neu'] = 0
    SET max_key to empty string
    FOREACH customers as (key, value)
        SET highest = customers[key]['pos']
        SET max_key to string 'pos'
        IF customers[key]['neg'] > highest
            SET highest = customers[key][‘neg']
            SET max_key to string 'neg'
        END IF
        IF customers[key]['neu'] > highest
            SET highest = customers[key]['neu']
            SET max_key to string 'neu'
        END IF
        increment summary[max_key] by 1
    END FOREACH
    sort summary in reverse order
    RETURN summary
END GetAnalysisSummary
```

The pseudocode for GetAnalysisDetails function to return the result of the analysis process including the feedback tokens for display purposes:

```
Function GetAnalysisDetails
    RETURN customers
END GetAnalysisDetails
```

System Development

As a developmental research to perform sentiment analysis on customer feedbacks, the system was developed using Prototyping. The technique provided ways of monitoring the intermediate stages of the design process and the researchers were able to react and re-plan immediately based on the evaluation of the prototype.

According to Dennis, Wixom, and Roth [6], the prototyping has the following phases: planning, analysis, design, and implementation which are performed concurrently. Hence, this design methodology is easy to follow. All the phases in prototyping are performed one step after the other and the cycle repeats until the development of the new system is completed.

Planning Phase

This was the important phase in the development process as the result of planning steered the direction of the next design phases. The researcher conducted a quick review of existing literatures and related studies to support and strengthen the design of the system, especially on Naïve Bayes algorithm.

The researchers elicited information from the company owner to get the most accurate information and determine the requirements of the system. These needs include the system's inputs, processes and outputs.

The collection of words to support the system to perform sentimental analysis and the classifier code were obtained from PHPInsight [7]. As an open-source library, PHPInsight was extended with some functions being redefined to suit the needs of the study.

The system's data and its transformations were likewise included in the planning stage. Here, the researcher decided to use MySQL as the system's database given its availability, popularity and security strength. PHP was chosen as the server-side and Javascript as the client-side language with Visual Studio Code as the Integrated Development Environment (IDE) and XAMPP as the tool to manage the database and create the database tables.

Lastly, during this phase, the researcher determined the system's scope, constraints and features to a website with support for gathering customer feedback and performing sentiment analysis.

Analysis Phase

During this phase, the researcher delved deeper into what was acquired during the planning stage.The proponent analyzed the system's specification, requirements and the various components that interact in the system. After this stage, the researcher already had determined the UI components of the system and the processes that the data must undergo.

Since the study performed sentimental analysis using Naïve Bayes, the researcher studied prevailing studies, source codes and libraries implementing such algorithm in order to come up with a processing strategy.

Design Phase

In the design phase, the researcher designed the numerous User Interface components of the system. The system tables were designed using XAMPP with adherence to the principles of normalization and referential integrity so as to ensure consistency of data.

In order to perform sentimental analysis, a collection of positive, negative, neutral, ignore and prefix words were reviewed and updated to fit the cleaning services domain.

Implementation Phase

For the purpose of testing and validation, the system was installed locally. After each stage that the researcher came up with a system prototype, a screen capture of all the system interfaces were taken, annotated and sent to the end-user's email for approval. Each recommended change(s) from the end-user triggered an update of the system and generated a new system prototype until the end-user was satisfied with the system's prototype.

3. Evaluation Component

The accuracy of the system's analysis was evaluated using F-measure while the functionality of the system was evaluated using ISO 20510 Software Quality Standards

3.1 Accuracy Testing

The accuracy of the system's sentiment analysis was tested using F-measure otherwise known as a Precision-Recall measurement.

According to Hussan and Saraswahi [8], Precision-Recall metric is used to evaluate classifier output quality. Precision is the measures of result relevancy and accuracy while recall is a measure of how many relevant results are completely returned [9]. Precision and Recall was computed using this formula

$$Precision = \frac{tp}{tp + fp}$$

$$Recall = \frac{tp}{tp + fn}$$

$$F = 2\frac{Precision * Recall}{Precision + Recall}$$

The total number of True Positive and False Positive were tabulated and the precision and recall of the system was computed. The result of the computation was described using the scale shown in Table 1.

Table 1: Scale used in Interpreting the Result of the F-measure

Scale	Description
0.90 – 1.0	Excellent
0.80 – 0.90	Good
0.70 – 0.80	Fair
0.60 – 0.70	Poor
0.50 – 0.60	Fail

In order to perform sentiment analysis and perform F-measure, the respondents fed the system with 42 customer feedbacks to test not just the accuracy of the system's output but also the preprocessing steps of the system.

3.2Functionality Testing

The system's functionality was tested using ISO 20510's quality standards which include functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability [10].

Using purposive-sampling, ten (10) respondents were chosen consisting of Software Developers and Information and Communications Technology (ICT) Faculty Members for the evaluation of the system using ISO 25010.

The respondents entered customer feedbacks and using a questionnaire, rated the output of the system based on the system's functionality criteria.The rating scale used by the respondents is shown in Table 2.

Table 2: Scale used in interpreting the ISO 25010 Evaluation Results

Scale	Description
4.50 – 5.0	Excellent
3.50 – 4.49	Very Satisfactory
2.50 – 3.49	Satisfactory
1.50 – 2.49	Good
1 – 1.49	Poor

Result and Discussion

Accuracy Testing:

Based on the process of entering forty-two customer feedbacks and performing sentiment analysis, the process yields 41 True Positive, 1 False Positive and 0 False Negative.

Using formula substitution, the following are the key features of the system based on F-measure:

True Positive = $\frac{38}{42}$

= 0.905 or 90.5%

False Positive = $\frac{4}{42}$

= 0.095 or 9.5%

False Negative = $\frac{0}{42}$

= 0%

Precision = $\frac{0.905}{0.905+0.095}$

= $\frac{0.905}{1.00}$

= 0.905 or 90.5%

Recall = $\frac{0.095}{0.095 + 0}$

= 1.0

F = $\frac{(2 \times 0.905 \times 1.0)}{(0.905 + 1.0)}$

= $\frac{1.81}{1.905}$

= 0.95 or 95%

The True Positive of the system is 0.905 or 90.5% wherein the system was able to correctly classify 38 out of 42 customer feedbacks. It means that out of 42 feedbacks, the system was able to correctly classify the sentiment of 32 customer feedbacks. The False Positive was at 0.095 or 9.5% where 4 out of 42 customer feedbacks were incorrectly classified by the system. This signifies that the system incorrectly classified 9.5% of the total customer feedbacks.

Even if Naïve Bayes classifier is not perfect, like any other

classifiers, the precision of the system is 0.905 which was denoted as Excellent using the threshold published by Hussan and Saraswahi [8]. According to Dandekar [11], precision is a measure of how precise the recall is. The result implies that the system performed well in sentiment analysis. This further means that the system can classify 90.5% of the customer feedbacks correctly.

The recall of the system is 1.00 which according to the threshold published by Hussan and Saraswahi means Excellent [8]. According to Mouse [12], recall is the number of correct matches found by the system. The result implies that the system was excellent in classifying the feedback of customers and correctly performs sentiment analysis.

The F-measure value using the software's precision and recall rate is 0.95, denoted as Excellent. It implies that the accuracy of the system to classify customer feedbacks is Excellent using the threshold published by Hussan and Saraswahi [8]. This result was further supported by Irena and Goran [13] indicating that F-measure value ranging from 66% to 95% is considered favorable.

The first classification error was at feedback number 5, "I am expecting a very excellent service. I get the opposite.".The sentiment is negative but the system classified it as positive with the sentiment "excellent". Another error was at feedback number 8, "I would appreciate it if you could give your new customers like me some discount or promo" with "like" classified as positive despite being a neutral sentiment. The third error was at feedback number 10 "The other day was your very first service. I hope you could make it better next time. I have some issues and do call me if possible, immediately." and "hope" as the sentiment.

The first classification error was really hard for the algorithm to correctly predict. But the other errors we supposed were inherent with the algorithm. According to the definition, Naïve Bayes algorithm is based on Bayes theorem where the predictor or feature has strong or naïve independence, in this case, from other predictors in the customer feedback. A negative feedback such as "I filed a complaint. I perceived things to happen; an apology would have been nice" was classified as positive with "nice" as the positive word.

On the other hand, Naïve Bayes performed well for brief, direct feedbacks. For instance, the feedback "I like your service. It was fantastic" was classed correctly with "like" and "fantastic" as features; "Very warm and respectful cleaning crew" was classified as positive with "warm" and "respectful" as features.

Lastly, the algorithm is a numbers game, meaning, whichever class has the greatest number of features is the overall feedback.

Functionality Testing

The system was evaluated by 10 respondents in terms of functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability. Table 3 shows the result of evaluation.

Table 3: Result of Functionality Testing using ISO25010

ISO 25010 Characteristics	Mean	Description
Functional Suitability	4.37	Very Satisfactory
Performance efficiency	4.23	Very Satisfactory
Compatibility	4.35	Very Satisfactory
Usability	4.42	Very Satisfactory
Reliability	4.25	Very Satisfactory
Security	4.40	Very Satisfactory
Maintainability	4.34	Very Satisfactory
Portability	4.20	Very Satisfactory
Overall	4.32	Very Satisfactory

The grand mean of the evaluation is 4.32 which is denoted as Very Satisfactory. The overall Very Satisfactory rating obtained by the Cleaning Services website with Sentiment Analysis indicates that the stated requirements of the system have been achieved very satisfactorily.

Conclusion And Recommendation

Based on the foregoing results, the following conclusions were drawn:

1. Based on the test conducted to assess the accuracy of the system's sentiment analysis using F-measure, the precision of the system was Excellent at 0.95 and its accuracy was also Excellent at 0.95 which signified that the system can classify customer feedback with minimal error.
2. Based on the Very Satisfactory perception of 10 respondents pertaining to software quality of the system using ISO 20510 metrics, the system has satisfactorily passed its stated and implied functional needs and objectives;
3. Based on the Very Satisfactory perception of the respondents pertaining to the software quality of this study and the excellent accuracy and precision test result of the system's sentiment analysis using F-Measure, this study has satisfied its stated goals and objectives as outlined in the objectives of the study.
4. Naïve Bayes Classifier is not the perfect algorithm for performing sentiment analysis but its precision and accuracy rate is very much acceptable.

Considering the findings of the study and the conclusions drawn, the following recommendations are hereby presented:

1. It is highly recommended that the sentiment analysis of the system be implemented in other business website or for other text-mining requiring sentiment analysis.
2. It is recommended for future researchers to make a study to enhance the sentiment analysis process of the system by extending the Naïve Bayes classification. The algorithm is a "numbers game", "rule of the majority" where whichever class has the most number will be the dominant sentiment. This is not always true. There are instances that even a single opposite sentiment changes the overall sentiment of customer feedback.

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