An integrated Assessment System of Citizen Reaction towards Local Government Social Media Accounts

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Abstract

A government should use social media for communicating with its citizen. The engagement index score is one of the methods for assessing the rate of governmental success in using social media as a tool in establishing interactive relationships with its citizen. In general, the engagement index score is obtained by calculating the number of posts, number of likes and comments, and so forth on a single social media account. Therefore, we propose an integrated engagement index score for three social media: Facebook, Youtube and Twitter. In this work, we carry out a study for local governments in Indonesia. The engagement index score was adopted from the previous research. However, we modified the formula to get a better distribution score. Our modified formula generates the same ranking sequences with previous research. Also, Facebook and Youtubes' reaction are considered in this work to analyzes the quality of sentiments to a Facebook fan page and Youtube channel of local governments.

Introduction

Communication can be defined as the act of transmitting and receiving information. Communication is also an instrument that is used in a successful organization, (Lunenburg, 2010). As an organization, government should consider to improve the communication to its citizen. According to Thomas & Streib (2005), the internet is a medium for interaction between the citizens and the government. The numbers of Internet users have been growing nowadays. (Asosiasi Penyelenggara Jasa Internet Indonesia (APJII), 2017) stated that in 2017, the number of internet users in Indonesia had reached 143.26 million people which is 54.68% of the total population. This indicates a substantial gain when compared to internet user data in 2005 which is only 16 million people, or in percentage of 7.8% of the entire population in that year (Indonesia, 2014). To date, the government and the people of Indonesia tend to utilize the internet as a tool to fulfil their everyday needs. The success of the policies and programs offered by the government depends on how effective the communications are. The government should utilise the potential of internet services. According to (Welta, 2013), one of the steps which was taken by the government is to implement the usage of social media. The successful communications, not only the government takes the role in communicating or conveying information to the public solely, but also how society and government can interact each other, especially how people can use it as a way of expressing their aspirations, suggestions or criticisms (Hofmann et al., 2013). Social media itself is adopted to meet the need for the development of internet network technology that also supports the development of Web 2.0 (Bonso´n et al., 2012), namely the realm of technology that needs participation and feedback by the society and not limited to only 'displaying'.

A study (Purser, 2012), conducted in Australia, shows that although most local governments use social media in a variety of needs, the majority of them assumes that they have just started using this method and they are in the early stages of getting the experience. Only a quarter of those who have a formal evaluation process to measure the social media effectiveness they are using. Likewise, recent research in the United States (Halpern & Katz, 2012; Mossberger et al., 2013; Norris & Reddick, 2013) indicates that the usage of social media by US municipalities is still mostly a one-way communication (push strategy) from external government. In other words, it does not fulfill the objective of the social media itself, which is to supports the Web 2.0. Some of the benefits that can be gained from the usage of social media are: building close relationships, expanding channel relations and accommodating society comments or feedback. Another benefit of social media is providing various opportunities to get new advantages such as increasing the effectiveness and efficiency in interacting among the colleagues (Alabdulkareem, 2015). Social media also supports the creation and distribution of user-generated content. It also allows users to participate, share in communication and gather in various forms such as blogs, social

networks, forums, wikis and others (Kaplan & Haenlein, 2010). Therefore, social media can improve the quality of the citizens engagement.

According to the Regulation of the Minister of Administrative Reform and Bureaucratic Reform of the Republic of Indonesia Number 83 of 2012 concerning Guidelines for Utilizing Social Media of Government Agencies (Kemenpan, 2012), there are three categories of advantages that can be obtained by the government in using social media, namely: efficiency, ease of service/usage, and society involvement. The coverage of social media penetration in Indonesia is about of 87.13% of all internet (Asosiasi Penyelenggara Jasa Internet Indonesia (APJII), 2017). Therefore, in this study, the scope is limited to only concern the local government's social media accounts. This is mainly due to two reasons (Lev-On & Steinfeld, 2015). First, a decision created at the level of local gov- ernment could be able to have a direct impact on its population. Secondly, the level of website usage or social media by the local government is able to represent the beliefs and perspectives of the population towards the government itself. According to Pina & Torres (2001), the local government also plays a significant role in the daily lives of citizens, both in administration of the field of delivery services and in the field democratic participation (Musso et al., 2000; Sisk, 2001). Local societies are able to make direct contact with local governments (Gaventa & Valderrama, 1999) In addition, local governments are also important to strengthen the level of democratic participation (Licha, 2002).

In this paper, we have concerned ourselves with calculating the engagement index of the local government's social media in Indonesia. The Engagement Index (EI) is a measurement tool that is related to how far the government social media account is able to attract the attention of the public and produce interactive relationships through the features found in the social media. The proposed EI is adopted from the research (Bonsón et al., 2017), which involves likes, comments, and sharing data from Facebook. In this work, the EI is not only for Facebook, but we also extend the method for calculating the engagement index for Twitter and YouTube since those two social media are also popular in Indonesia. The main contributions of this work can be stated as follows:

- proposed combination for EI metric for Facebook, Youtube and Facebook
- described the use of social media in Indonesian local government

Literature Review

- ***Social Media in Indonesian Local Governments***

Indonesia consists of 32 provinces, 97 cities and 413 municipalities. In majority, those local governments has official media accounts. To identify the official account of each local government, we only take in social media accounts that are published in the official site of local government. Table 1 describes the number of official accounts in Facebook, Twitter and Youtube. Twitter is the most popular social media in local governments, followed by Facebook and Youtube.

Table 1. Social Media Accounts in Indonesia Local Government

Social Media	Official Account
Facebook	260
Twitter	297
Youtube	223

- ***Engagement Index***

Engagement Index is a method of measurement of the Engagement level obtained in a social media account. There are several research that measure social media account in a country by using a set of metrics (Jukic´ & Svete, 2018; Faber et al., 2019; Lev-On & Steinfeld, 2015; Bonso´n et al., 2017; Gruzd et al., 2018).

- Jukic´ & Svete (2018)

Social Media: Facebook Country: Slovenia Metrics:
  - Availability of link to the Facebook page on the official site
  - Availability of link to the official site on the Facebook page
  - Possibility of writing on the Facebook page by other users
  - Number of posts submitted by other Facebook users
  - Number of likes of posts
  - Number of shares of posts
  - Number of comments on posts
  - Number of comments submitted from municipality
  - Number of comments submitted from other users
  - Page level interaction rate
  - Number of polls
  - Number of prize contest

- Faber et al. (2019)

Social Media: Twitter, Facebook, LinkedIn, YouTube, and Instagram Country: Dutch Metrics:
  - Number of posts
  - Number of replies
  - Number of followers
  - Number of following

- Gruzd et al. (2018)

Social Media: Instagram and Twitter Metrics:
  - Number of posts

- Number of replies
- Number of likes of posts

- Bonso´n et al. (2017)

Social Media: Facebook Metrics:

- Number of posts
- Number of replies
- Number of followers
- Number of following
- Number of likes of posts
- Number of shares of posts
- Number of comments on posts

Those metrics were combined into a single metric which was called the engagement metric. We adapted this metric in our case.

Most works only present the statistical information of each means without combining them into a single metric. Therefore, it is hard to compare which government has a better performance in terms of citizen engagement.

Bonsón et al. (2017) proposed a metric for measuring the level of Engagement by specifying the types of certain parameter, namely Popularity, Commitment, and Virality. Those parameters are calculated based on Facebook likes, comments and share on a set of Municipalities on Europe. However the research only covers the Facebook fan page, and it does not consider other social media such as Twitter and Youtube.

Methods

In this section, the methodology of the study will be explained. Figure 1 describes the architecture of the application.

Initially, the data was obtained from each social media API, namely Facebook Graph API v3. 0 for Facebook, YouTube Data API v3 for YouTube, and Twitter API v3. 0 for Twitter. These data were crawled and stored in the MongoDB database. The scoring program (Scorer) automatically read the incoming data along with the attributes of the data. The scoring results were delivered back to the MongoDB database. Finally, the results of the assessment were be displayed on the website.

Data Acquisition

At this stage, data that are collected from the government social media will be carried out from YouTube, Facebook, and Twitter account through the crawling process. The crawling process is managed by using the Application Programming Inter- face (API) from each social

media site. Crawling will be done with the aim of taking the entire data owned by the local government social media account. The attributes of the social media data that are considered in the assessment are explained in Table 2.

Facebook Reaction was a feature released by Facebook in 2016. This feature is an extension of the previous traditional Like system. Facebook users is able to use the feature just like a Like system. There are five types of Facebook Reactions such as Like, Love, Haha, Sad and Angry which are described as emoji. By using this feature, the user is able to convey a reaction or response that is more varied. Therefore, the value of the sentiment statistics based on the good or bad of the reaction can be explored (Tian et al., 2017). Our work will take into account Facebook Reaction as one of engagement index parameter.
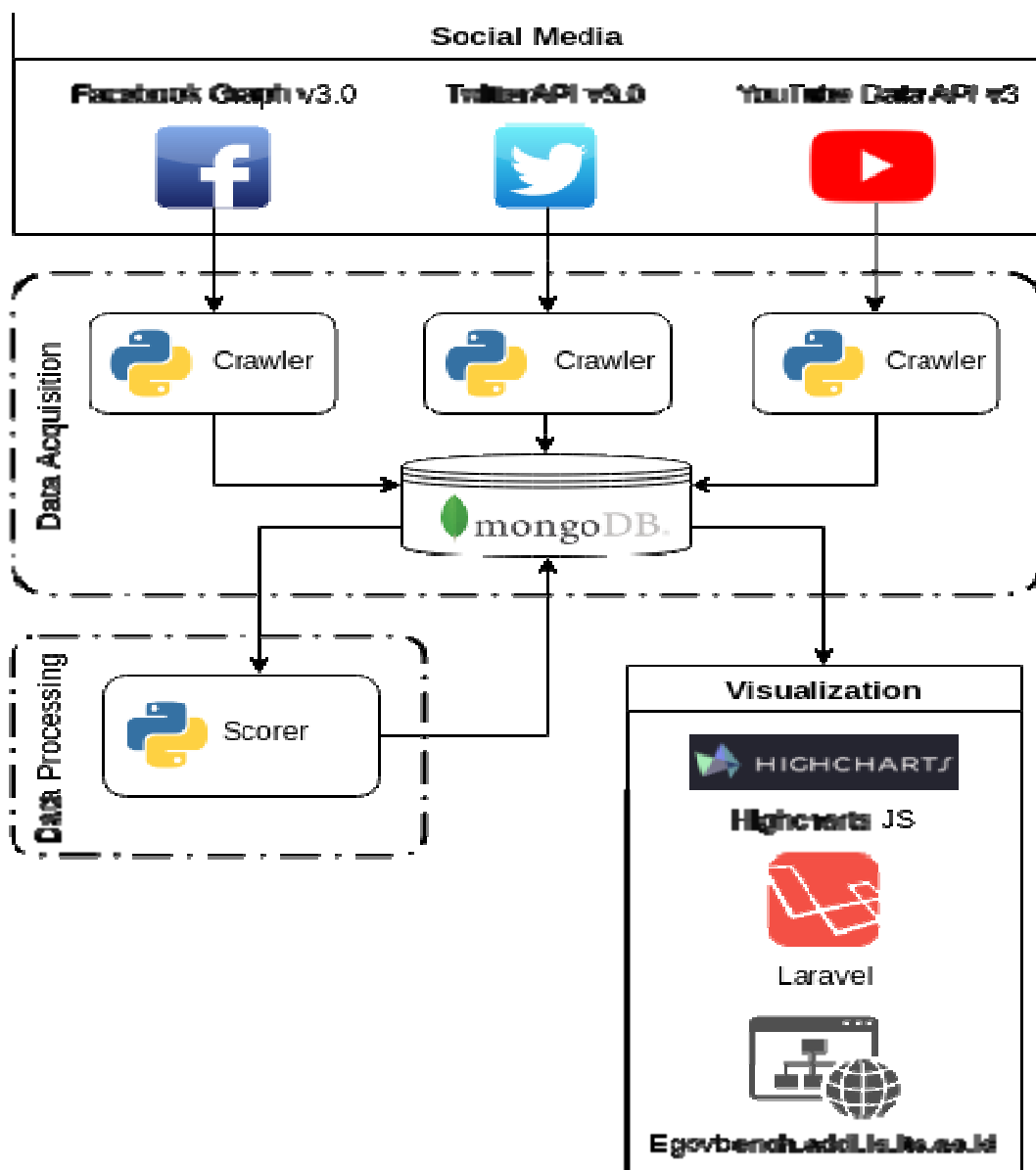

Figure 1. System architecture

Table 2. Social Media Attributes

Parameter	Facebook	Twitter	Youtube
Likes	Facebook Reaction: like	Like	Like
Comment	Comment	Reply	Comment
Share	Share	Retweet	
Fans	Follower	Follower	Subscriber count & Follower count
Sentiment Scoring	Facebook Reaction		Rating Youtube (like / Dislike)

Youtube Rating consists of Like and Dislike. The data have implications in the pattern of positive sentiments for Like and negative for Dislike, both of which come from features on YouTube. Since the Youtube API does not give any information about number of shares of posts, the share metric for Youtube is not available for measuring engagement index.

Engagement Index Scoring Method

Engagement Index score is calculated based on popularity, commitment and virality. The popularity calculation is based on the following metrics:

- Facebook: Number of likes
- Twitter: Number of favorite tweets
- Youtube: Number of likes

The commitment value depends on following metrics:

- Facebook: Number of Comments
- Twitter: Number of replies
- Youtube: Number of comments

The virality is obtained from the following metrics:

- Facebook: Number of shares of post
- Twitter: Number of re-tweet

Given P as a set of post p in a social media account, N as number of fans/-followers/subscribers and $M(p)$ as a function for calculating number of likes / comments/ replies / shares / retweets / favorite tweets depend on the metrics need to be calculated, then the popularity, commitment and virality can be formulated as follows:

$$S(P,N) = \frac{P_2 P M(p)}{|P|} \frac{N}{1000} \tag{1}$$

For instance, city X has social media account data with number of Facebook fans = 2392 and the list of post along with the stastical information of the post in Table 3.

Table 3. Facebook Fans Page for city X

Post ID	#likes	#comments	#shares
1	2	1	0
2	7	0	2
3	14	2	0
4	4	0	0
5	9	0	0

Suppose that $S_p(P,N)$ is the value of popularity, $S_c(P,N)$ is the value of commitment and $S_v(P,N)$ is the value of virality, then the Facebook enggagenent index of the city X social media account can be calculated as follows:

$$S_p(P,N) = \frac{2+7+14+4+9}{|5|} \frac{2392}{1000} = 3:01$$

$$S_c(P,N) = \frac{1+0+2+0+0}{|5|} \frac{2392}{1000} = 0.25$$

$$S_v(P,N) = \frac{0+2+0+0+0}{|5|} \frac{2392}{1000} = 0.9568$$

Note that, the above formula are modified for Youtube as follows:

$$S(P,N) = \frac{P_2 PM(p)}{|P|} = \frac{N}{1000} \tag{2}$$

N for Youtube is based on Number of subscribers and number of total of video views, which is defined as follows:

$$N = 0.5\text{Norm(subscribers)} + 0.5\text{Norm(views)} \tag{3}$$

where $Norm(x)$ is the normalisation formula to re-scale the data to have values between 0 and 1, which is calculated as follows:

$$Norm(X) = \frac{x_i - \min(X)}{\max(X) - \min(X)} \tag{4}$$

Suppose that city X has a Youtube channel with 1000 subscribers, 10000 views and five posts as described in Table 4. The maximum value for Youtube subscribers is 5000 and the minimum is 100 for Youtube channels of the Indonesia local governments. The maximum value for Youtube views is 30000 and the minimum is 2000 for Youtube channels of Indonesia local governments.

Table 4. Youtube channel for city X

Post ID	#likes	#comments
1	2	1
2	7	0
3	5	2
4	4	0
5	10	3

The value N for city X Youtube channels is calculated as follows

$$Norm_{subscribers}(X) = \frac{1000 - 100}{5000 - 100} = 0.18$$

$$Norm_{views}(X) = \frac{10000 - 2000}{30000 - 2000} = 0.28$$

$$N = 0.5 \; 0.18 + 0.5 \; 0.28 = 0.23$$

Suppose that $S_p(P, N)$ is the value of popularity and $S_c(P, N)$ is the value of commitment, then the Youtube engagement index of the city X social media account can be calculated and follows:

$$S_p(P, N) = \frac{2 + 7 + 5 + 4 + 10}{|5|} \; 0.23 = 1.288$$

$$S_c(P, N) = \frac{1 + 0 + 0 + 3 + 10}{|5|} \; 0.23 = 0.276$$

According to Bonson et al. (2017), the engagement index score (e) calculation will add up the values of popularity S_p, commitment S_c and virality S_v of social media account:

$$e = S_p(P, N) + S_c(P, N) + S_v(P, N) \tag{5}$$

However, the range of the results are vary. Thus, the formula is modified by using the logarithmic calculation:

$$e = \log \left(1 + (S_p(P, N) + S_c(P, N) + S_v(P, N))\right) \tag{6}$$

Based the city X information, the engagement index of Facebook fans page is:

$$e_{facebook} = \log(1 + 3.01 + 0.25 + 0.95) = 0.71$$

Since Youtube does not have virality score, the engagement index for Youtube is:

$$e_{Youtube} = \log \left(1 + (S_p(P,N) + S_c(P,N) + S_v(P,N))\right) \tag{7}$$

Therefore, the enggagement index of Youtube city *X* is:

$$e_{Youtube} = log(1 + 1.288 + 0.276) = 0.40$$

After all the social media enggament index in the same scale, we can combine them in one single metric as follows:

$$E + e_{facebook} + e_{twitter} + e_{youtube} \tag{8}$$

Suppose that city *X* engagement index for Twitter is 0.60, then the enggament index is:

$$E = 0.71 + 0.60 + 0.40 = 1.71$$

Facebook Reaction Score

The value of emoji sentiments has a nominal range between -1 to 1, where the negative value indicates a negative sentiment score, and the positive value indicates a positive sentiment score. The Facebook reaction data used is in the form of an emoji with scores determined by the results of the research conducted by Novak et al. (2015). The details of the score will be described in Table 5.

Table 5. Facebook Reactions Emoji Score

Name	Image	Sentiment Score
Like		0.521
Love		0.746
Haha		0.221
Wow		0.123
Sad		0.007
Angry		-0.173

Let *R* be a set of Facebook reaction score and *F(p, i)* as a function for calculating number of reaction *i*, then the reaction score of a social media account is For example, the Facebook of city *X* has Facebook reaction in Table 6.

$$F \, B \, Reactions \, core \, (M, S) = \frac{r_i F(p, i)}{F(p, i)} \tag{9}$$

Table 6. Facebook Reaction Post of city X

Emoji	Sentiment	#Reactions	FReactionScore
Like	0.521	100	0.212
Haha	0.221	50	0.0451
Sad	0.007	40	0.0011
Angry	-0.173	30	-0.0212
Wow	0.123	15	0.0075
Love	0.746	10	0.0304
Total		245	0.2756

The Facebook reaction score of city X is 0.2756.

Youtube Reaction Score

The YouTube reaction score is based on the number of likes and dislike which is de- fined as the ratio of number of likes and total of number likes and dislikes of a Youtube channel. The formula of youtube reaction score can be defined as follows:

$$Y_{Reaction \, Score} = \frac{l}{l + d} 100 \tag{10}$$

where l = number of likes and d = number of dislikes For example, the Youtube channel of city X has number of likes and dislikes in Table 7.

Table 7. Youtube Reaction Post of city X

ID Video	Like	Dislike	Like + Dislike
1	90	6	96
2	25	2	27
3	68	10	78
4	35	4	39
5	12	1	13
Total	230	23	253

The Youtube reaction score of city X is:

$$Y_{Reactopm\ Score} = \frac{230}{230 + 23}\ 100\% = 90.9\%$$

Results

Table 8 shows the 10 highest engagement scores of Indonesian local governments on June 22, 2018, where the detail of engagement index of each social media are presented in Table 9. Bengkulu Selatan reaches the high score since the Bengkulu Selatan's Facebook and Twitter score are the highest score in Indonesia Local Governments.

The members of top ten highest Facebook reaction scores in Table 10 differs from the member of top ten highest engagements scores in Table 11. As seen in Table 11,

Table 8. Engagement Index Scoring Results

Rank	Local Governments	Score
1	KAB. BENGKULU SELATAN	179.82
2	KAB. KARIMUN	173,73
3	KOTA TOMOHON	162,16
4	KAB. TAPIN	160,64
5	KAB. PROBOLINGGO	150,57
6	KAB. BELITUNG TIMUR	148,68
7	KAB. SUKOHARJO	146,38
8	KOTA SAWAHLUNTO	141,29
9	KAB. BLORA	137,4
10	KAB. HULU SUNGAI UTARA	130,87

Table 9. The Details of Engagement Index Scoring Result

Rank	Facebook	Twitter	Youtube	Total Score
1	79.82	100	0	179.82
2	36.79	69.46	67.48	173.73
3	36.69	71.76	53.71	162.16
4	39.96	61.68	59	160.64
5	36.14	41.23	73.2	150.57
6	35.81	39.99	72.88	148.68
7	24.53	21.85	100	146.38
8	50.11	31.9	59.28	141.29
9	35.84	36.75	64.81	137.4
10	31.1	49.86	49.91	130.87

Table 10. Facebook Reaction Scoring Result

Rank	Local Government	Facebook Reaction
1	KOTA PALEMBANG	0.56386
2	KAB. SOPPENG	0.5628
3	KAB. MINAHASA SELATAN	0.55082
4	KAB. WONOGIRI	0.539
5	KAB. BANYUWANGI	0.53855
6	KAB. TANAH DATAR	0.53831
7	KOTA BITUNG	0.53742
8	KOTA MADIUN	0.53607
9	KAB MOROWALI	0.53506
10	PROVINSI RIAU	0.53284

Palembang obtains the first position. Although it's number of likes and loves are lower than Soppeng, but Palembang does not get any sad and angry reaction.

Table 12 shows that 13 local governments got a perfect score (100) for Youtube rating score. However, according to Table 13, the number of likes of those 13 local governments is less than other local governments that are in position 14. They have obtained the perfect score since they have not had any dislikes in their Youtube channel. There- fore, in the future, we should consider to give a weight for likes feature.

Figure 2-4 displays the visualization of the ranking of social media. The stacked graph in Figure 2 presents the engagement index score for each social media. The color blue denotes a city, color blue represents a municipality and color red denotes a province in Figure 3 and 4

Now, we compare the three types of scores namely unmodified formula score, the score after logarithmic operation applied and the score after the logarithmic and normalization applied.

Table 11. Detailed Facebook Reaction Scoring Result

Like	Haha	Love	Sad	Wow	Angry	Score
17	0	4	0	0	0	0.56386
4539	49	1320	19	43	8	0.5628
72	0	11	0	0	0	0.55082
23	0	2	0	0	0	0.539
329952	1105	37092	784	2404	194	0.53855
12	0	1	0	0	0	0.53831
216	0	17	0	0	0	0.53742
46724	232	4247	33	157	45	0.53607
1013	0	70	1	0	0	0.53506
108	0	6	0	0	0	0.53284

Table 12. Youtube Rating Scoring Result

Rank	Local Government	Score
1	KAB. SOPPENG	100
2	KAB. BELITUNG TIMUR	100
3	KAB. GARUT	100
4	KAB. TASIKMALAYA	100
5	KAB. INDRAMAYU	100
6	KAB. SUBANG	100
7	KOTA BATU	100
8	KOTA PEMATANG SIANTAR	100
9	KOTA TANJUNG BALAI	100
10	PROVINSI SUMATERA UTARA	100
11	KAB. SUKOHARJO	100
12	KAB. KULON PROGO	100
13	PROVINSI D.I.YOGYAKARTA	100
14	PROVINSI KALIMANTAN SELATAN	99.12
15	KOTA BENGKULU	98.91
16	KODYA JAKARTA PUSAT	98.67
17	KAB. TANAH BUMBU	98.01
18	KAB. TEGAL	97.67
19	KAB. GRESIK	97.56
20	KOTA PARE PARE	97.52

Table 13. Detailed Youtube Rating Scoring Result

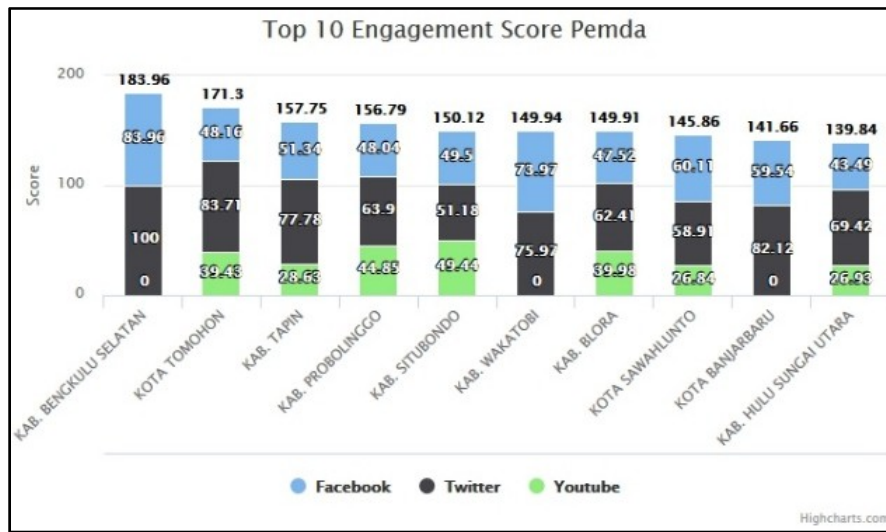| Rank	Like	Dislike	YouTube Score	Rating
1	4	0	100	
2	4	0	100	
3	53	0	100	
4	2	0	100	
5	1	0	100	
6	1	0	100	
7	6	0	100	
8	7	0	100	
9	6	0	100	
10	11	0	100	
11	8	0	100	
12	1	0	100	
13	18	0	100	
14	113	1	99.12	
15	182	2	98.91	
16	372	5	98.67	
17	296	6	98.01	
18	42	1	97.67	
19	40	1	97.56	
20	197	5	97.52	

Figure 2. Engagement Index Score Rank Visualization
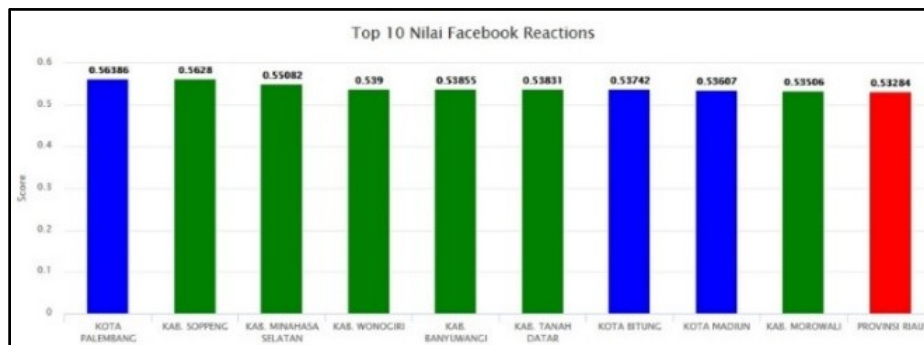

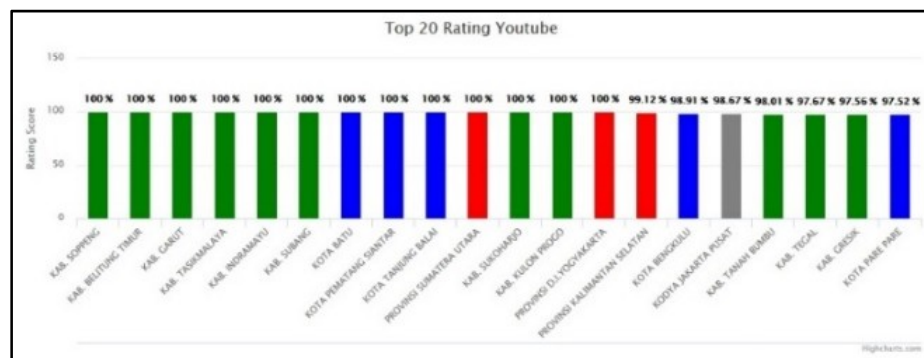**Figure 3.** Facebook Reaction Rank Visualization

Figure 4. YouTube Rating Rank Visualization

Based on Table 14, it can be seen that the score before the formula is modified, the score after logarithm, and the normalization score (final score) produce the same ranking sequence. By looking at Figure 5 and 6, the modified score graph looks normal.

Table 14. Comparison score of Engagement Index Scoring Results

rank	unmodified formula	logarithmic operation applied	normalization applied (Final Score)
1	68,97	1,84	79.82
2	17,51	1,27	50.11
3	9,25	1,01	39.96
4	7,52	0,93	36.79
5	7,44	0,93	36.69
6	7,20	0,91	36.14
7	7,06	0,91	35.84
8	7,05	0,91	35.81
9	5,12	0,79	31.1
10	3,17	0,62	24.53

Table 15. The summary of scores

	Min	Q1	Median	Q3	Max
Scores with un modified formula	3.17	7.05	7.32	8.81	68.96
Scores after nor malization (Final score)	24.53	35.81	36.41	39.1	79.8

Table 15 shows that the unmodified score (using the formula in the study Bonso´n et al. (2017)) generates a various range of values, where the minimum value is 3.17, and the maximum value is 68,97. While our modified formula has produced a more even distribution, and it will give more benefits to a local government who has just created a social media account recently.

Conclusion

We have presented the engagement index score for three social media: Facebook, Youtube and Twitter. Those three social media were chosen since they are mostly used by local governments in Indonesia. Based on those three social media characteristics, we adopted the formula proposed by Bonso´n et al. (2017). The formula consists of three components namely popularity, commitment and virality. Facebook and Twitter have those three components,

where Youtube only has the popularity and commitment components. Since we could not get the number of shares from Youtube's API,We proposed a modified formula from Bonso´n et al. (2017) formula by using the logarithmic function and normalization score. Our modified formula generates the same ranking sequences with Bosson formula. The modified formula produces a more centralized data distribution engagement index score. In addition, we have described the Facebook reaction score and Youtube reaction score as one of the ranking methods for engagement indexing score. For the next step, we should give different weights for those three components since the commitment requires more effort than popularity and virality. Furthermore, the Facebook reaction can be taken into account in the Engagement index score.
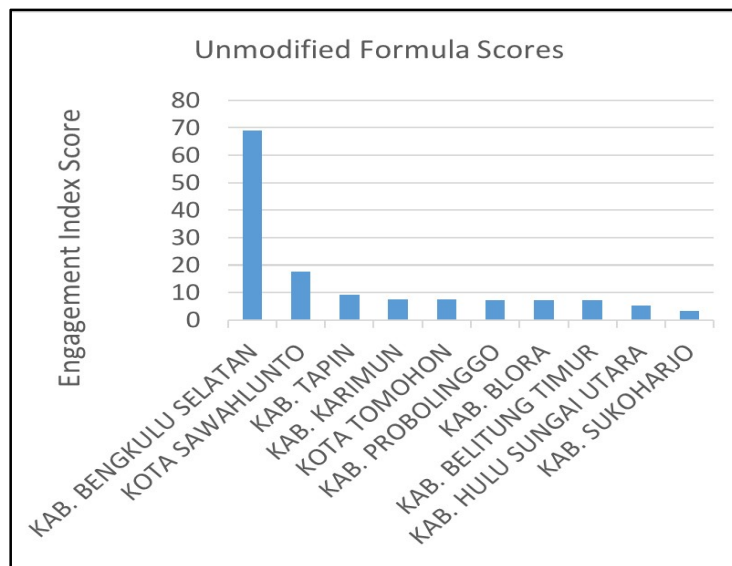

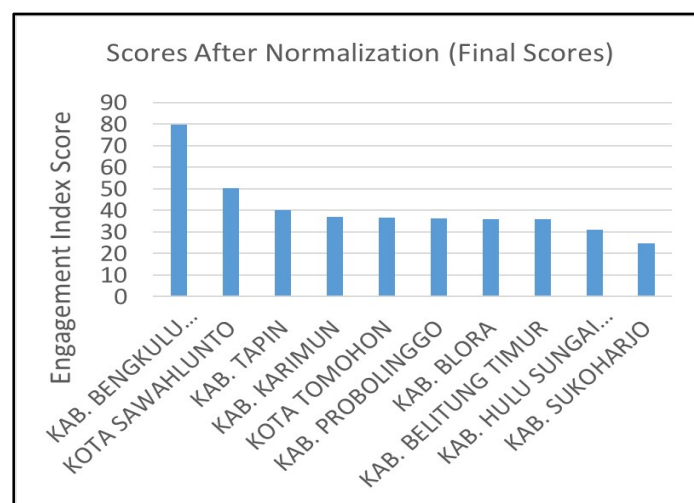**Figure 5**. Scores from unmodified formula

Figure 6. Scores after normalization (final scores)

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