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Social Network Analysis of Twitter Users on BTS Topic Using Degree Centrality, Betweenness Centrality, and Closeness Centrality

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Abstract

Nowadays, a trademark is starting to be built through content on social media by involving influencers whose roles are increasingly needed in digital marketing. Hence, finding them on social media networks is an important thing. In brand recognition, BTS has a great influence where a brand they collaborate with gets an enthusiastic response from fans who participate in disseminating information and recommending it to others via Twitter. Therefore, this study aims to identify the potential influencer on the delivery of information on the topic of BTS on Twitter using social network analysis. Social network analysis applies the concept of graph theory where the potential influencer which is denoted by the central vertex is measured by measures of centrality, namely degree centrality, betweenness centrality, and closeness centrality. The result of the network consists of 649 vertices and 730 directed edges that form a disconnected and directed network with 67 weakly connected components. This study indicates that the influencers in the network can be fan accounts or fanbase accounts.
Keywords: BTS; centrality; central vertex; influencer; social network analysis; Twitter.

Abstrak

Dewasa ini, suatu merek dagang mulai dibangun melalui konten di media sosial dengan melibatkan pemengaruh yang perannya semakin dibutuhkan pada pemasaran digital sehingga menemukan mereka di jaringan media sosial adalah suatu hal yang penting. Dalam pengenalan merek, BTS memberikan pengaruh yang besar dimana suatu merek yang berkolaborasi dengan mereka mendapat respon antusias dari penggemar yang ikut menyebarluaskan informasi dan merekomendasikannya kepada orang lain melalui Twitter. Oleh karena itu, penelitian ini bertujuan untuk mengidentifikasi pemengaruh potensial dalam penyampaian informasi pada topik BTS di Twitter menggunakan analisis jaringan sosial. Analisis jaringan sosial menerapkan konsep teori graf dimana simpul sentral diukur dengan ukuran sentralitas, yaitu sentralitas derajat, sentralitas keantaraan, dan sentralitas kedekatan. Diperoleh jaringan dengan 649 simpul dan 730 sisi berarah yang membentuk jaringan berarah tak terhubung yang terdiri atas 67 komponen terhubung lemah. Adapun hasil dari penelitian ini menunjukkan bahwa simpul sentral atau pemengaruh dalam jaringan dapat berupa akun personal dari pengemar (fan account) atau akun basis penggemar (fanbase).
Kata Kunci: *analisis jaringan sosial, BTS, pemengaruh , sentralitas, simpul sentral, Twitter.*

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1. INTRODUCTION

The marketing strategy of a brand in the current digital era utilizes the role of influencers, which is becoming a trend and will continue to increase in the future [1]. Hence, is important to determine the right influencer for e-commerce, online shops, or producers of goods and services in offering their products. An influencer on social media can be identified using social network analysis methods by

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looking at the intensity of interaction between users [2]. This mathematical approach can study the relationship between groups, organizations, or individuals through the application of graph theory where the vertices represent individuals and the edges represent social relations [3].

In social network analysis, there are measures of centrality to identify which vertex has a more important or central position. Several measures like Degree Centrality and Eigenvector Centrality [4], Betweenness Centrality and Closeness Centrality [5], [6] play an important role which particularly can be used to identify influential vertex in social networks. Furthermore, this study applied to identify influencers on Facebook [7], [8] or Twitter [5], [6] and many other social media platforms. Some recent studies allow this method to be applied in a variety of issues such as to analyze coauthorship networks in academic issues [9], to identify opinion leaders in political issues on the Twitter social network [10], [11], to study the influential actors in a network in the dissemination of information related to vaccines of covid 19 on Twitter conversation [12], [13], to analyze a brand marketing network in economical issue[4], [14], etc. So, in this study, degree centrality, betweenness centrality, and closeness centrality were applied in the case of influencer identification. Degree centrality indicates a vertex with a maximum degree, betweenness centrality which indicates a vertex that is often located between two other geodesic vertices, and closeness centrality which indicates a vertex with a minimum distance to each vertices in the network [15].

Social network analysis is widely used to observe the spread of information on social media, especially Twitter. Twitter provides convenience in retrieving data through API access, compared to other social media. Through Twitter, abundant data can be obtained with various topics that can be used as information for digital marketing. Various topics are grouped based on certain keywords or hashtags using the trending topic feature so that users can find out what is currently popular [16]. In this study, research by keyword is used to obtain relevant data to a given topic that is discussed by users [17] to find out and reach the right targeted community [18].

This study was conducted to analyze the social network of Twitter users on the topic of BTS. BTS (*Bangtan Sonyeondan*) is a South Korean music group that has been actively using Twitter as the main communication medium with fans since 2013. They have been known as the public figures with the most retweeted tweets in 2020 [19]. In product marketing, they become a brand ambassador with a strong influence. This can be seen from the high response from fans in conversations on Twitter to recommend brands that collaborate with them [20]. The potential of BTS fans to become influencers who give their opinions by recommending brands to others through their interaction activities is something that will be investigated. Thus, this study will identify the influencer in the delivery of information related to the topic of BTS on Twitter using social network analysis with measures of degree centrality, betweenness centrality, and closeness centrality. These measurements are chosen because it is the first known centrality measures that existed and even though the concept is simple it can be effectively used.

2. METHODS

The data in this study was obtained from Twitter through crawling with the keyword "BTS" which was taken on February 24, 2022, at 17:54 WITA with RStudio. The keyword "BTS" was chosen because hashtags, mentions, and words "BTS" became one of the most referring tweets to the group music of BTS [21]. There were 1000 collected tweets within the time stamp 17:21-17:37 WITA. To know the relatively short time interval this study results in only the influencers that particularly for the obliged data in this research and can not be generalized, but still can be considered effective since this period coincides with the first announcement of collaboration between CGV Indonesia, CBI pictures and BTS [22] which can imply the right momentum to get intense conversation about the product among Twitter users [23]. Afterward, the data component consists of the data of the user who made the tweet, the data of the user who was replied to, the data of the user who was mentioned, and the

data of the user who was retweeted. This data is filtered so that each user has at least 100 followers to avoid fake accounts. The users are coded in the form of a unique number to form vertices data. The reply, retweet, or mention between vertices defined the directed edges. The weight of directed edges is the number of interactions between two vertices. Furthermore, the vertice data and edges data are created network graph model to be analyzed and visualized. Analysis measures used are in-degree centrality, out-degree centrality, betweenness centrality, and closeness centrality.

Table 1. Example of dataset

Created_at	2/24/2022, 17:37
Screen_name	Apayakepodehwk
Reply_to_screen_name	Inakimfl
Retweet_screen_name	-
Tweet 1	"@inakimfl @armyfess_ ya kaya kamu nonton streaming konser bts online kaya biasa yg di web kiswe, tp ini nobar di bioskop. di luar negri juga harganya segituan, malah lebih mahal"
Created_at	2/24/2022, 17:21
Screen_name	Laviedenoona
Reply_to_screen_name	anothersteffi
Retweet_screen_name	-
Tweet 2	"@anothersteffi @rahmdess27 @BTS_twt @BIGHIT_MUSIC Nanti lanjut lagi"

Table 2. Examples of edges (relationships) and weights

No	Edges	Relationships	Weights
1	apayakepodehwk-> armyfess	1 Mention	1
2	apayakepodehwk-> inakimfl	1 Mention , 1 Reply	2
4	laviedenoona-> anothersteffi	1 Mention , 1 Reply	2
6	laviedenoona-> BIGHIT_MUSIC	1 Mention	1
7	laviedenoona-> BTS_twt	1 Mention	1
8	laviedenoona-> rahmdess27	1 Mention	1

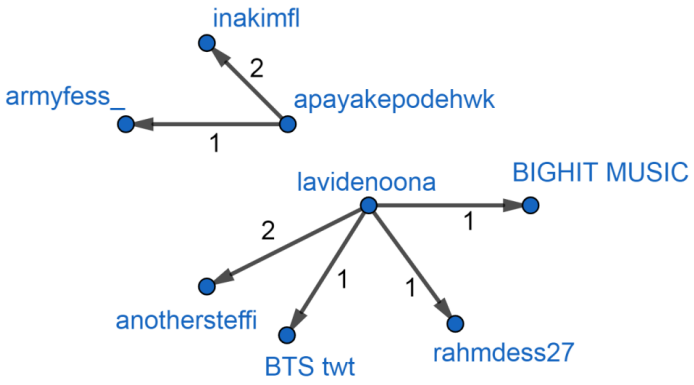

Figure 1. Example of a dataset graph

2.1 In-degree centrality

In-degree centrality is defined as

$$C_{D_{in}}(v_k) = \sum_{i=1}^{n} w_{ik} \, . \tag{1}$$

To remove the influence of network size from the centrality value, centrality with a scale is used. In-degree centrality with scale is the result of comparing the in-degree centrality with the maximum degree centrality value [15] as follows,

$$C_D{}^{maks} = \begin{cases} n-1, & unweighted\ graph; \\ (n-1).w^*, & weighted\ graph; \end{cases} \tag{2}$$

where $C_{D_{in}}(v_k)$ is in-degree centrality of vertex v_k, $C'_{D_{in}}(v_k)$ is in-degree centrality with the scale of vertex v_k, $C_D{}^{maks}$ is maximum degree centrality, w_{kj} is weight of directed edge with initial vertex v_k and terminal vertex v_j, w^* is maximum weight on a graph, and n is total number of vertices in the graph.

2.2 Out-degree centrality

Out-degree centrality of vertex v_k ($C_{D_{out}}(v_k)$) is defined as

$$C_{D_{out}}(v_k) = \sum_{j=1}^{n} w_{kj} \, , \tag{3}$$

where w_{kj} is the weight of the directed edge with initial vertex v_k and terminal vertex v_j. Out-degree centrality with scale, denoted by $C'_{D_{out}}(v_k)$, is the result of comparing the value of the out-degree centrality $C_{D_{out}}(v_k)$ with the maximum degree centrality value.

2.3 Betweenness centrality

The vertex with high betweenness centrality is most often traversed by the shortest path of the other vertices or located between two other geodesic vertices and is defined as

$$C_B(v_k) = \sum_{\substack{i=1 \\ i \neq k}}^{n} \sum_{\substack{j=1 \\ j \neq k \\ i \neq j}}^{n} \frac{g_{ij}(v_k)}{g_{ij}} \, . \tag{4}$$

Betweenness centrality with scale is the result of comparing the value of the betweenness centrality with the maximum betweenness centrality value as follows,

$$C_B{}^{maks} = \begin{cases} n^2 - 3n + 2, directed\ graph; \\ \dfrac{n^2 - 3n + 2}{2}, undirected\ graph; \end{cases} \tag{5}$$

where $C_B(v_k)$ is betweenness centrality of vertex v_k, $C'_B(v_k)$ is betweenness centrality with the scale of vertex v_k, $C_B{}^{maks}$ is maximum betweenness centrality, $g_{ij}(v_k)$ is total number of geodesics connecting v_i and v_j containing v_k, g_{ij} is total number of geodesics connecting v_i and v_j, and n is total number of vertices in the graph.

2.4 Closeness centrality

Closeness centrality indicates a vertex with a minimum distance to each vertex in network and is defined as

$$C_c(v_k) = \frac{1}{\sum_{i=1}^{n} d(v_i, v_k)}, \tag{6}$$

Closeness centrality with scale is the result of comparing the value of the closeness centrality with the maximum closeness centrality value as follows,

$$C_C{}^{maks} = \begin{cases} \dfrac{1}{(n-1)}, \ unweighted\ graph; \\ \dfrac{1}{(n-1).w^-}, \ \ weighted\ graph; \end{cases} \tag{7}$$

where $C_c(v_k)$ is closeness centrality of vertex v_k, $C_C{}^{maks}$ is maximum closeness centrality, $d(v_i, v_k)$ is geodesics distance connecting v_i and v_k, w^- is the minimum distance contained in the network, and n is total number of vertices in the graph.

3. RESULTS AND DISCUSSIONS

In this study, the influencer of the delivery of information related to the topic of BTS on Twitter is sought. Identification of influencers was carried out using social network analysis with measures of degree centrality, betweenness centrality, and closeness centrality. The results obtained are in the form of a graph model of the Twitter user's social network, analysis and visualization of the network, as well as the interpretation of the results of the identification of potential influencers in the network.

3.1 Network Analysis and Visualization

The social network of Twitter users shown in Figure 2 consists of 649 vertices and 730 directed edges that form a disconnected and directed network with 67 components. These components are weakly connected networks. Small-sized components are scattered on the outermost or at the side of

the network, while the main network (the component with the largest size) is in the middle and looks like a cluster of clustered dots. The weight of directed edges defines the strength of the relation between two adjacent vertices, so each weight is inverted first to get the distance. Furthermore, Dijkstra's algorithm is applied to find the shortest path (geodesic) between the vertices [24]. For the unconnected vertices, there are given a distance equal to the network size (n= 649).

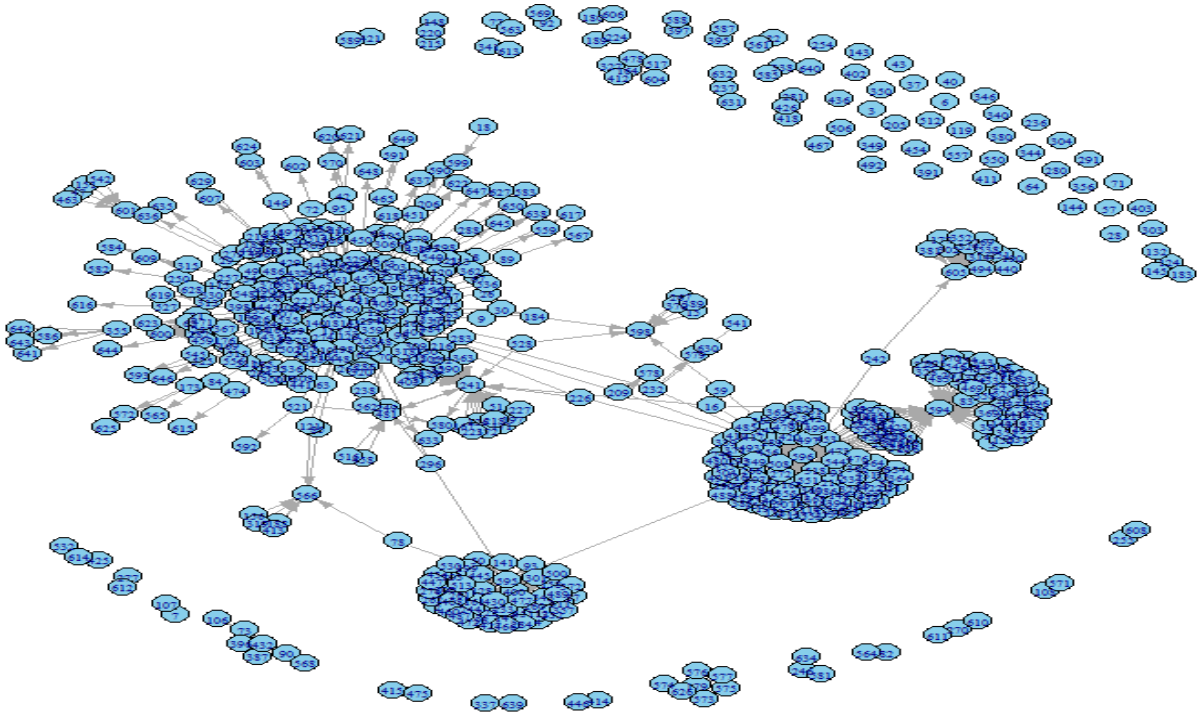

Figure 2. Twitter user network

3.2.1 In-degree Centrality

The number of tweets of a user being retweeted, replied to, or mentioned by other users is interpreted as in-degree centrality [25]. A vertex with a high in-degree centrality is seen as a point in the center of the network where many arrows from other vertices around it are pointed. The vertices with the lowest in-degree values or isolated vertices are scattered at the side of the network as shown in Figure 3. The vertices that receive many ties are often said to have high authority, i.e., many other vertices seek to direct ties to them which indicates the importance of their position in the network [26]. The calculation results of ten vertices with the highest in-degree centrality are shown in Table 3.

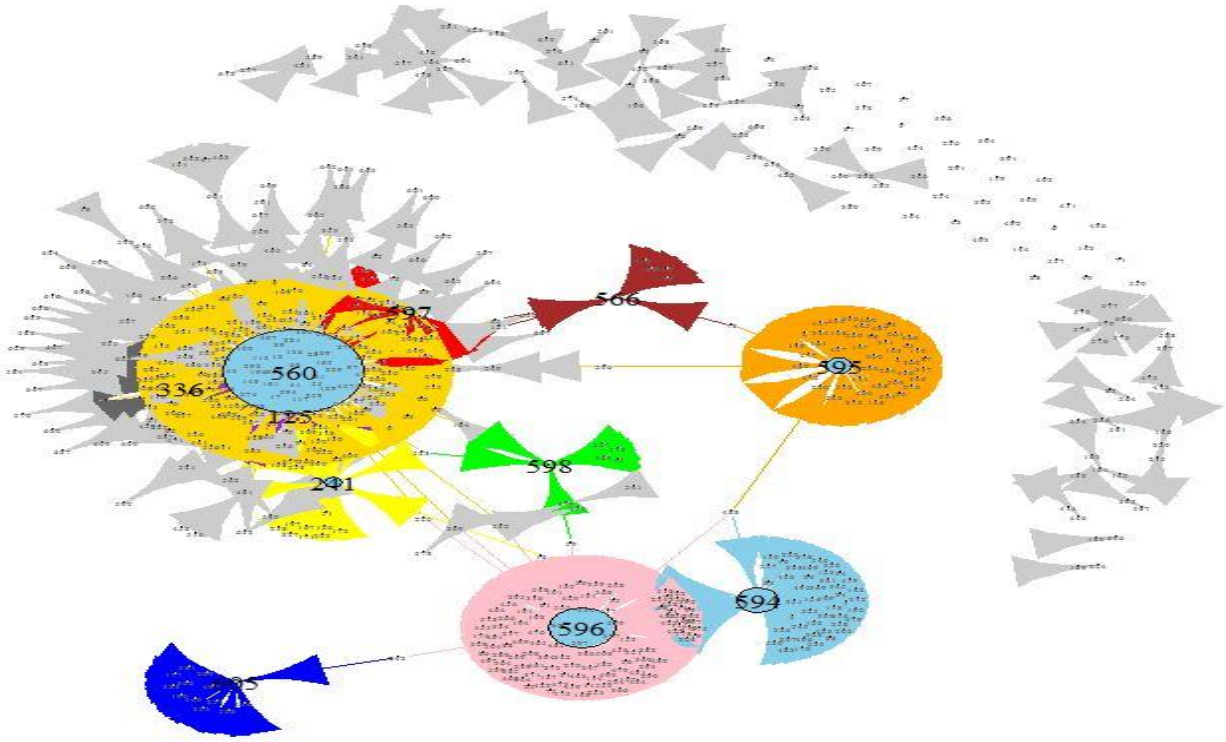

Figure 3. Network by In-degree centrality

Table 3. In-degree Centrality of Vertices

Vertex	User	In-degree Centrality	Scaled In-degree Centrality
v_{560}	BTS_twt	497	0.038348
v_{596}	CGV_ID	243	0.018750
v_{594}	CBIpictures	148	0.011420
v_{595}	BTStranslation_	98	0.007562
v_{241}	laviedenoona	69	0.005324
v_{597}	Univers_Bangtan	36	0.002778
v_{605}	vallerylia	28	0.002160
v_{125}	_peuupeuuu	15	0.001157
v_{598}	chizikook_	14	0.001080
v_{336}	Mcyxjm	14	0.001080
v_{566}	7btsupdates	14	0.001080

3.2.2 Out-degree Centrality

Out-degree centrality shows how many times a user retweet, replies, or mentions other user's tweets [25]. A vertex with a high out-degree centrality is indicated as a point that gives many exit arrows to other vertices. This vertex is often said to be an influential vertex because it can exchange ideas with many people or make others aware of their views [26]. Figure 4 gives a visualization of the network based on the centrality of the out-degree. The vertices with a high out-degree centrality were

mostly within the main network indicating that conversations occurred more frequently within it than other components. The calculation results of ten vertices with the highest out-degree centrality are shown in Table 4.

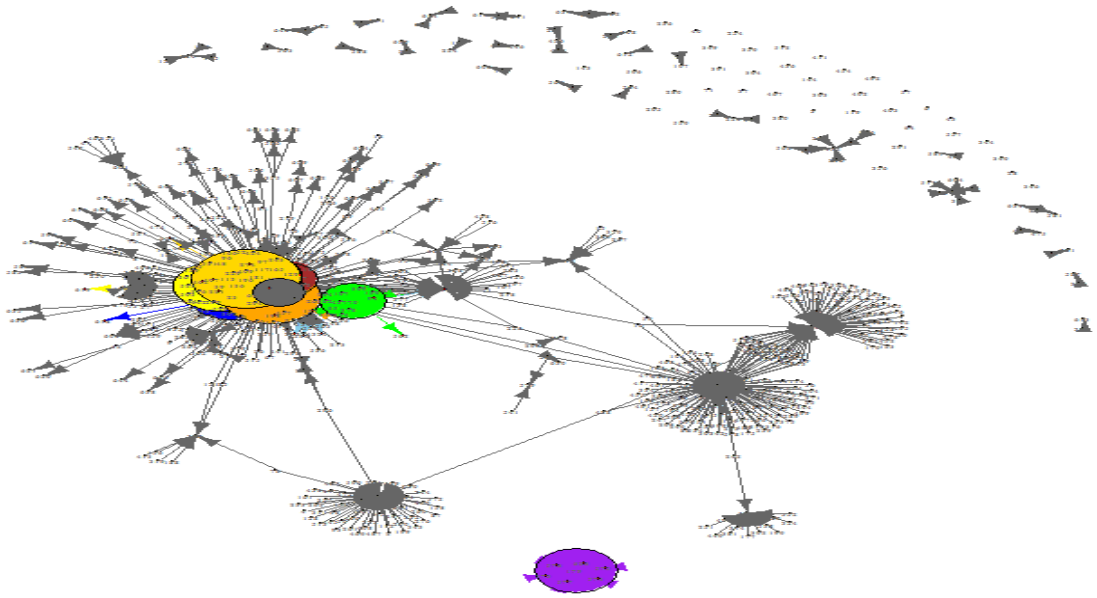

Figure 4. Network by Out-degree centrality

Table 4. Out-degree Centrality of Vertices

Vertex	User	Out-degree Centrality	Scaled Out-degree Centrality
v_{196}	staeberriyy	21	0.001620
v_{125}	_peuupeuuu	20	0.001543
v_{136}	littleejung	20	0.001543
v_{41}	jjkluvv7	19	0.001466
v_{39}	Curhatansuka	18	0.001389
v_{23}	Arcymera	17	0.001311
v_{181}	tegikuks	17	0.001312
v_{179}	furtari	16	0.001235
v_{70}	Gbrlje	13	0.001003
v_{55}	voojwankoo	12	0.000926

3.2.3 Betweenness Centrality

Vertex with a high value of betweenness centrality is visualized as a point that bridges the path from the vertices that give it incoming ties to the vertices that give outgoing ties. Figure 5 shows the paths that pass through the vertex v_{241} (@laviedenoona) that get the highest value. A vertex with a high betweenness centrality value has an important role in establishing communication between vertices and without this vertex, it can cut off the flow of information in the network. In Table 5, the

ten highest betweenness centrality values obtained using the RStudio software are given.

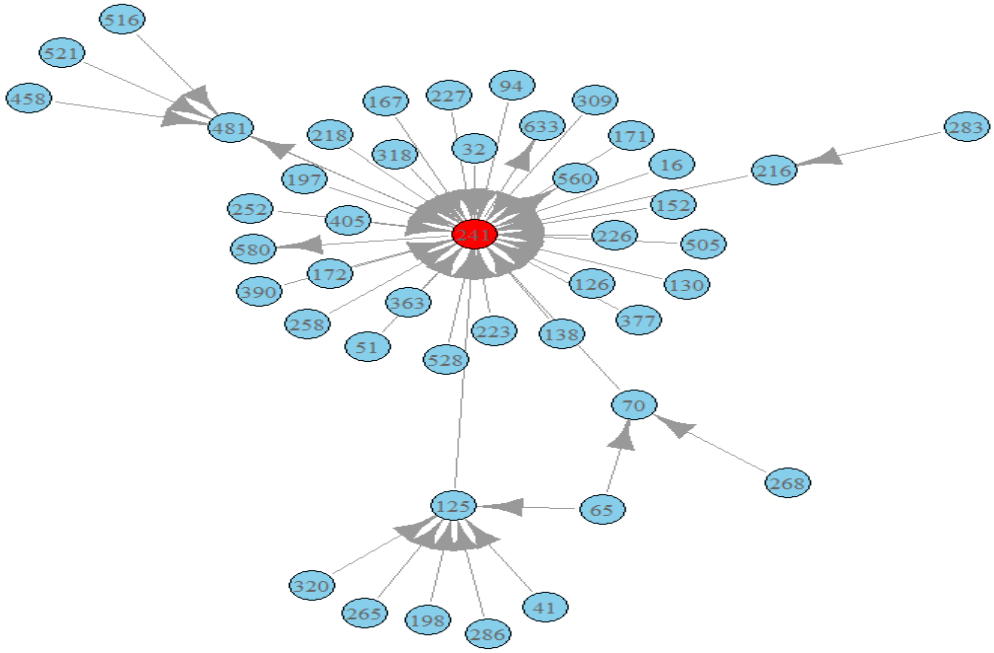

Figure 5. Betweenness centrality of vertex v_{241}

Table 5. Betweenness Centrality of Vertices

Vertex	User	Betweenness Centrality	Scaled Betweenness Centrality
v_{241}	laviedenoona	129.5	0.0003088805
v_{125}	_peuupeuuu	65	0.0001550365
v_{70}	Gbrlje	25	0.0000596294
v_{136}	littleejung	25	0.0000596294
v_{221}	gfkatehaaa_	19	0.0000453183
v_{65}	ssgmin95lv	18	0.0000429332
v_{39}	Curhatansuka	17	0.0000405480
v_{164}	BTS_PERSONA	13	0.0000310073
v_{481}	rahmdess27	11	0.0000262369
v_{198}	imoeth02	9	0.0000214666

3.2.4 Closeness Centrality

Vertices with high closeness centrality are the best disseminators of messages and information to others to minimize time [8]. The shortest path from vertex v_{41} (@jjkluvv7) to the vertices connected to it is shown in Figure 6. In Table 6, the ten highest closeness centrality values obtained using the RStudio software are given.

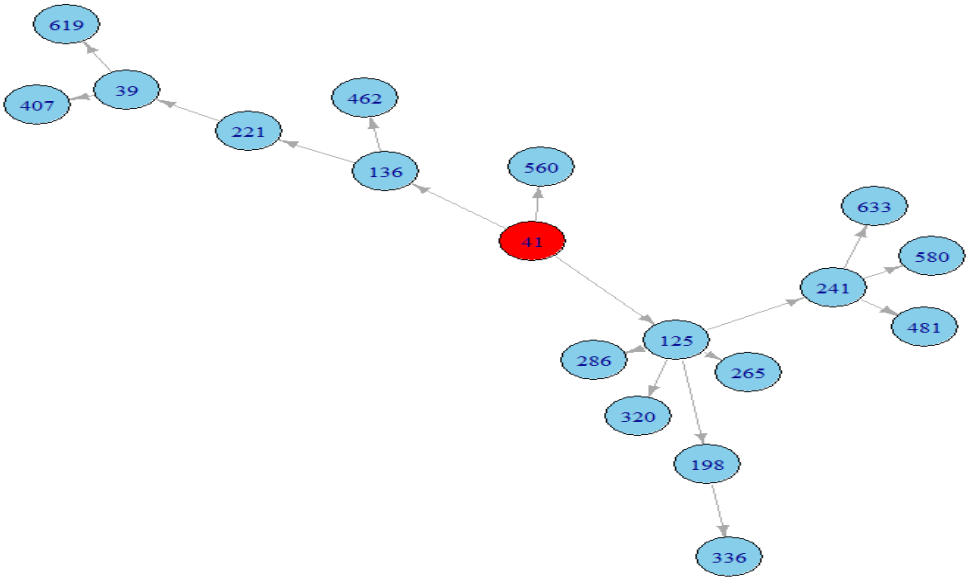

Figure 6. The shortest path of vertex v_{41}

Table 6. Closeness Centrality of Vertices

Vertex	User	Closeness Centrality	Scaled Closeness Centrality
v_{41}	jjkluvv7	2.441778e-06	7.911360e-05
v_{268}	_pjmmygs_	2.434044e-06	7.886304e-05
v_{70}	Gbrlje	2.430248e-06	7.874002e-05
v_{65}	ssgmin95lv	2.430246e-06	7.873997e-05
v_{94}	Aiseegrl	2.430222e-06	7.873920e-05
v_{125}	_peupeuuu	2.415056e-06	7.824780e-05
v_{198}	imoeth02	2.415046e-06	7.824748e-05
v_{265}	Fantaesiii	2.415029e-06	7.824695e-05
v_{286}	Cutiebibble	2.415029e-06	7.824695e-05
v_{320}	Loubieeskoo	2.415029e-06	7.824695e-05

3.3 Interpretation of Influencer Identification Results

In Table 3, accounts that act as sources of information get a high in-degree centrality because they receive a lot of responses from fans in the form of replies, retweets, or mentions. The main sources of information on the network are @BTS_twt, @CGV_ID, and @CBIpictures. The fanbase accounts such as @BTStranslation_, @Univers_Bangtan, and @7btsupdates in the network also play an important role as a news source that many fans go to for information. In contrast to the main source of information or fanbase accounts, a fan account can also get a high in-degree centrality because of its attractive image and popularity.

In Table 4, it was found that the out-degree centrality of fanbase accounts in the network is not so good because in communication they rarely respond to other users. The low value of the out-degree centrality indicates that inward interactions they received are not forwarded to other vertices so they do not adequately act as vertices that are traversed in the interaction flow. On the other hand, fan

accounts get a high out-degree centrality because they actively provide feedback in conversations, interact a lot with each other via Twitter, exchange ideas, or mention each other to spread information so that the flow of interaction between them occurs more frequently. The intensity of this interaction makes the fan accounts obtain a good value of in-degree centrality and out-degree centrality so that they have a better value of betweenness centrality for the number of geodesics mediated by them are higher compared to fanbase accounts as can be seen in Table 5.

For closeness centrality, in Table 6, the accounts in the network get very low scores and do not have a significant difference. This shows that the speed of information between users takes more time to reach the appropriate users and implies lower levels of social connection and contagion across the network [14]. The limitations in the data taken can be the other reason, which is too short in timestamp and only uses one unique keyword to refer to a topic.

Based on the result of central vertices from the centrality measures, accounts @_peuupeuuu, and @laviedenoona are the most recommended fan accounts as influencers. Account @_peuupeuuu got high scores of in-degree centrality, out-degree centrality, betweenness centrality, and closeness centrality. This means that this account actively interacts with other users as both recipients and opinion givers, has the potential to be an information liaison, and is also the fastest account to reach other users in the network. Account @laviedenoona is the fan account with the best in-degree centrality and gets the highest betweenness centrality. It can be seen from its centrality that this account is one of the accounts that is often becoming the destination of other user interactions and also acts as a good information liaison.

Through the presentation of the result of this research analysis, it is known that most users of online communities are consuming content by passively observing what is on the site which in this research dominated by fan accounts. In contrast, active participants in social communities add value to social media by posting comments and sharing social content. Such users have higher levels of engagement in the exchange process in social communities and have greater potential to be influential which in this research dominated by fanbase accounts and less number of personal fan accounts [27]. Fanbase accounts can be utilized by producers of goods and services to become influencers who advertise and campaign for a brand through their role as content creators with strong appeal [27]. Furthermore, quite several fan accounts can be used as influencers through their activeness in giving opinions and disseminating information they received.

4. CONCLUSIONS

Based on the results of the discussion in the previous chapter, several conclusions were obtained as follows.

1. The social network that is formed on Twitter social media users is represented in a directed and weighted graph model.
2. The results of the analysis of social networks on Twitter identify the influence in the delivery of information related to BTS topics based on each centrality as follows:
   a) The ten accounts that became the center of interaction the most other accounts went to are @BTS_twt, @CGV_ID, @CBIpictures, @BTStranslation_, @laviedenoona, @Univers_Bangtan, @Vallerylia, @_peuupeuuu, @chizikook_, @mcyxjm, and @7btsupdates.

b) The ten accounts that have the most potential to influence others to believe their opinions are @staeberriyy, @_peuupeuuu, @littleejung, @jjkluvv7, @Curhatansuka, @Arcymera, @tegikuks, @furtari, @gbrlje, and @voojwankoo.
c) The ten accounts that are the best link for the flow of information are @laviedenoona, @_peuupeuuu, @gbrlje, @littleejung, @gfkatehaaa_, @ssgmin95lv, @Curhatansuka, @BTS_PERSONA, @ rahmdess27 and @imoeth02.
d) The ten fastest information sharing accounts on the network are @jjkluvv7, @_pjmmygs_, @gbrlje, @ssgmin95lv, @aiseegrl, @_peupeuuu, @imoeth02, @fantaesiii, @cutiebibble, and @loubieeskoo.

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