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SEIR MODEL OF DISSEMINATION FALSE INFORMATION ON FACEBOOK

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Abstract:

Dissemination of false information on social media has become a major problem in creating a peaceful community and led to many outrageous behaviours such as racial discrimination and interpersonal discord. Allegations against individuals, misinterpretation of ideologies, and misrepresentation of the conduct of specific individuals are among the various manifestations of false information that have proliferated extensively on the Facebook platform. Thus, this study aims to analyze the dissemination of false information on Facebook using the SEIR model. The data obtained from the selected postings in August 2023 from *Info Berita Semasa*, *Berita Hari Ini Official* and *Malaysia Buat Apa Hari Ini*. The postings have been classified and filtered to ensure the false information being studied. The results show that the false information was viral, and its posting was received by more than half of the group members and only few numbers of group members have realized that the information is fake. Therefore, the administrator in the group should play a vital part in controlling the dissemination of false information. This study will benefit social media controlling association like Malaysian Criminology and Correctional Association to back-pedal the dissemination of false information on Facebook.

Keywords:

Community Group, False Information, Facebook, Leaving Rate, SEIR Model

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Introduction

Social media is an online platform that enables individuals to create, share, and exchange information, ideas, and opinions. The proliferation of social media platforms includes Facebook, Instagram, Twitter, WhatsApp, Snapchat, and many others. Social media offers a convenient platform for both posting and receiving information. Based on Global Social Media Statistics from 1st October to 31 December 2023, 83.2% of smartphone users using Facebook applications actively, after WhatsApp (83.4%) and YouTube (100%). Facebook is a platform that facilitates user interaction through features such as following, messaging, and sharing posts. It grants users the freedom to express their thoughts and opinions on a wide range of subjects without constraint. Moreover, Facebook offers a plethora of additional features that are arduous for other social media platforms to rival. It also offers a range of features, including a marketing place, a video segment, a game lobby, and a topics page. One notable characteristic of Facebook is its unique provision of a platform wherein individuals with a shared interest in a specific subject can convene and exchange their viewpoints. This feature is commonly referred to as a group or community. Groups or communities consist of pages overseen by one or multiple administrators, who have the authority to extend invitations or accept users into the community. This community or group can express their opinion within the confines of a closed conversation. The group can exist in two conditions: a public group or a private group, as well.

Rumor and false information possess distinct connotations. According to Macmillan Dictionary (2023), rumor is a form of unofficial information that possesses the potential to be either true or false. False information, however, is characterized as deceptive narratives that give misleading information on any news content when disseminated through social media platforms with the intention of shaping perspectives or as a form of jest (Cambridge Dictionary, 2023). False information, commonly known as misinformation, encompasses a wide range of deceptive content, including fabricated news stories, counterfeit articles, and deceptive messages, among others, which aim to deceive individuals into believing they are genuine (Balakrishnan et al., 2021). Meanwhile, rumors traditionally known for their gradual dissemination, have experienced an accelerated pace of propagation in contemporary times. This phenomenon can be attributed to the pervasive influence of the internet, advancements in technology, and widespread engagement in social media sharing activities. Consequently, the global circulation of a single rumor has occurred at an unprecedented rate, deviating from the norm (Meel & Vishwakarma, 2020). False information is pervasive across a wide range of topics that are subject to debate. The prevalence of false information in various domains, such as medicine, politics, entertainment, and sports, is a significant concern in contemporary society.

Considering the prevalence of Facebook and the dissemination of false news, individuals experiencing negative peer conditions and engaging in peer communication often exhibit a propensity for disseminating inaccurate information with the intention of causing disruption within the public sphere. Meanwhile, individuals exhibiting elevated levels of self-efficacy will commence experiencing a state of distress in response to the dissemination of inaccurate information (Luo et al., 2021). Based on this analysis, it is evident that the disseminating of inaccurate information is prevalent on various social media platforms. The significant impact of this phenomenon on the proliferation of false information, particularly in the realm of news, is well recognized. False information, in its essence, encompasses the intentional dissemination of fabricated or deceptive content masquerading as legitimate news, strategically employed to sway the collective sentiment of the populace. The topic at hand pertains to the dissemination

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of fabricated or distorted information through a diverse range of media channels, encompassing social media platforms, websites, and traditional news outlets. The misinformation can manifest as deceptive headlines, manipulated images, concocted quotes, or fictional narratives.

The dissemination of false information can be contextualized and analyzed using the Susceptible, Exposed, Infectious, and Recovered (SEIR) model. Originally, SIER is a compartmental model used in epidemiology to understand the spread of infectious diseases. The transitions between Susceptible, Exposed, Infectious, and Recovered are governed by differential equations describing how individuals move from one state to another over time. The model helps researchers and public health officials simulate and understand the dynamics of disease spread within a population. It's a valuable tool for predicting the course of an outbreak, assessing the impact of interventions, and planning public health strategies. The model describes how individuals move between these compartments over time. It's particularly useful for predicting the course of an epidemic and understanding the impact of various interventions, like vaccination or social distancing. It's important to note that the SEIR model makes certain assumptions, such as a well-mixed population and constant parameters. There are more complex variations of the model that consider spatial dynamics, age structures, and other factors. For instance, some models include additional compartments for individuals with severe or mild symptoms, and some consider factors like vaccination or quarantine. False information dissemination exhibits propagation patterns akin to those observed in the spread of diseases. Like how an infectious disease spreads via interpersonal contact, false information can be disseminated through social interactions on the Facebook platform. The concept of the SEIR model is deemed to be a suitable fit for this study. The SEIR model possesses the capacity to assess the rate of propagation of false information on Facebook. The SEIR also provides the model framework with a valuable mechanism for analyzing the dissemination of false information on Facebook. With that, The SEIR model is considered as one of the best tools for analyzing the dissemination of false information on Facebook.

The dissemination of false information on Facebook was occurring at a concerning pace. A multitude of subjects gained significant traction in online discourse. Misinformation pertaining to allegations against individuals, misinterpretation of ideologies, or misrepresentation of the conduct of specific individuals are among the various manifestations of false information that have proliferated extensively on the Facebook platform. The issue at hand pertains to the exacerbation of the situation due to the dissemination of false information, commonly referred to as "false information," particularly during a closely contested and specific period, which had a pervasive impact on the general populace. The dissemination of false information has resulted in the fragmentation of the community, giving rise to various societal challenges including racial discrimination, interpersonal discord, diminished communal confidence, and related issues. As a consequent, Malaysia might be no longer as a tranquil and harmonious nation if this issue is not solved appropriately.

Another chaos from this false information is that it could affect the status of valid news. With the larger spread and more false information on social media, people will be more confused and unable to make the right decision on which one is true. If people fail to decide and make the wrong decision, false information will be rampant on people's lips. If this keeps happening and not in control, innocent people will be on the wrong path for some time.

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Therefore, this study aims in identifying the virality of false information and analyzing the dissemination of false information in Malaysia by using the SEIR Model. The data used for the study is the propagation of misinformation on two Facebook profiles with distinct features in Malaysia. The first account is determined to be a legitimate news account, such as *Berita Awani*, which is well-known and acknowledged among Malaysians. The second account will be an active user in any community or a member of a news update on Facebook. The spread of false news shall be followed up as soon as feasible, or two days following the spread of false information. The study's shortcomings occur throughout the validation procedure. The model's validity may be assessed by comparing forecasts to real-world data on the spread of false news. This implies that the SEIR model's estimations of the number of Susceptible, Exposed, Infectious, and Recovered populations involved in the spread of false news will be compared to actual observed data. The model may or may not be well matched with the observed trends. This might thus suggest the accuracy of the SEIR model. It should be noted, however, that the SEIR model is a simplified portrayal of reality. It states that its validity depends on the environment and condition being examined. While it gives useful insights into the processes of false news propagation, it may not capture all the nuances of real-world circumstances.

The importance of this research is to show the distinction between false and legitimate news and to backpedal the dissemination of false news. Understanding the mechanism behind the propagation of false news will make it simpler for people to judge the accuracy of a news report. It enables active Facebook users, who are quickly swayed by every post, to distinguish between false news and legitimate news. This research will assist agencies that govern the spread of news and the active users. For example, Malaysian Criminology and Correctional Association, may gain benefit from the research by raising early awareness of false news to avoid and treat the illnesses of false information spread through Facebook. With all of this, users may filter their news stream to make Facebook a more social site.

Literature Review

False Information and Facebook

False information may drastically mislead individuals, erode faith in one news source, and split people into various groups. The proliferation of false news is a problem for society, particularly in a world where social media is no longer an exception. False information has the potential to swiftly spread to many individuals (Pennycook & Rand, 2019). Individuals are more prone to trust bogus news that confirms their preexisting opinions or biases (Bago et al., 2020).

False information seems legitimate and spreads quickly on social media and other internet channels. There are always keys to spotting false news and distinguishing it from legitimate news. One strategy is to double-check the primary source of information. False news frequently emanates from untrustworthy or biased sources (Shu et al., 2017). Having several checks on the sources can help distinguish bogus news from legitimate news. The language of the material, on the other hand, is a crucial aspect for determining its legitimacy. False information jargon has a way of catching people's attention. In such cases, the language used is often harsh, to target a certain human feeling or circumstance (Shu et al, 2017). Another method is to gather proof to back up one's claims. False information is also noted for contradicting reliable sources or supporting proof. Assessing the veracity of information by looking for proof and several sources can help distinguish between false and legitimate news (Roozenbeek & van der Linden, 2019).

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Another method of differentiating the validity of news is through conducting in-depth research. It includes the possibility of an event occurring. From one uncertain news, the event of the news is always in two decisions whether impossible or possible. This situation then will lead to deep research. Whenever one event is viewed as impossible after deep research and understanding the consequences, the news is more likely to be fake or misleading in information. Even without deep research, the comment on one post could also be considered as reasoning in labeling one news validity. The comments usually seem like hateful speech and disagreement towards one statement. However, it is important to note that any information from expert comments will be significant for deep research to estimate one news's validity (Aldwairi & Alwahedi, 2018).

Differentiating false information and valid news is always possible by double-checking the primary source of information, having several checks on the sources online, defining the linguistic characteristic of one news and deep researching from expert comments to understand the possibilities of one event. These methods are highlighted in various studies since they have proven to be highly effective. However, the method needs to be done perfectly to obtain the results. The platform for checking source information needs to be considered and filtered. The linguistic uses of news writing need to be studied to distinguish the formal and informal language in news writing. If the method of differentiating the news is aligned with the right way, the process of differentiating the news can be obtained in a short period and with the least effort.

Social media has grown in popularity in recent years, particularly since billions of people across the globe use it daily (Kaplan & Haenlein, 2010). Facebook is one of the social media platforms that have proliferated in the contemporary networking world. With billions of users on these social networking platforms, people can communicate with one another by sharing different types of material, such as text, photographs, and videos. Thus, Facebook contributes to the spread of information by increasing the reach and frequency of dissemination. In a highly clustered network, individuals have a greater possibility of being interconnected, allowing information to be disseminated through a larger number of channels. A node in a highly clustered network has more opportunities to receive information from neighboring nodes, not just specific nodes. As a result, individuals with more friends in a highly clustered network are more likely to affect dissemination outcomes and increase the reach of information. The dense network structure facilitates stronger information dissemination on social network sites, as it allows for more connections and pathways for information to flow through the network (Luarn et al., 2014).

Facebook was proven to relate to the spread of false news. This platform has also been linked to a variety of problems and issues, such as the propagation of disinformation, cyberbullying, and addiction. Video modality on Facebook appears to be the most prominent false news format (Demuyakor & Opata, 2022) Video makes false news and misleading information more credible than audio, boosting the chance of their dissemination and this bogus news might be distributed by any user. The users that were involved in the specific issues highly affect the spread of false information. Faithful fans and future popularity have proven to have a highly linear correlation between the proportion of faithful fans in the early stage of content sharing on Facebook and the future popularity of the content. It means that if content has a higher proportion of faithful fans sharing it in the early stage, it is more likely to become popular in

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the future (Wang et al., 2020). Facebook has a high potential of spreading false information, especially with millions of users divided by specific interests. There are no restrictions on disseminating false news activities on Facebook, and as a result, the proliferation of false information on Facebook has never been a frustrating issue for debate.

SEIR Model

The SEIR Model is an extended model of the SIR Model, which stands for Susceptible-Infected-Removed Model. These models are originally a compartmental epidemiological model used to understand the spread of infectious diseases within a population. The acronym SEIR stands for Susceptible, Exposed, Infectious, and Recovered, representing the different groups an individual can go through during an infectious disease. This model has included a new compartment which was Exposed. The existence of the Exposed compartment was when researchers acknowledged the existence of a latent phase amidst an individual's exposure to a pathogen and their eventual onset of infectiousness. As a result of this realization, the SEIR model is developed, a more complex depiction of disease transmission dynamics. The SEIR model is comparable to the latent state of the diseases model. In disseminating information through social media, this model explains a class of exposed individuals who are aware of the knowledge but unsure whether to disseminate. As a result, the SEIR model provides a more thorough and appropriate description of infectious diseases and any situation that shares the same mechanism of the spread such as the dissemination of information (Zhao et al., 2018).

Numerous studies have aided in comprehending the SEIR model's capacity to interact with contemporary situations. In addition to being a key concept in medicine, the SEIR Model has now been modified for use in social media analysis. The SEIR model helps academics comprehend diseases transmission such as Covid-19 (He et al., 2020), market interaction (Ryu, 2019) and dissemination of information on social media. These transmissions throughout different surroundings somehow share similarities in their population, characteristic and behavior to the disease’s situation. Due to this, the SEIR model can be utilized to achieve a specific solution to different problems.

The SEIR model, which was the integrated form of the SIR model, was the better tool to study the propagation of false information on the internet. Dong et al. (2017) proposed the SEIR model in studying the spread of rumors in social networks while considering the uncertain population. This model considers the varying total number of users and user deactivation rate in online social networks to calculate the equilibrium points, reproduction number and accurately reveals the characteristics of rumor spreading in online social networks. The population of the study is divided into four classes as in the SEIR model respectively. The total number of online social network users at time t was taken as the population, N which includes four classes of nodes as in the SEIR model. The Susceptible group represents the group of users who have not received news about a rumor while the Exposed group represents those who have already received the rumor, the Infected group represents users who receive, read, and believe in the rumor, and the Recovered group represents users who have contacted the rumor but do not believe in it. The parameters such as the unit time rate of new registrations and the speed at which new users join the online social network may affects the scale of rumor spreading. The frequency of new messages received by an average user also influences the intensity of rumor spreading. These parameters play a crucial role in determining the characteristics and dynamics of rumor spreading in online social networks, as observed in the simulations and theoretical analysis of the SEIR model. The validation process involves analysing the

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behaviour of rumour spreading in the simulated online social network and comparing it with the predictions of the SEIR model. The results show that the theoretical results of the model align closely with the simulation results on the real-world Facebook network.

The SEIR model has also been proposed to tackle the dissemination of fake information issues (Ojha et al., 2023). In this study, all individuals on the online social network (OSN) are considered as *N*. The susceptible group (*S*) refers to the individuals who have yet to discover fake information but will happen to do so. The exposed group (*E*) refers to the individuals who have discovered the idea of the fake information on the OSN but are not infectious or have no intention to share the information. The infected group (*I*) signifies the individuals who trusted the fake information and then became an active speaker of the information on OSN. The last group is the recovered group (*R*), which emerged from the speakers' group. Between these groups, the author stated that there was a transmission rate which includes the joining rate of individuals into the OSN, the rate of leaving the OSN or deactivating their account, the rate of infection which was the rate of rumors spread, the rate of one individual in blocking or escaping the active speaker, the rate of susceptible users to become an exposed user, the rate of the exposed group to become an active speaker and the rate of verification of susceptible users. Graphically, each group will show their attribute in ascending or descending pattern depending on the parameters interchange. By understanding the mechanism in reproduction number, analyzing the parameter and the numerical simulation may help resolve and analyze the problems within the spread of false information. This strategy will make it feasible to stop fake news from spreading in the future on the popular internet platforms other than Facebook, such as Telegram and WhatsApp.

The extended model of SEIR model can also be applied to describe the information dissemination process in real online social networks. This model is known as UHIR model that considers the effect of user and information attributes; influence, confidence, interest value, and information timeliness to the dynamics of information dissemination. The UHIR model divides users into four categories: unknown (*U*), hibernator (*H*), infector (*I*), and removed (*R*). This study showed that the more social groups the users participate in, the greater the influence of the users in the network. Then, the faster information will be spread. The consistency of the information with the interest of users is also proportionate to the speed of information dissemination. However, if the majority of the users have a high level of confidence, the speed of the information dissemination will be slow down. The faster the old information is updated or replaced by new information, the chances that the users get the same information will decline. The information will be no more spread to the whole network in a shorter time (Gong et al., 2023).

Methodology

The steps to analyze the dissemination of false information is shown in Figure 1. The first step will use the qualitative approach and the following steps use the quantitative approach.

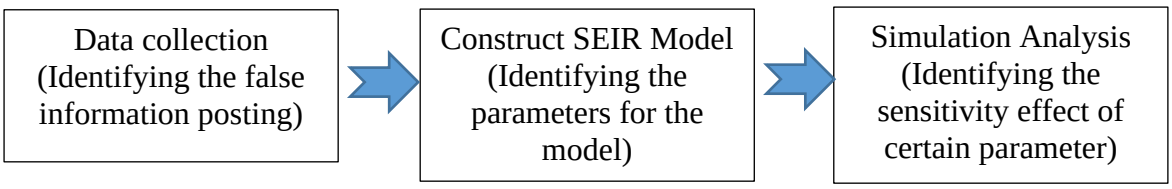

Figure 1: Flowchart of the Dissemination Analysis of False Information

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Data Collection

The following steps must be considered to identify the information is a fake news. Since the data will be collected in any Facebook group, the specifications and the characteristics of the group must be taken into consideration. The news can be posted by any individual throughout the group, so it clutches a higher probability of being a fake. Then, the fake posting will be selected. These postings will be studied and assumed to be fake initially. Finally, the posting needs to be confirmed fake. The detail procedures are as follows:

Step 1: Identifying and Joining Group

The first step is to discover a Facebook group or community that keeps up to speed on the newest developments in the field. In deciding the group, few characteristics below are considered since it will play a significant result in identifying fake news. The characteristics of the group are:

1. **Publicly open**, which means any users that were interested in the group is free to join.

2. **High number of members**. High number of members will lead to a high number of interactions between post. This will play a crucial part in providing key variables for the model so that the analyzation of the data is accessible.

3. **High posting per day**. The frequency of posts in the group can be looked at through the group statistical report. The high frequency of post will lead to high probability of fake news post.

Step 2: Selecting Post

To categorize whether the post is suitable for this study, the following characteristic must be obeyed:

1. **Check for the provided sources of news from the post**. If the user failed to provide a reliable source, the status of the news must be concerned (Shu et al., 2017).

2. The language used in the content is the next item to pay attention to. Jargon with false information has a way of drawing people in. In these situations, **harsh language** is frequently used to target a particular human emotion or situation (Shu et al., 2017).

3. **The possibilities of the news** are other characteristics to note. If an event was thought to be impossible after extensive investigation and consideration of the ramifications, the news is probably fake or contains false information (Aldwairi & Alwahedi, 2018).

4. **Post's comment** may also be considered when determining the veracity of a piece of news. Comments on one post may be used to contradict the status of the news if the comments are against the news (Aldwairi & Alwahedi, 2018).

Step 3: Confirming the News

In confirming the news, assessing the accuracy of information by looking for proof and several sources can help distinguish between false and legitimate news (Roozenbeek & van der Linden, 2019). When the selected news was lost in track during specific period, it is considered as

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confirmation that the news is fake. This was due to the assumption that the administration of the group had decided to delete the post because it was misleading information or the users themselves just realized that the news was fake. In conclusion, to confirm the news is fake,

1. False information that has enough value will be highlighted in *Berita Awani* main page as false news which was crucial as double confirmation.
2. Post that was deleted within specific period, it is considered as false news.

Application of SIER Model

In application of the SEIR model towards this study, the Facebook users will be separated into four classes as in Figure 2 and the parameter were described in Table 1.

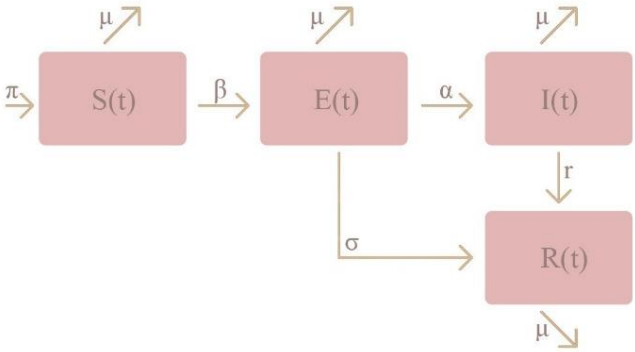

Figure 2: Visualization of SEIR Model

Table 1: Definition of Parameters

Parameter	Definition
$S(t)$	Susceptible. Group members that eligible to receive the post at time *t*.
$E(t)$	Exposed. Active group members that accept the post through the group at time *t*.
$I(t)$	Infected. Members that have believe and share the post at time *t*.
$R(t)$	Recovered. Members that no longer rely to the post at time *t*.
π	Rate of gaining new members in the group.
μ	Rate of members leaving the group.
β	Transition rate from S(t) to E(t)
σ	Transition rate from E(t) to R(t)
α	Transition rate from E(t) to I(t)
r	Transition rate from I(t) to R(t)

The variables $\pi, \mu, \beta, \sigma, \alpha$ and r from Table 1, represent the transition rate of one compartment to another compartment as follows.

$$\pi = \frac{Number\ of\ user\ joined\ between\ t_0\ and\ t_1}{Time\ between\ t_1\ and\ t_0} \quad (1)$$

Using the feature in Facebook group insight, the user that join in between time t_0 and after some time at time t_1 can be observed.

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$$\mu = \left| \frac{n_0 + the\ number\ of\ user\ joined\ between\ time - n_1}{Total\ time\ between\ t_1\ and\ t_0} \right| \quad (2)$$

Facebook active user is defined as a registered and logged-in user to Facebook who visits the site through a mobile device application or web browser in the last 30 days as of the date of measurement. Statistics show that 65.9% from 2.9 billion users was labeled as active user (Dean, 2023). Thus, the rate was:

$$\beta = \frac{Active\ group\ member}{Total\ group\ member} = \frac{active\ facebook\ user}{total\ facebook\ user} = 0.659 \quad (3)$$

The rate of active group users who aware the status of the news that was posted is

$$\sigma = \frac{Active\ group\ member - (total\ reaction)}{Active\ group\ member} \quad (4)$$

The rate of active group users who thinks that the fake news was true.

$$\alpha = \frac{Total\ reaction}{Acrive\ group\ member} \quad (5)$$

The rate of negative reaction such as comments and emoji response on the post, can be represent disagreements or denial on the news.

$$r = \frac{Negative\ reaction}{Total\ reaction} \quad (6)$$

The reproduction number, R_0 is regarded as the number of people who were infected during an average period of the spreading of the information. The R_0 equation is,

$$R_0 = \frac{\alpha\beta\pi}{\mu(\sigma+\alpha+\mu)(r+\mu)} \quad (7)$$

Reproduction number, R_0 value will define a certain position for the post such that when $R_0 < 1$, the spread of the information will die out in the long run. On the other side, when $R_0 > 1$, the posting of one information can spread among a disclosed population. However, when R_0 is exactly 1, the dissemination of the fake news is constant (Sharif et al., 2021).

The formulation of the SEIR Model in Figure 1 is interpreted in Table 2.

Table 2: Interpretation of Derived Equation

Equation	Interpretation
$S'(t) = \pi - \beta S(t)I(t) - \mu S(t)$	The rate of change of Susceptible compartment.
$E'(t) = \beta S(t)I(t) - \sigma E(t) - \alpha E(t) - \mu E(t)$	The rate of change of Exposed compartment.

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$I'(t) = \alpha E(t) - rI(t) - \mu I(t)$	The rate of change of Infected compartment.
$R'(t) = rI(t) + \alpha E(t) - \mu R(t)$	The rate of change of Recovered compartment.

The above equation will result in either positive or negative values which then will give the direction to the derived equation. It indicates whether the rate of change of each compartment is decreasing or increasing. The simulation analysis has been done based on posting with the highest value of R_0. Then, the numerical experiment will apply the sensitivity test of a certain value of parameter.

Result and Discussion

Data Analysis

The process of observing postings to be considered as false information has been done in one month (from the 1st 0f August 2023 until the 1st of September 2023). In order to identify the false information among all of the postings, a simple form of guideline suggested by the previous study have been applied. It starts from selecting an appropriate groups, followed by identifying the prospected false information from those group. Confirmation of the selected information to be fake should be acquired first, before the process of collecting and analyzing data start.

Selection of Group

In the first phase of the data collecting period, a few groups have been discovered, including *Info Berita Semasa*, *Malaysia Buat Apa Hari Ini* and *Berita Hari Ini Official*. Unlike other groups that may take time to form due to the group's privacy policy, these groups were founded openly. When the group was established publicly at first, this will speed up the process of getting accepted into the group's circle. Each group has more than 100,000 members, which is a huge number. These groups were also selected due to the astounding volume of daily post, which was more than 10 posts per day. The detailed information of the group can be seen in Table 3. The group *Malaysia Buat Apa Hari Ini* has the greatest number of posts per day among these three other groups. This group will act as the main source of the study since it has a higher probability of containing false information posting. The other group will also be scouted and play minor roles in selecting the false information posting.

Table 3: Information of Selected Group

Group Name	Group Type	Group Members	Post per day
Info Berita Semasa	Public	480,100	84
Malaysia Buat Apa Hari Ini	Public	222,400	203
Berita Hari Ini Official	Public	223,796	17

Selection of News

After joining the group, the next step was to select the posts that may be fake. From the characteristics classified, the selection of posts that may be fake was made. These posts were posted by different users in the closed communities. By looking at the characteristics of the

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posting as shown in Table 4, the post will be assumed to be fake since the evidence is very strong. This post will then be scouted for further information.

Table 4: False Information Posting Criteria

News Topic	Primary source check	Language used in the post	Possibilities of the event?	Comment against the post?
Kedah president arrested by PDRM again.	Not provided by user	Harsh	Not possible	Yes. Some user mentioned this was fake
Chinese immigrants were brought in for PRN.	Not provided by user	Harsh	Not possible	Yes. Some user mentioned this was fake
Perak Sultan were accused of being involved in politics.	Not provided by user	Not Harsh	Not possible	No comment that says this post was fake

Identifying News Status

After selecting the post, the post was scouted for 7 days. The status and the availability of the news throughout the Facebook group page can be detected by following the guidelines. The results from the scouting were shown in Table 5.

Table 5: False Information Confirmation

News	Further Engagement
Kedah president arrested by PDRM again.	1. Posted as fake news on *Sinar Harian* 2. Not deleted by the users after complete scouting
Chinese immigrants were brought in for PRN.	1. Posted as fake news on *Berita Awani* 2. Not deleted by the users after complete scouting
Perak Sultan were accused of being involved in politics.	1. Posted as fake news on Sinar Harian 2. Not deleted by the users after complete scouting

At the end of the data collection period, the three selected posts have been accused of being fake. All three posts have been posted and labeled as misleading content from the main news sources; *Sinar Harian* and *Berita Awani*.

SEIR Model Analysis

After collecting the data, the simulation of the data will be done on the model. The R_0 will first be calculated. After determining the best suited data for the model, numerical experiment will be done, and the solution will be analyzed.

Parameter Analysis

From the three collected posts, the best suited post will be determined by calculating the R_0. From the calculations, the data was tabulated as in Table 6.

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Table 6: R_0 of Each Post

Post	R_0
Kedah president arrested by PDRM again.	1.1358
Chinese immigrants were brought in for PRN.	0.9001
Perak Sultan were accused of being involved in politics.	0.9120

From Table 6, the post "Kedah president arrested by PDRM again" recorded the highest number of R_0. It shows that this post was the most viral among the three other posts. The post is then stated to be the best data for the model in further simulation. After deciding on the best possible post, the next step is to calculate the transition rate of the data. The variables that will be calculated are crucial for completing the simulation.

Table 7: Collected Data from Post $R_0 = 1.1358$

Data for Post $R_0 = 1.1358$	Values		
Total Group Members	480100		
Active Group Members	316386		
Like	427		
Share	33		
Comments	**Positive**	**Negative**	**Total**
	113	34	147

Table 7 shows the data obtained from the posting of "Kedah president arrested by PDRM again" on 2nd August 2023. It appeared in the group "*Info Berita Sema*sa". This post has been confirmed as fake information through *Astro Awani* (*Berita Awani*) on 5th August 2023. Based on the data, the following values have been uncovered:

The rate of gaining new members.

$$\pi = \frac{20\ users\ join}{4\ hours} = 5\ users\ join\ per\ hour$$

The rate of group members leaving the group.

$$\mu = \left|\frac{480{,}091 + 10 - 480{,}100}{20\ hours}\right| = 0.05\ leave\ per\ hour$$

The rate of active users was viewed as constant, which was 0.659. Hence,

$$\beta = 0.6590\ of\ users\ are\ active$$

The rate of active group users who ignored or realized the status of the posted news

$$\sigma = \frac{316{,}386 - (427 + 147 + 33)}{316{,}386} = 0.9980\ of\ users\ ignored\ the\ post$$

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The rate of active group users who think that the fake news was true.

$$\alpha = \frac{427 + 147 + 33}{316{,}386} = 0.0019\ of\ users\ believe\ the\ post$$

The rate of active users who just realized the status of the posted news after believing it.

$$r = \frac{34}{427 + 147 + 33} = 0.0560\ of\ users\ recovered\ afterward$$

The reproduction number, R_0 is

$$R_0 = \frac{0.0019(0.68)(2)}{0.05(0.9980 + 0.0019 + 0.05)(0.0560 + 0.05)} = 1.1358$$

The reproduction number exceeds 1 means that the selected post went viral among the group members.

Table 8: Interpretation of Values Derived Equation

Equation	Interpretation
$S'(t) = \pi - \beta S(t)I(t) - \mu S(t)$ $S'(t) = 0.5 - 0.68(480{,}100)(607)$ $- 0.05(480{,}100)$ $= -192070241.3$	The number of group members who are not exposed yet to the post decreased tremendously.
$E'(t) = \beta S(t)I(t) - \sigma E(t) - \alpha E(t) - \mu E(t)$ $E'(t) = 0.68(480100)(607) - 0.9980(316386)$ $- 0.0019(316386)$ $- 0.05(316386) = 191705850.3$	The number of active group members that have received the post increases overtime.
$I'(t) = \alpha E(t) - rI(t) - \mu I(t)$ $I'(t) = 0.0019(316386) - 0.0560(607)$ $- 0.05(607) = -15246.29981$	The number of group members that have reacted to the fake news decreases overtime.
$R'(t) = rI(t) + \alpha E(t) - \mu R(t)$ $R'(t) = 0.0560(607) + 0.0019(316386)$ $- 0.05(34) = 315811.9882$	The number of group members that realized the news was fake increased overtime.

Simulation Analysis

Figure 3 is the graph of SEIR Model obtained based on observation after 2 days the post has been published. The first compartment, Susceptible, group members not exposed yet to the post starts at 480,100 at 0 hours. The Exposed, Infected and Recovered compartment which was active group members that have received the post, group members who had reacted to the fake news and group members who realized the fake news is fake, respectively all begin with 0 group members at time 0. After some time, the graph starts to shape up. The group members not exposed yet to the post dropped exceedingly as low as 9.9900 users in 1 hour. Simultaneously, after 1 hour, the active group members receiving the post hit the peak of

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458,530. The false information is said to have reached 458,530 users after 1 hour. Meanwhile, after 60 hours of observation, 436,917 group members have reacted to the fake news. This shows that the false information post still received engagement after almost 3 days. After 7 days of observation, only roughly 65,932 group member that realized the fake news is fake. As the number of group members that react to the fake news went decreasing after some time, the number of group members realize the news was fake kept on increasing. Both subjects convey their trends at a slow pace.

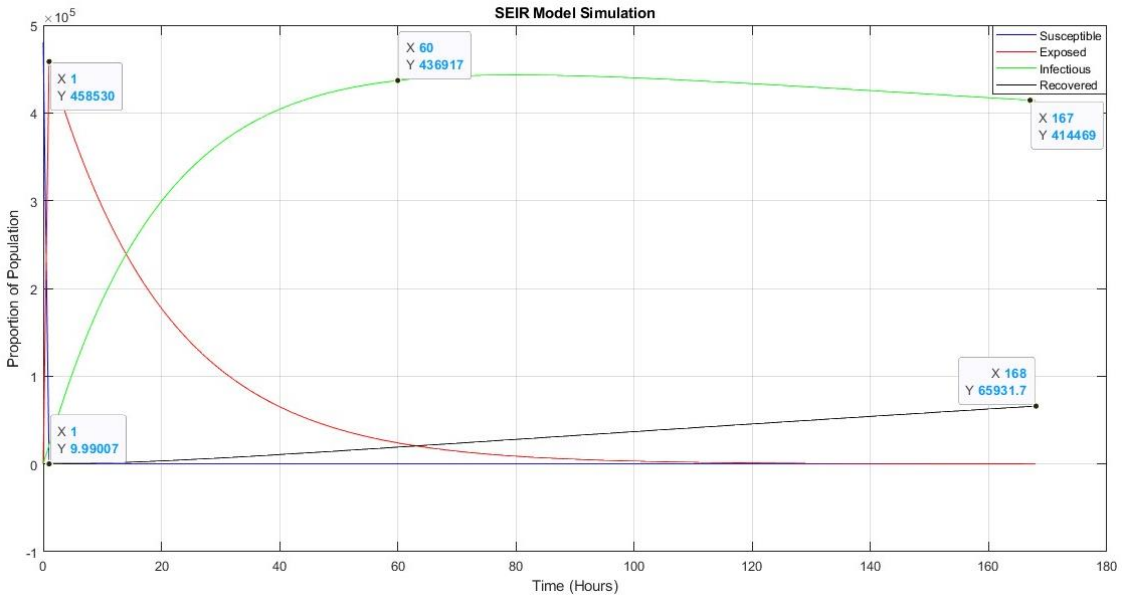

Figure 3: Graph for SEIR Model Simulation ($R_0 = 1.1358$)

Numerical Experiment

The graph from Figure 3 shows that the exposed news reached 458,531 just after 1 hour of posting, however only roughly 65,932 group members realized the news was fake. The experiment aims to reduce the virality of the posting by increasing the number of leaving rate (μ) based on equation (2). The leaving rate was originally 0.05. The value 0.05 leaving rate denoted that in one hour, only 0.05 users will tend to leave the group. The new value of the μ leads to a new R_0 value as shown in Table 9.

Table 9: Tabulation of New μ Value

Assumed μ Value	New μ Value	New R_0 Value ($R_0 = 1.1358$)
$\left\lvert\frac{480{,}100 + 10 - 480{,}105}{24\ hours}\right\rvert$	0.20	0.1029
$\left\lvert\frac{480{,}100 + 15 - 480{,}105}{24\ hours}\right\rvert$	0.41	0.0235
$\left\lvert\frac{480{,}100 + 20 - 480{,}105}{24\ hours}\right\rvert$	0.63	0.0100

From the table, the higher value of the leaving rate will lead to the lower virality of the news (R_0). The data from Table 9 produces different simulation results as in Figure 4, Figure 5 and Figure 6.

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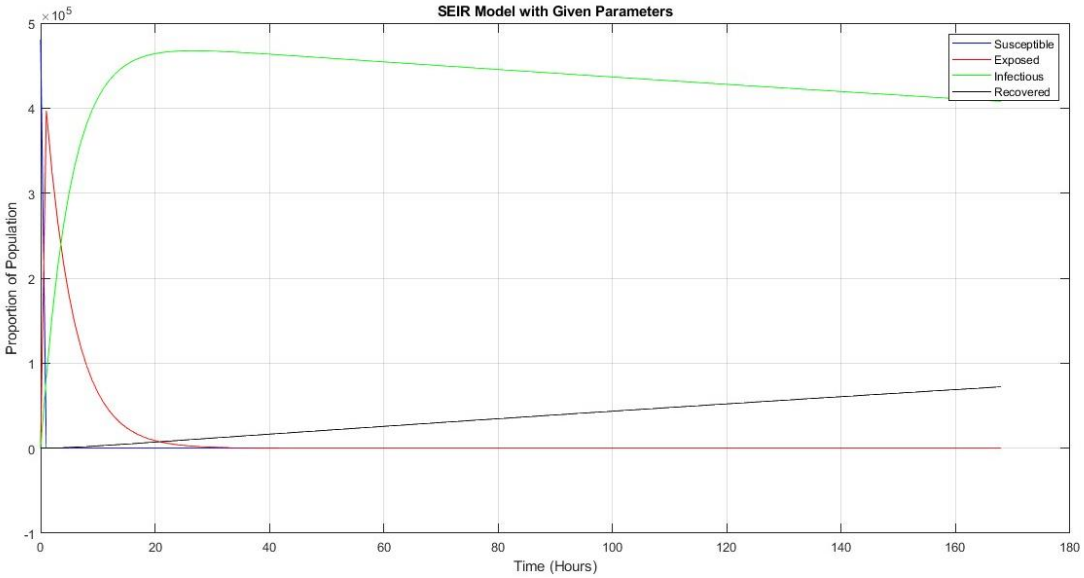

Figure 4: Graph for $\mu = 0.20$ ($R_0 = 0.1029$)

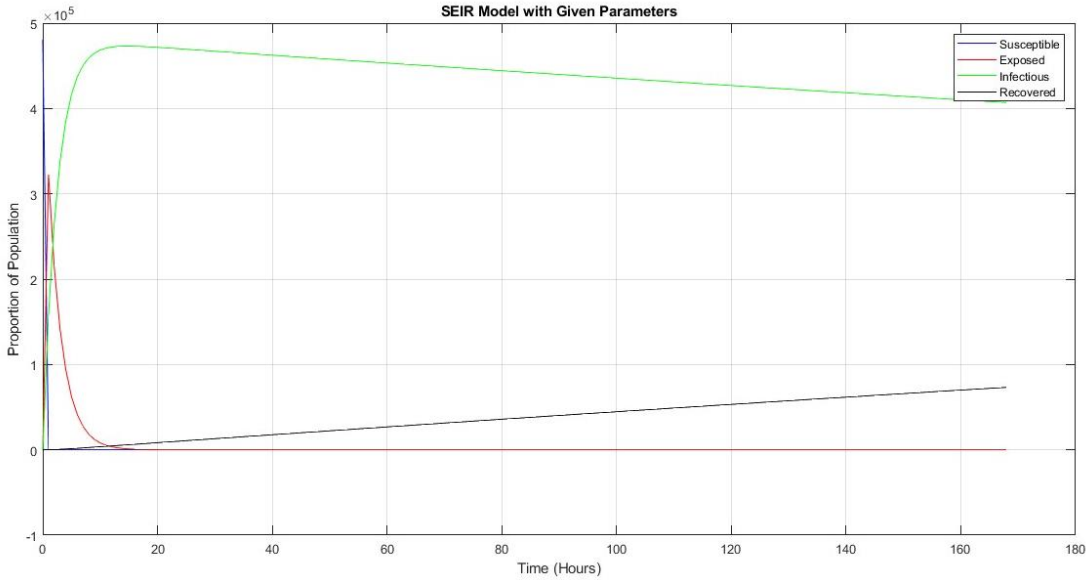

Figure 5: Graph for $\mu = 0.41$ ($R_0 = 0.0235$)

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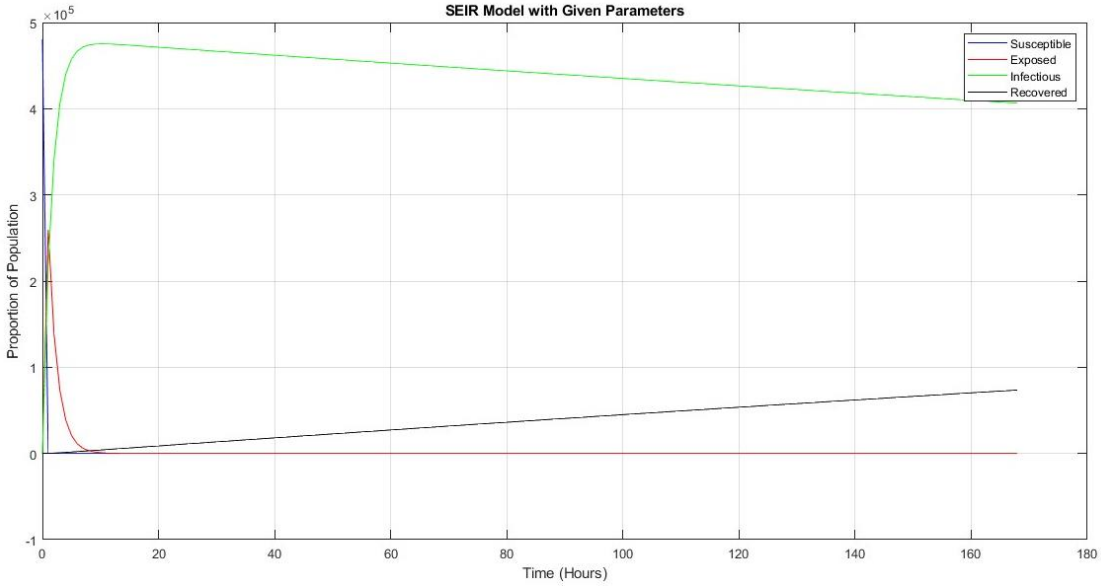

Figure 6: Graph for $\mu = 0.63$ ($R_0 = 0.0100$)

From the three graphs above, the higher value of the leaving rate will lower the number of active group members that have received the post. At the same time, the number of group members that reacted to the fake news reached a higher peak and became less infectious overtime, compared to the original simulation.

Conclusion and Recommendation

After collecting various false information on Facebook, three postings have been selected for this study. The posting defined every false information characteristic classified in this study. The post was posted without any sources, the language use was harsh since it contains slurs and hate speech, the event was also impossible to happen and finally, some users are commenting against the post, which contradicts the post's stated information. From this study, the group chosen was also a crucial decision in determining the population. The chosen group in this study was able to contribute as much as possible. The selected group was a public group, with over a hundred thousand members and most importantly, the group recorded astonishing numbers of posts per day, which was more than 10 posts. After 7 days of scouting the issues, an official news page *Berita Awani* posted a news saying that the current issues were made up by irresponsible Facebook users and were spread to multiple groups and pages. The post went viral among Facebook users especially in the determined population of this study.

Among the three postings that have been confirmed fake, the post of "Kedah president arrested by PDRM again." when viral (R_0 = 1.1358 > 1) Based on thr graph of SEIR Model in Figure 3, the post was exposed to too many users in the group and the number of group users who realized the post was fake was too low. To reduce the virality of the posting, the simulation process has been done by adjusting the leaving rate (μ). As a result, the higher the leaving rate, the lower the virality of the posting. In the same time, the number of active group members receiving the post was also reduced. Thus, the objective of this study has been achieved.

It means that more group members should leave the group so that the false information will be exposed to fewer group members. This action results in a higher number of group members that realize the existence of false information and also results in a lower number of group

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members who will react to the false information. The finding is synchronized with the findings stated by Gong et al. (2023).

The analysis of the solution has led to numerous decisions to decrease the significantly high reproduction number. The extremely low rate of the population leaving the community as well as active users has become the main challenge. It took at least 20 hours to acquire only one user to leave the group. The possible steps to increase the leaving rate are:

1. Administrator and moderator should check for active users monthly and kick out the inactive.
2. Administrator and moderator should ban any users from the community who have already disseminated any false information.
3. Any users that tend to provide hate speech and slur in any form of reaction should be kicked out from the group.
4. Admission Rule to the group should be enforced.

While most of the users mentioned above play a part in showing the activity rate of the community, it is important to note whether the activity rate is negative or positive. Decreasing the number of users mentioned above will simultaneously force any users that support hate speech and false information to leave their spots since they may find it difficult to commit their activities alone. Rule enforcement will have psychological effect on hate speech and slur committers. They will lose interest in joining the group if they have not joined and those who have already joined will possibly leave the group as soon as possible since they feel threatened. Administrators and moderators need to be firm in managing the group.

In this study, all of parameters being used to apply SEIR model are fixed parameters that come from the number of reactions of users at a particular time. For the future study, the parameters in the form of probability distribution might be considered such as UHIR model that has been introduced by Gong et. al (2023). Thus, the results that come from two different models can be discussed further.

In order to reduce the virality of false information, more parameters should be considered in the future study, to see the sensitivity of reproduction number to the change of individual parameter as well as to the change of the combination of parameters. It can be done by simulating multiple scenarios to consider the diverse ways information disseminate among users. Thus, the results may provide a more realistic understanding of false information dissemination that enable researchers to quantify uncertainty, conduct robustness analyses, and gain insights into the dynamics of social interactions related to the spread of misinformation. The outcome from the study will benefit various social media platforms to decrease their dissemination of hate speech, false information and propaganda.

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