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A Dynamic Mathematical Model for the Viral Spread of Rumours Across Facebook and Twitter, Focusing on Entertainment, Health, and Social Interests

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ABSTRACT

Facebook and Twitter are popular social media platforms for daily communication activities in Malaysia. Despite the growing prominence of rumours, particularly among Malaysian social media users, this issue has received limited attention. As such, this study aims to analyse the effectiveness of Facebook and Twitter in spreading rumours among social media users in Malaysia. The effectiveness of spreading the rumour is measured based on the virality rate of the selected topic using the Susceptible-Exposed-Infected-Recovered (SEIR). This study added two new parameters to the SEIR model, assuming different movements among the population group in spreading the rumours and investigating the effect of the parameters involved. This study also verifies three types of rumours: entertainment, health and social interest, with a higher chance of spreading rumours. Based on the selected topics, this study found that Facebook has 100% effectiveness in spreading rumours among social media users in Malaysia compared to Twitter. The findings suggest that leveraging Facebook, particularly for health-related information, offers an effective strategy for expediting information dissemination. The integration of the identified parameters enhances the model's utility, providing valuable insights into understanding and managing the spread of rumours within contemporary social media environments.

Keywords: Facebook, Twitter, SEIR, Rumours spread

INTRODUCTION

Nowadays, technology has brought various outcomes to our daily lives, including intelligent applications and the internet. The internet is crucial, especially for communication, and its growth has led to the emergence of online services like social media, websites, and online games (Dwivedi et al., 2021). Social media, such as Facebook and Instagram, has become an essential element globally. However, the excessive availability of the internet can lead to its misuse, causing issues like misinformation (Gelfgren et al., 2021; Wu et al., 2019). On the brighter side, this situation makes communication more accessible.

The trend of information dissemination through social media has become global, including among Malaysians (Ngadiron et al., 2021). Facebook has the highest percentage of users compared to other platforms in Malaysia, with 85.04% (StatCounter Global Stats, 2019). The changes brought by the Covid-19 pandemic, such as remote work and increased leisure time, contribute to the spread of new rumours on social media (Hutchinson, 2020). Similarly, students spending more time with their gadgets due to the new norms in education also increase internet usage. In 2019, authorities addressed the issue of fake news spread by users on Facebook and Twitter, confirming the presence of rumours among Malaysian social media users (BruDirect, 2019). However, for rumours to evolve, the topic must go viral. Going viral can have negative consequences, but it also helps in spreading awareness quickly. During the Covid-19 pandemic, researchers conducted a study on misinformation and social media users' responses. The study aimed to understand the reactions of Facebook users to misinformation (Al-Zaman, 2021). Researchers collected comments from five different posts on Covid-19 misinformation and found that 60.88% of Facebook users in Bangladesh trust such posts. Additionally, 34.50% of users reacted positively to the misinformation, with religious misinformation being the most popular (94.72%), followed by entertainment (72.22%) and health (45.7%).

Microblogs are the most popular communication channel on the internet (Liu et al., 2017). Researchers developed an SEIR model to study rumour spreading on a heterogeneous network and explored immunization strategies. They found that targeted immunization is more efficient than uniform schemes, as demonstrated by raw data from Sina Microblog. Another study focused on modelling and analysing rumours' propagation in social networks (Yu et al., 2021). Researchers developed the Ignorance-Discussant-Spreader-Remover-Ignorance (IDSRI) model, which considers the influence of discussants, and used actual Twitter data. They concluded that the IDSRI model effectively describes the propagation of rumours, emphasizing the significant role of discussants. Previous researchers have studied various rumour-spreading models, including the SEIR model (Wang et al., 2021), originally developed for studying disease spreading (Paul et al., 2021). A study on Covid-19 utilized a new SEIR model that considered additional movements, such as the direct transition from the suspected group to the recovered and infected groups (Annas et al., 2020). Another study focused on the spread of rumours on the Sina Microblog using a new SEIR model (Liu et al., 2017). The researchers incorporated two new parameters: the exposed group transitioning to the removed group and the infected group potentially becoming the exposed group again.

Motivated by previous studies using the basic parameters of the SEIR model (Paul et al., 2021), this study constructs an extended SEIR model with additional parameters. One parameter represents the exposed group transitioning to the recovered group, while the other assumes the susceptible group directly becomes the recovered group. These modifications differentiate this model from previous ones. Using this new SEIR model, the study aims to investigate the effectiveness of rumour propagation on Facebook and Twitter, focusing on selected topics and identifying the most interesting issues for users.

MODEL FORMULATION

The SEIR model extends the SIR (Kermack and McKendrick, 1926). In the early stages, this model focuses on the spread of disease. As time goes by, researchers worldwide have extended this model and used it in situations similar to the spread of disease as the spread of rumours. Like diseases, social media also has its population, which is the number of users. In this model, users are denoted as *N*, representing the number of populations spreading rumours. The population is divided into four different groups, which are the Susceptible (S), Exposed (E), Infected (I) and Recovered (R). Since the SEIR model will fluctuate over time, the summarization is as bellows:

S(t): The number of social media users suspected of receiving the rumors at the time t
E(t): The number of social media users exposed to the rumors at the time t
I(t): The number of social media users who react to the rumors at the time t
R(t): The number of social media users that stop spreading the rumors at the time t

Hence, the entire population for this model is represented as:

$$N = S(t) + E(t) + I(t) + R(t) \tag{3.1}$$

Figure 2 below shows the SEIR model's flowchart used in this study.

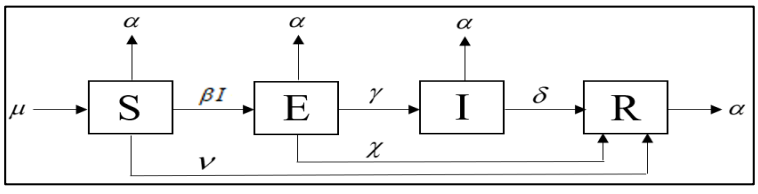

Figure 1: The SEIR model flowchart

The description for each parameter involved in this model is summarised in Table 1 below:

Table 1: The description of parameters involved in the SEIR model

Parameters	Description
μ	The birth rate represents the number of new users on social media
α	The death rate represents the number of users that stop using the social media
β	The infection rate represents the users who most likely received the rumours
γ	The evolution rate represents the user that has the intention to spread the rumours
δ	The recovery rate represents the number of users that stop spreading the rumours
ν	The uninfectious rate represents the number of users that not exposed to the rumours
χ	The incurious rate represents the number of users who are exposed to the rumours but do not have the intention to spread the rumour

All the parameters in Table 1 are positive constant. Hence, the equation produced based on ordinary differential equations (ODEs) for the SEIR model are as below:

$$\frac{dS}{dt} = \propto - \text{b}SI - \text{a}S - \text{n}S \tag{3.2}$$

$$\frac{dE}{dt} = \text{b}SI - \text{a}E - \text{g}E - \text{c}E \tag{3.3}$$

$$\frac{dI}{dt} = \text{g}E - \text{a}I - \text{d}I \tag{3.4}$$

$$\frac{dR}{dt} = \text{d}I + \text{n}S + \text{c}E - \text{a}R \tag{3.5}$$

The Rumour-Free Equilibrium (RFE) point is calculated by setting $\frac{dS}{dt} = 0, \frac{dE}{dt} = 0, \frac{dI}{dt} = 0$ and $\frac{dR}{dt} = 0$. The RFE for the proposed model is as follows:

$$\left(S^*, E^*, I^*, R^*\right) = \left(\frac{\mu}{\alpha + \nu}, 0, 0, \frac{\nu\mu}{\alpha(\alpha + \nu)}\right). \tag{3.6}$$

Basic reproduction numbers R_0 describe the rate of virality caused by an infected individual in a susceptible population throughout their infection period by spreading the rumours. In this study, the next generation matrix is used to calculate the value of the basic reproduction number. By using the Next-Generation Matrix, the calculation involve several steps as follow:

$$R_0 = \rho\left(FV^{-1}\right) = \frac{\beta\mu\gamma}{\left(\alpha + \nu\right)\left(\alpha + \gamma + \chi\right)\left(\alpha + \delta\right)} \tag{3.7}$$

where ρ denotes the spectral radius of the matrix FV^{-1}. Using the Jacobian stability, the stability of rumours-free equilibrium for this study is proved based on the obtained RFE point $\left(S^*, E^*, I^*, R^*\right) = \left(\frac{\mu}{\alpha + \nu}, 0, 0, \frac{\nu\mu}{\alpha(\alpha + \nu)}\right)$. Based on Equation (3.2)-(3.5), the Jacobian Matrix is;

$$F = \begin{bmatrix} -\beta I - \alpha - \nu & 0 & -\dfrac{\beta\mu}{\alpha+\nu} & 0 \\ \beta I & -\alpha-\gamma-\chi & \dfrac{\beta\mu}{\alpha+\nu} & 0 \\ 0 & \gamma & -\alpha-\delta & 0 \\ \nu & \chi & \delta & -\alpha \end{bmatrix}$$

Substitute the value $\left(S^*, E^*, I^*, R^*\right)$ into the Jacobian matrix above,

$$F_{\left(S^*,E^*,I^*,R^*\right)} = \begin{bmatrix} -\alpha - \nu & 0 & -\dfrac{\beta\mu}{\alpha+\nu} & 0 \\ 0 & -\alpha-\gamma-\chi & \dfrac{\beta\mu}{\alpha+\nu} & 0 \\ 0 & \gamma & -\alpha-\delta & 0 \\ \nu & \chi & \delta & -\alpha \end{bmatrix}$$

From the Jacobian matrix, the calculated eigenvalues are $\lambda_1 = \left(-\alpha - \lambda\right), \lambda_2 = \left(-\alpha - \nu - \lambda\right)$;

the remaining roots are determined by the quadratic equation:

$$\lambda^2 + \left(2\alpha + \gamma + \chi + \delta\right)\lambda + \left(\alpha + \gamma + \chi\right)\left(\alpha + \delta\right)\left(1 - R_0\right) = 0 .$$

Therefore, this proves that the basic reproduction for Rumours-Free Equilibrium is asymptotically stable when $R_0 < 1$ and unstable state when $R_0 > 1$.

NUMERICAL RESULTS AND DISCUSSION

The number of Facebook and Twitter users in Malaysia, denoted by *N*, is 21700000 and 4400000, respectively (Mortimer, 2016). Table 2 below illustrates the early stage of recorded data for all selected accounts based on each topic, including the number of followers, reactions, comments, and likes on Facebook while like, comment and retweet on Twitter. The initial condition for each post for the selected topic represents the initial number of users in of susceptible, exposed, infected, and recovered group at a time equal to 0. Thus, Table 3 below shows the initial condition for each selected post on entertainment, health and political topic on Facebook and Twitter. Table 4 above illustrates the formula for each parameter for this model. The number of users aged 50 is the assumption of the number of users that do not spread rumours even though they have social media accounts (Théro and Vincent, 2022). The parameter's value is then substituted using Microsoft Excel based on Equation (3.2) -(3.5) in Maple Software to get the SEIR graph.

Table 2: The initial time for recorded data

	Entertainment Topic		Health Topic		Social Interest Topic	
Topic/ Variables	Manilla Bulletin	RtGane Daniel	Sky News	Rick Wilson	Judge Jeanine Pirro	SCOTUS blog
Follower	4000000	28900	9800000	1400000	2700000	621000
Reaction/ Like	6400	26400	218	10800	5700	42500
Comment	334	34	158	476	504	6150
Share/ Retweet	1300	1200	12	3306	989	39400

Table 3: The value of the initial condition

	Entertainment Topic		Health Topic		Social Interest Topic	
Initial Condition	Manilla Bulletin	RtGane Daniel	Sky News	Rick Wilson	Judge Jeanine Pirro	SCOTUS blog
S(0)	17691966	4083366	11899612	2985418	18992807	3690950
E(0)	4000000	289000	9800000	1400000	2700000	621000
I(0)	8034	27634	388	14582	7193	88050
R(0)	0	0	0	0	0	0

Table 4: Formula involved in SEIR Model

Parameter	**Formula**	
	Facebook	**Twitter**
N	$N = 21700000$	$N = 4400000$
μ	$\mu = \frac{Number\ of\ user\ 1^{st} quarter\ 2022}{Number\ of\ user\ 4^{th} quarter\ 2021} - 1$	
α	$\alpha = \frac{Number\ of\ user\ aged\ above\ 50}{N}/365$	
β	$\frac{Follower - (Reaction + Comment + Share)}{N}$	$\frac{Follower - (Like + Comment + Retweet)}{N}$
γ	$\frac{Reaction + Comment + Share}{N - Follower}$	$\frac{Comment + Retweet + Like}{N - Follower}$
δ	$\frac{Reaction}{N - Follower}$	$\frac{Like}{N - Follower}$
ν	$\nu = 1 - \beta$	
χ	$\frac{Reaction + Comment + Share}{N}$	$\frac{Comment + Retweet + Like}{N}$

To find the solution for each selected post, the value of the parameter $\mu, \alpha, \beta, \gamma, \delta, \nu$ and χ were calculated by using the formula in Table 4. In this study, Facebook and Twitter were used to investigate the effect of each parameter related to this model. Hence, the topic plays a crucial role here; from the issue, this study can determine the impact of each parameter involved and then conclude how the parameter effect social media as the platform. For social media, the effectiveness can be determined based on the virality rate calculated based on the selected post for each topic.

Entertainment Topic

Table 5 summarises the parameter value related to entertainment topics on both platforms, Facebook and Twitter. The graph of the SEIR model for entertainment topics is illustrated in Figures 3 and 4. Based on Figure 3, the susceptible line shows a declining pattern from the initial value. Meanwhile, the exposed curve represented by the brown line shows an increase in the number of exposed used towards the rumours but starts to decline after 0.7 hours. The infected and recovered users show an increase in the pattern, but after a certain point, both lines reach a

slow movement where the red line decreases after 7.9 hours and the green line increases after 1.2 hours. As shown, there is a difference between the pattern on the behaviour graph on Facebook and Twitter, which is due to the difference in the value of the basic reproduction number, where Facebook has a higher value compared to Twitter, with 4.14 and 1.00, respectively. Compared to Figure 3, Figure 4 has a different graph pattern where three groups of susceptible, exposed, and infected start to reach a steady state near 0. But it differs for the recovered line, where it reaches the maximum population at 12.7 hours.

Table 5: The value of parameters for the entertainment topic

Topic/ Parameter	Entertainment Topic		References
	Manilla Bulletin	RtGane Daniel	
μ	0.07080	0.37801	Estimated base on Table 4
α	0.00048	0.00047	
β	0.18285	0.05471	
γ	0.00181	0.01174	
δ	0.00136	0.01058	
ν	0.81715	0.94529	
χ	0.00148	0.01097	

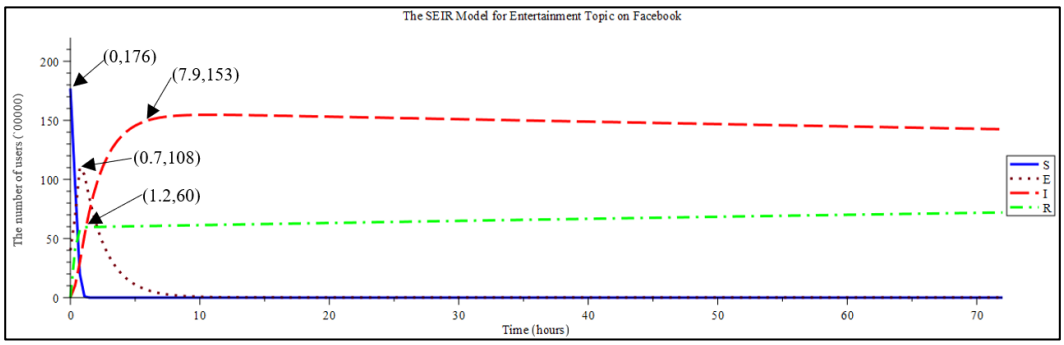

Figure 2: The SEIR model graph for entertainment topics on Facebook

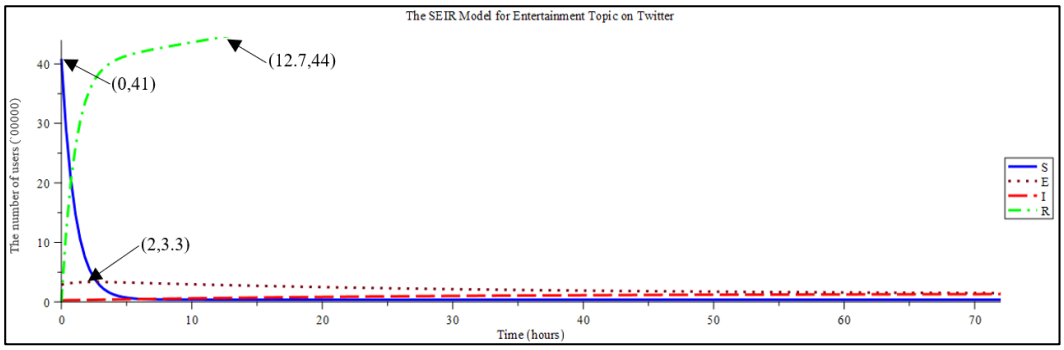

Figure 3: The SEIR model graph for entertainment topics on Twitter

Health Topic

Table 6 implies the value of parameters related to health topics on both platforms, Facebook and Twitter.

Table 6: The value of parameters for the health topic

Topic/ Parameter	Health Topic		References
	Sky News	Rick Wilson	
μ	0.07080	0.37801	Estimated base on Table 4
α	0.00048	0.00047	
β	0.45157	0.31366	
γ	0.00007	0.00663	
δ	0.00004	0.00490	
ν	0.54843	0.68634	
χ	0.00004	0.01421	

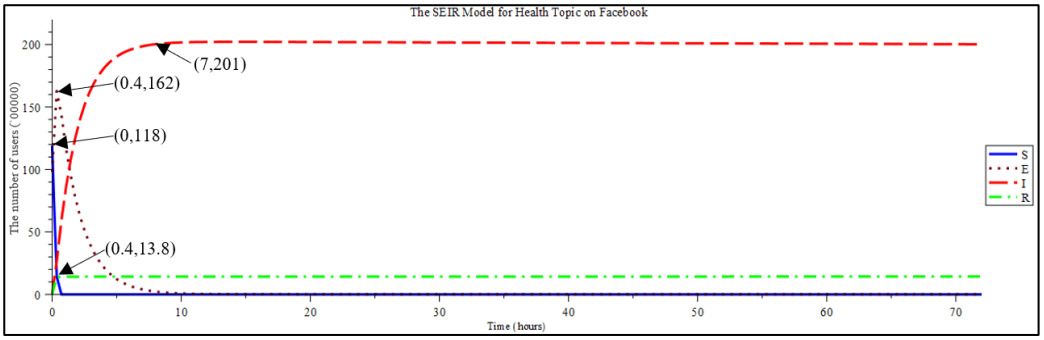

Figure 4: The SEIR model graph for health topics on Facebook

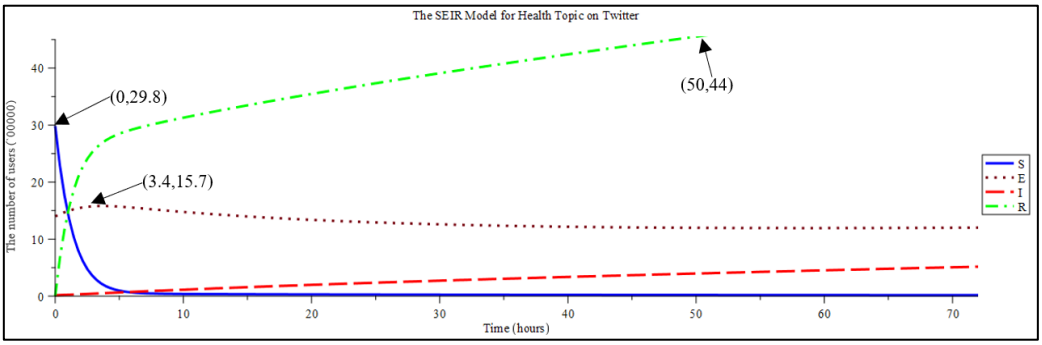

Figure 5: The SEIR model graph for health topics on Twitter

Using the value of the parameter in Table 6, Figure 5 and Figure 6 illustrated the graph for the SEIR model related to health topics. The susceptible and exposed group shows almost the same pattern as the entertainment topic, but the exposed group reaches a higher number of users in 0.4 hours. Meanwhile, there is a huge gap between the infected and recovered line. The infected group starts to reach its steady state after 7 hours. Next, for the recovered line, after 0.4 hours, it reaches the steady state over time. Like entertainment, the health-related topic also has a different graph pattern between Facebook and Twitter since there is a difference in the value of basic reproduction numbers on Facebook and Twitter with 13.38 and 10.01, respectively. But for the health-related topic on Twitter, the recovered group on Twitter reached out maximum population by 50 hours which is longer than the entertainment topic. Meanwhile, the susceptible group approaches a steady state at point 0 after declining. For the infected group, it has a gradually increasing pattern over time. Lastly, for the exposed group, after reaching its point, it starts to decrease over time.

Social Interest Topic

Table 7 simplify the value of parameter related to entertainment topic on both platforms, Facebook and Twitter.

Table 7: The value of parameters for the social interest topic

Topic/ Parameter	Social Interest Topic		Reference
	Judge Jeanine Pirro	SCOTUSblog	
μ	0.07080	0.37801	Estimated base on Table 4
α	0.00048	0.00047	
β	0.12366	0.11837	
γ	0.00087	0.02650	
δ	0.00068	0.01334	
ν	0.87634	0.88163	
χ	0.00076	0.02276	

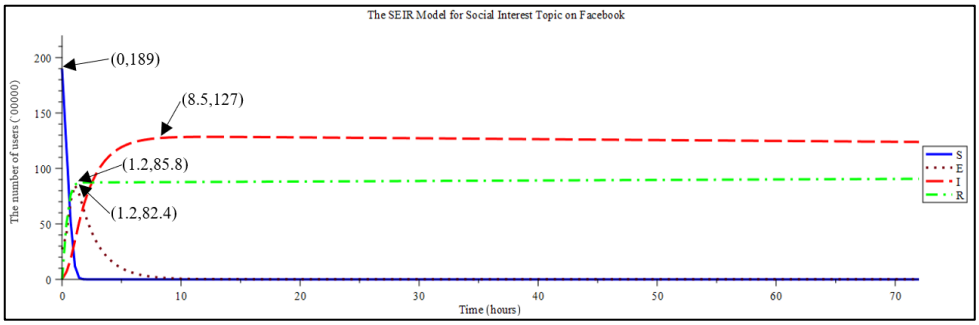

Figure 6: The SEIR model graph for social interest topics on Facebook

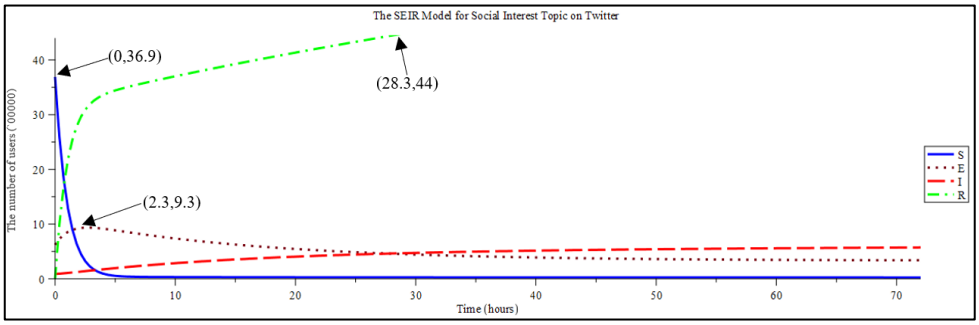

Figure 7: The SEIR model graph for social interest topics on Twitter

The SEIR graph for the social interest topic is described in Figures 7 and 8. With 1.56 different in the value of basic reproduction number where 3.52 on Facebook and 1.96 on Twitter, both graphs also have different patterns. Both exposed and recovered groups have the same peak number of users in 1.2 hours before a decline and reach a steady state point at 0 on the exposed line and reach a steady state after reaching the peak population for the recovered group. The susceptible group shows a declining pattern over time. As for the infected line, there is also a decrease after 8.5 hours in the pattern but compared to the health topic, it has a smaller gap than the recovered group. The graph on Twitter also shows almost the same pattern as the previous one for Twitter. But it shows an interception in the number of exposed and infected groups in 27 hours before both reach their steady state. Lastly, compared to health issues, the infected group required less time by 28.3 hours, to get its maximum population.

Sensitivity Analysis

The analysis allows the researcher to calculate the changing rate when the parameter changes. Hence, based on the formula obtained for the basic reproduction number, it is easier to calculate the sensitivity analysis using same method in (Hamdan and Kilicman, 2019). Hence, the general expression of the sensitivity index is as Equation 4.1, where p represents the parameters involved in the model:

$$\gamma_p^{R_0} = \frac{\partial R_0}{\partial p} \times \frac{p}{R_0}. \tag{4.1}$$

Tables 8 until Table 10 below summarize the value of sensitivity indices for entertainment, health, and social interest topics, respectively. The value of indices for each table is arranged from the most sensitive to the least sensitive for both Facebook and Twitter. The value of the index for each parameter in the model is then illustrated in Figure 12 until Figure 14. The positive sign in the value of indices of a parameter implies that the value of the basic reproduction number increased when the parameter increased and the infected were also expected to increase (Kamarujjaman et al., 2022). Meanwhile, when the parameter value decreases, the value of the basic reproduction number and the infected are also likely to decrease.

Table 8: The value of sensitivity indices for the entertainment topic

	Entertainment Topic	
	Manilla Bulletin (Facebook)	RtGane Daniel (Twitter)
μ	+1.0000	+1.0000
β	+1.0000	+1.0000
ν	-0.9994	-0.9995
δ	-0.7377	-0.9576
γ	+0.5196	+0.4935
χ	-0.3918	-0.4733
α	-0.3907	-0.0631

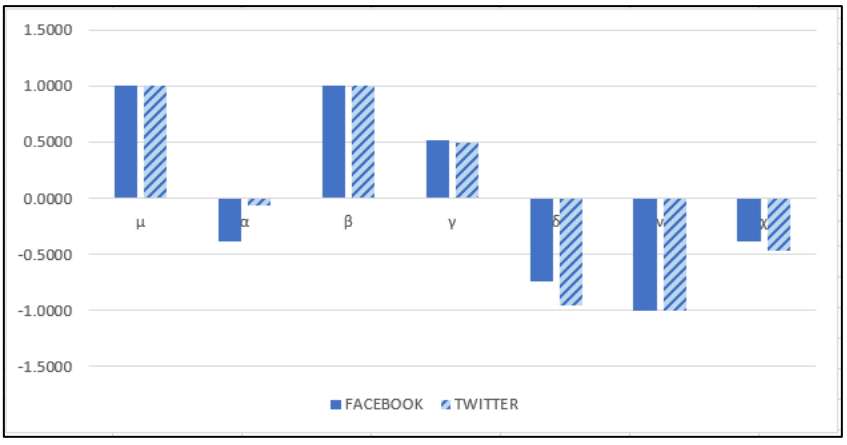

Figure 8: The sensitivity indices for the entertainment topic

In Table 8 and Figure 12, the highest sensitivity index for entertainment topics on Facebook and Twitter is represented by μ and β followed by the parameter ν. From the result, the sensitivity index, which equals +1, can be interpreted as for every 10% increment in the

parameter μ and β, it indirectly increases the value of the basic reproduction number and the infected group by 10%. Likewise, for the sensitivity index ν, which equals -0.9994 on Facebook, and -0.9995 on Twitter, an increase of 10% on the parameter's value ν, will decrease the value of the basic reproduction number and the infected user by approximately 10%. Next, based on the sensitivity index of the parameter χ, it shows that if there is an increase of 10% in the parameter's value, it will decrease the value of the basic reproduction number by 3.9% on Facebook while 4.7% on Twitter. In other words, the infected group was also reduced by the same value.

Table 9: The value of sensitivity indices for the health topic

Health Topic			
Sky News (Facebook)		Rick Wilson (Twitter)	
α	-1.7400	+1.0000	μ
μ	+1.0000	+1.0000	β
β	+1.0000	-0.9993	ν
ν	-0.9991	-0.9127	δ
γ	+0.8802	+0.6888	γ
δ	-0.0754	-0.6668	χ
χ	-0.0657	-0.1099	α

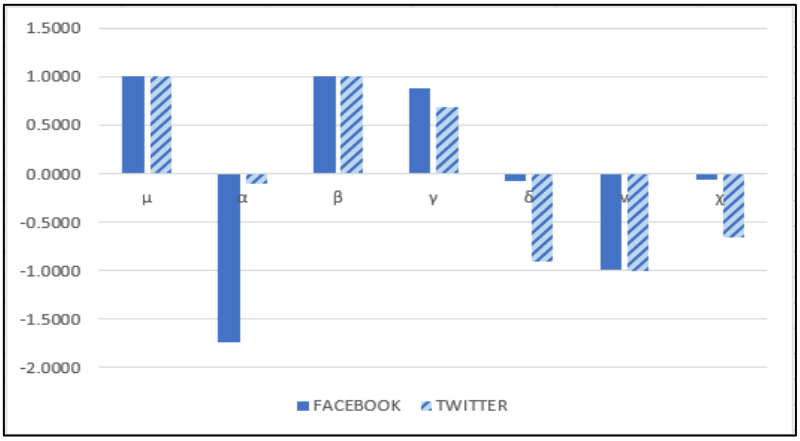

Figure 9: The sensitivity indices for the health topic

Based on Table 9 and Figure 13, the highest sensitivity index for health topics on Facebook is represented by a parameter α. Other significant parameters are followed by μ and β. Meanwhile, on Twitter, the highest sensitivity index is parameters μ and β, followed by a parameter ν. Hence, the sensitivity index can be interpreted as, for instance, the sensitivity index α, which equals -1.74 on Facebook and -0.9993 on Twitter, an increase of 10% on the parameter's value α, will result in a decrease of around 17% on Twitter and nearly 10% on Twitter in the value of basic reproduction number and the infected. Besides, for a sensitivity index μ on Facebook, μ and β on Twitter that equals +1, a 10% increase in the parameter μ and β value will increase the value of the basic reproduction number and infected by 10% on both Facebook and Twitter. Next, the value of the sensitive index related to the parameter χ shows that it is more significant on Twitter than on Facebook. A 10% increase in the parameter value

will decrease the value of the basic reproduction number by 6.7% on Twitter and 0.6% on Facebook.

Table 10: The value of sensitivity indices for social interest topic

Social Interest Topic			
Judge Jeanine Pirro (Facebook)		SCOTUSblog (Twitter)	
μ	+1.0000	+1.0000	μ
β	+1.0000	+1.0000	β
ν	-0.9995	-0.9995	ν
α	-0.6424	-0.9929	δ
γ	+0.5886	+0.4445	γ
δ	-0.5866	-0.4415	χ
χ	-0.3602	-0.0106	α

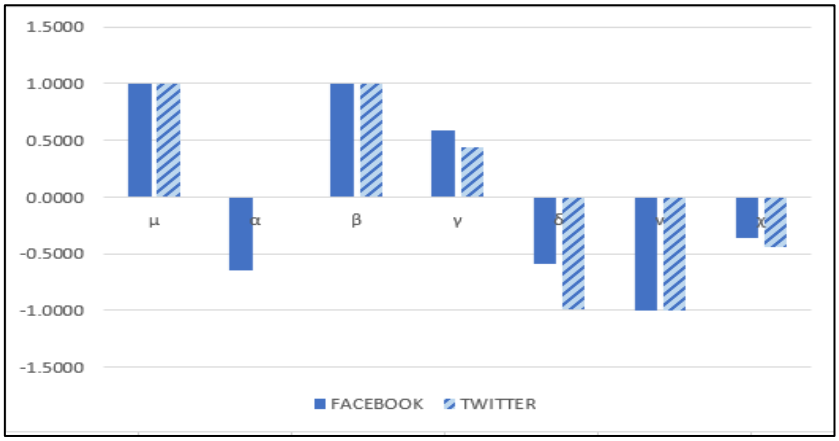

Figure 10: The sensitivity indices for the social interest topic

For the social interest topic, based on Table 10 and Figure 14, it is evident that the highest sensitivity index are represented by μ and β, followed by the parameter ν. From the result, the sensitivity index can be interpreted as, for sensitivity index of μ and β that equal to +1, indicates that an increase of 10% in the value of parameters μ and β on Facebook and Twitter will result in an increase by 10% in the value of basic reproduction number and the infected group. Next, for the sensitivity index ν, which equals -0.9995 on both social media platforms, an increase of 10% on the parameter's value ν, results in a decrease in the basic reproduction number, which also decreases the infected group by about 10%. Lastly, like health-related topics, the sensitivity index for the parameter χ is more significant on Twitter than on Facebook at 0.8%. The difference between these values might be because social media users on Twitter are more familiar with social interest rumours. Hence, they are not easily affected by these rumours. Therefore, the value of the basic reproduction number and the infected group will decrease by 3.6% on Facebook and 4.4% on Twitter whenever the parameter value χ is increased by 10%.

Figures 15 to 17 illustrate the time-series graph of the effect of infected users on Facebook and Twitter, with an increase of 10% in the parameter value. The plots represent the sensitivity index in Tables 8 to 10 above for each entertainment, health, and social interest topic, which summarizes the significant parameters contributing to the virality rate. The result gives a significant insight into the dynamic of rumours spreading. Analyses show that the most

significant parameter is the death rate represented by α on Facebook about health-related topics. If the number of social media users who leave social media increases, the virality rate will decrease. But this is one of the most challenging parameters to control since it relates to the number of users who left social media. Therefore, the suggested solution is exposing the users to how social media works.

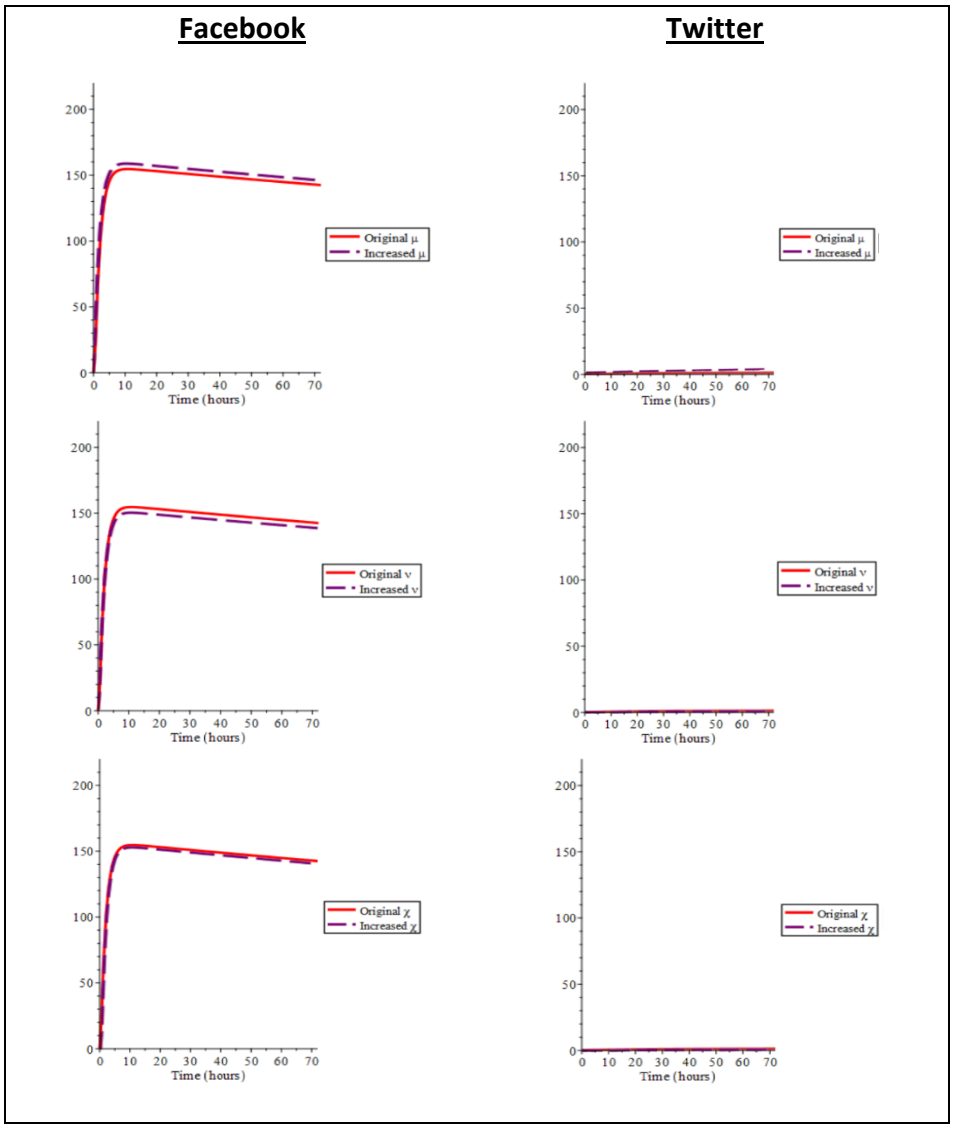

Figure 15: Graph of the infected users over time on entertainment topic with an increase of 10% of parameters value

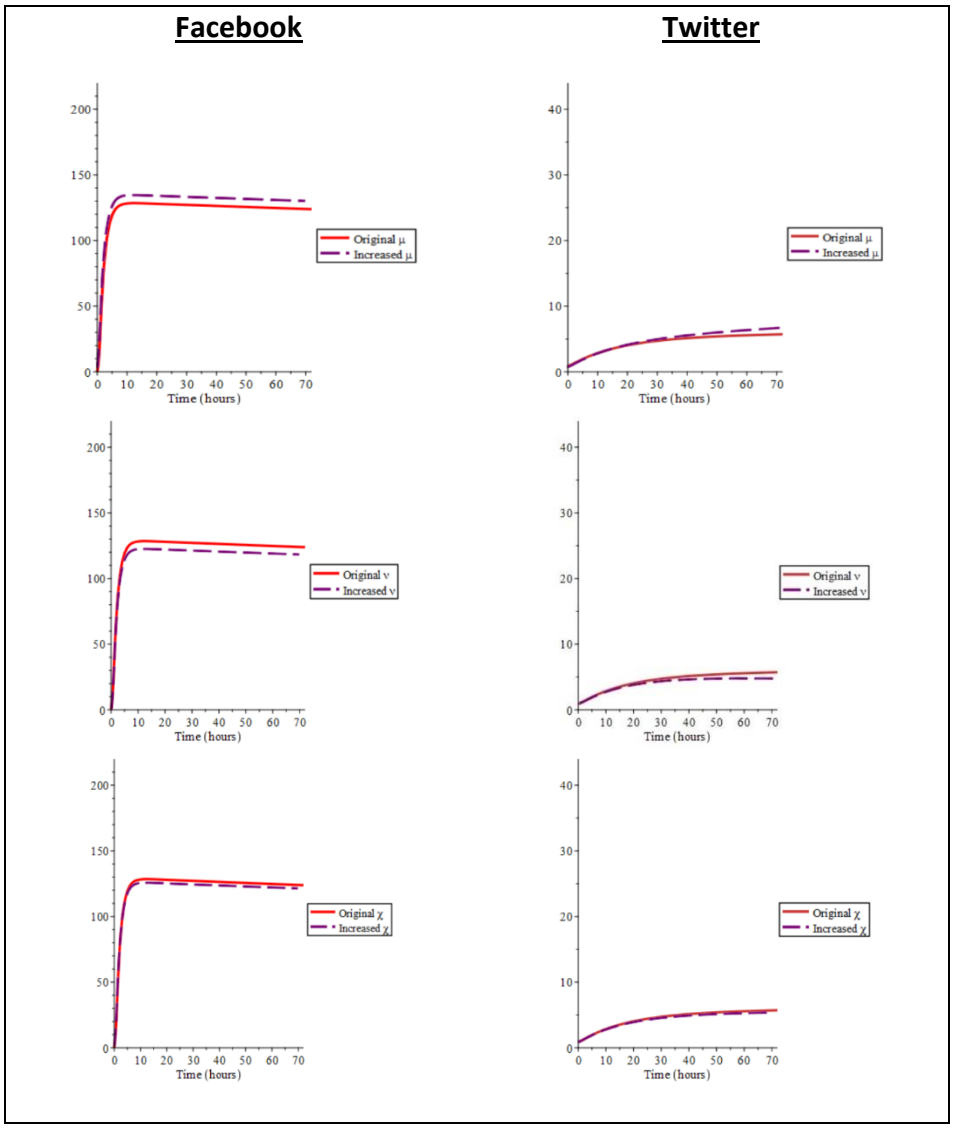

Figure 16: Graph of the infected users over time on social interest topic with an increase of 10% of parameters value

The birth rate μ is also classified as one of the most significant sensitivity indexes directly impacting the rumour's virality rate. Like the death rate, the birth rate is much harder to control since it is undeniable that the number of new social media user keep growing over time. This can be seen not just in Malaysia but globally. Hence, instead of controlling the number of new users, it could be done by governing the use of social media, especially among teenagers. Nowadays, there are some cases where underage users have already used social media. Thus, being able to control the situation might help solve this issue. This study also agrees (Théro and Vincent, 2022), who suggests that policy must play its role truthfully to reduce the chances of spreading rumours.

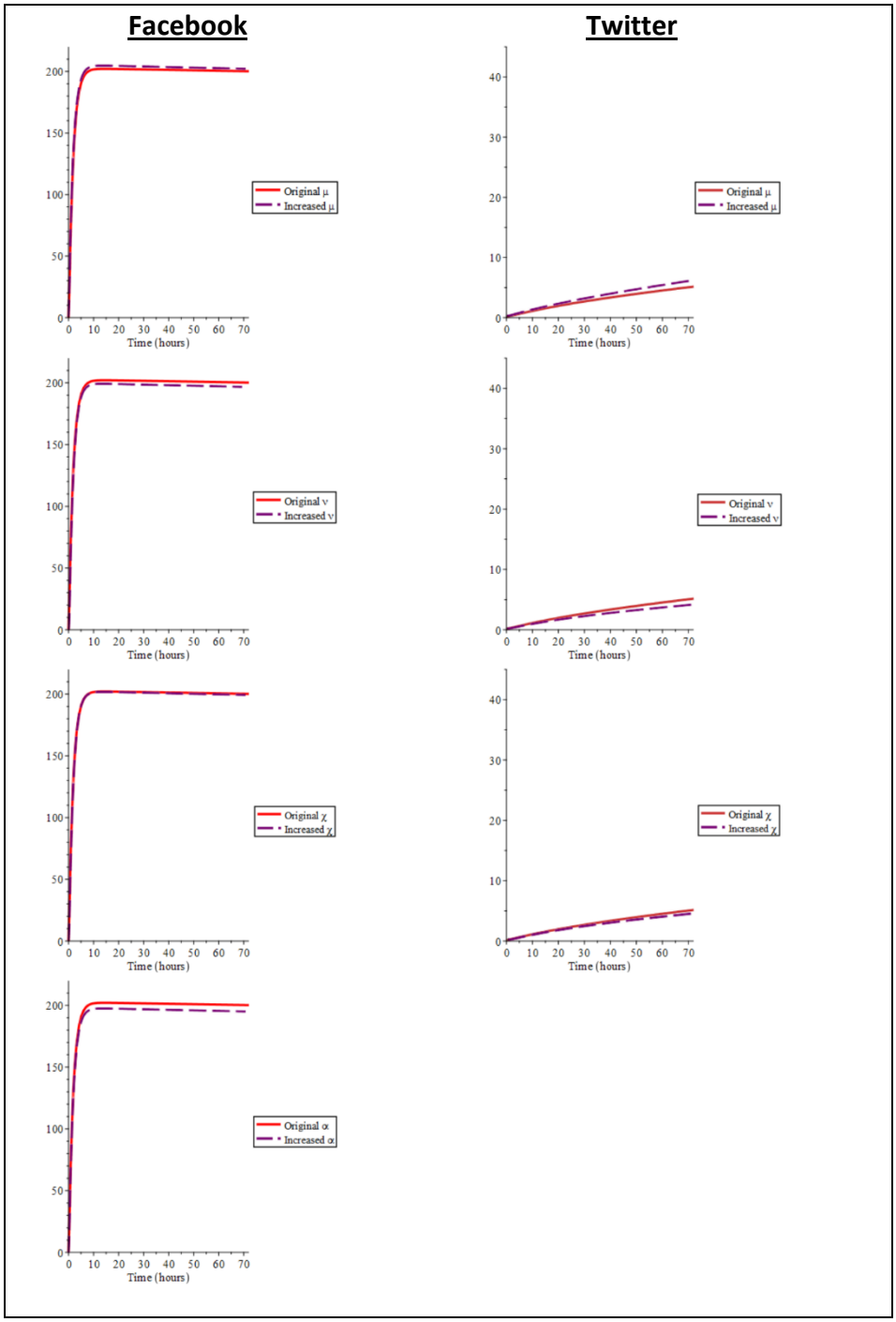

Figure 17: Graph of the infected users over time on health topic with an increase of 10% of parameters value

The parameter ν that describes the uninfectious rate also contributes to the virality rate of rumours. From this study, it is concluded that an increase in parameter value will reduce the virality rate. Therefore, this finding supports the finding of (Annas et al., 2020), who also used this parameter in their study. Besides, this finding also proves that the spreading of rumours and diseases has a similar situation as mentioned by the previous researchers. For this rate, several preventions can be made to decrease the parameter's value, for instance, by tightening the policy of social media users. This measure will eventually reduce the number of responses to the post and directly affect the decrease in a rumour's virality rate.

Lastly, for the parameter χ which describes the incurious rate among social media users, even though this parameter is not classified as the most significant sensitivity value, from the result, this study concludes that even though the value of the sensitivity index for this parameter is lower than the most significant parameter. But still, it contributes to the changes in the infected group, as shown in the figure. Hence, based on the effect of parameters, this study concludes that increasing the incurious rate on social media will help reduce the spread of rumours in Malaysia. Other than the basic parameter (Paul et al., 2021), this parameter will also help reduce the number of infected users related to the rumours. Therefore, the best way to increase the parameter value in real life is by increasing the user's knowledge about the behaviour of the rumours.

CONCLUSION

Mathematical modeling related to the spreading of rumors has been conducted in this study by using the SEIR model. This model consists of four different groups from Malaysia's total population of social media users. In this study, only three types of topics that usually evolve in social media were used: the topic related to entertainment, health and social interest.

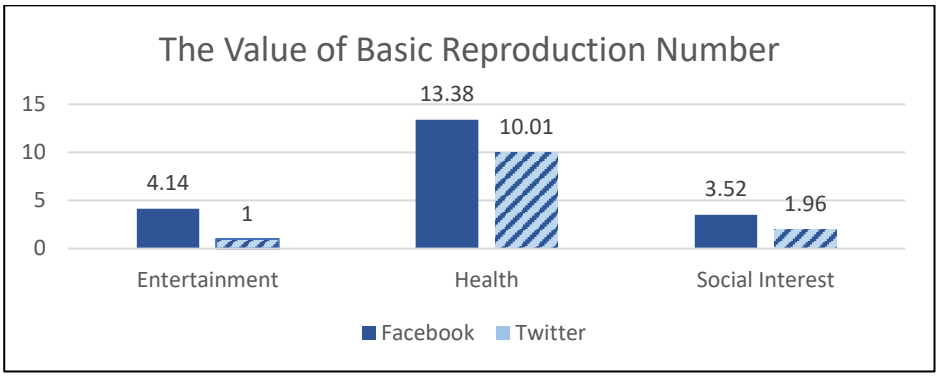

Figure 18: The value of the basic reproduction number

Figure 18 above summarizes the value of the basic reproduction number from each type of topic used in this study. From the bar chart above, it shows that in all of the three topics used, Facebook has a higher value compared to Twitter. Hence, this result answers the objective of this study where from the above result, compared to Twitter, Facebook is 100% more effective in spreading rumours on social media in entertainment, health and social interest topic. So, it is concluded that spreading rumours on Facebook is more effective than on Twitter.

Furthermore, the bar chart above illustrates that health-related topics garnered the highest values of R0 on both Facebook and Twitter platforms, with 13.38 and 10.01, respectively. In comparison to the other topics, health issues captured more attention among social media users in Malaysia on Facebook and Twitter. This finding may be attributed to the global impact of the recent Covid-19 pandemic, leading social media users to exhibit heightened sensitivity towards health-related issues. To combat the spread of rumours, it is crucial for authorities to prioritize the dissemination of accurate information on Facebook while focusing on reducing the spread of rumours on Twitter. Additionally, in order to effectively disseminate information, authorities should prioritize Facebook, as it exhibits a higher virality rate for all entertainment, health, and social interest topics compared to Twitter. Based on the sensitivity analysis conducted, the study shows that compared to all other parameter involved in this study, the birth rate represents the number of new social media user and the death rate that represent the number of social media user that leaves social media, playing the most crucial role in the spread of rumours. Besides, the newly incorporated parameters are significant in reducing rumours' propagation. Hence, authorities can

use the result from this study to find ways to reduce the parameter's value that is highly significant to the spread of rumours to benefit them in reducing the time taken to spread any information.

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