RESEARCH ARTICLE

How social media crisis response and social interaction is helping people recover from Covid-19: an empirical investigation

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Abstract

Community resilience following a crisis has become essential to avoid panic. In contrast, social media usage has been practical to improve public resilience. However, the impacts of social media crisis response and social interaction have not been fully addressed. Therefore, this study aims to investigate the effects of social media crisis communication on public resilience. The study data were collected through an online medium, and the final responses consist of 393 observations, mainly of Malaysians who have experienced Covid-19 isolation, quarantine, or lockdown. The assessments of the reflective measurement models based on path analysis in PLS-SEM are reliable and valid. The Cronbach's alpha, rho_A, composite reliability, and discriminant validity revealed acceptable values. PLS prediction algorithm was run to assess the model's predictive power, and the findings show that the predictive relevance is satisfactory. Furthermore, the IPMA was applied to evaluate the model's usefulness, which compares the level of the variables from the performance scale mean value against the importance level. The result shows that all the variables are useful and reveal good performance. Thus, crisis management and communication activities should pay more attention to these variables for effective social media crisis communication. Thus, the study offers theoretical and practical implications in the field of social media-based crisis communication and crisis informatics.

Keywords Crisis communication · Social media · Crisis response · Social interaction · Resilience · Covid-19

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Introduction

The function of social media is pivotal to the crisis communication literature [2], seen as extending crisis communication by allowing dialogue between the public and authorities [36, 53], sometimes summarised under the termed 'crisis informatics' [48]. Social media is effective in helping the victims of crisis and is widely used as an information source [18]. Crisis management and communication are increasingly being challenged by the impact of social media as a forum for crisis communication. The concept of social media usage in crisis informatics literature views stakeholders' crisis response as an expanded social system [49] which encourages public and crisis management authorities to engage in knowledge sharing of crisis-related information [35]. Similarly, the crisis management and communication authorities are tasked with evaluating the public responses to increase a sense of resilient community [43]. Social networking sites bring the public into groups, creating a social forum to discuss crisis events [29] which could add pressure to the management stakeholders. This paves the way for new questions, including how and to what purpose should crisis management embark on social media usage to participate in social interaction as inter-media dialog and how neutral crisis management voices may stay neutral or positive on social media [5].

Whereas the emergence of Coronavirus (Covid-19) has exposed people to digital interaction via social media platforms, physical interaction has been difficult and challenging due to the nature of the virus spread. The condition deteriorates as experts and authorities encourage and force residents to reduce movement for several weeks to contain the spread of the virus. Public resilience to avoid panicking as a result of the crisis has become even further critical. While social media provides the environment where people communicate, help the affected citizens, and as information source [18]. Despite its importance, the literature review has identified. Reference [41] as the only study that investigated how social media usage could improve community resilience after a crisis. Besides, social networking sites have created more concerns on the ability of the public to scrutinize information and potential relationship building through social media interaction. Thus, this study intends to add to the literature on resilience building through social media usage and social media-based crisis communication. Hence, this study addressed the research question; what is the impact of social media crisis communication on the ability of the people to recover from a crisis? Consequently, the main objective of this study is to investigate the impact of social media crisis response and social interaction on public resilience. Thus, the study is presented as follows; section II discussed the theoretical framework and hypothesis, section III discussed the research methods, section IV presents the results and analysis, and section V presents the discussion of the study and then the conclusion.

Theoretical model and hypothesis

According to [3], the situational crisis communication theory (SCCT) is the most prevalent. It focuses on reputation building, whereas the social-mediated crisis communication (SMCC) theory examined the impact of social media users on crisis communication, which is used to increase organizational reputation. Although there are numerous models that emphasise public resilience [41, 59, 64], and stakeholder relationships [4, 10, 24, 40]. For instance, the model by [41] demonstrates how social media can enhance hotel resilience. Additionally, [3] reported that a study conducted by [64] concluded that traditional models are incapable of providing the optimal solution for social media crisis communication. However, [38] insisted that two models which integrate social media and may be able to provide reputation building, resilience, and an understanding of complexity: the networked crisis communication model (NCC) and the social media crisis communication model (SMCC). The majority of these models are static, oblivious to the dynamic of social media. While the SMCC attempted to address the dynamism of social media, the model focuses primarily on the types of public engagement in crisis response. Traditionally, integrated crisis mapping (ICM) has placed a premium on comprehending the full spectrum of public emotions [34]. The dynamic STREMII model was introduced solely to address social media crisis management. A study based on the ICM outlines a general approach and directions for developing a crisis communication and management model and a direct method for more effectively responding to public emotional reactions during a crisis [32]. Additionally, the interactive crisis communication model (ICCM) is the first model to provide an integrated strategy toolkit for social media crisis communication by synthesizing SCCT and CCS into five primary crisis responses. The social media crisis management matrix and framework (SMCMF) [64] emphasizes emotions, accountability, and response strategy, whereas STREMII emphasizes a systematic approach to dynamically responding
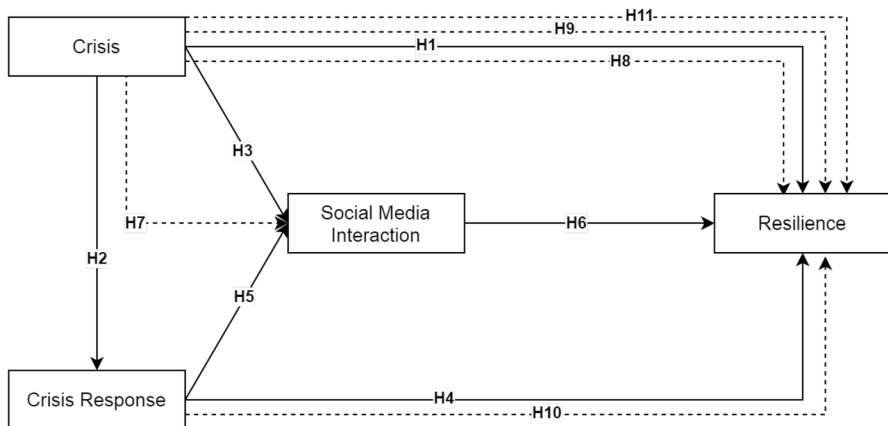

Fig. 1 Hypothesize conceptual model

to a crisis. Despite their importance, the studies have not examined the potential impact of social media crisis communication on people's ability to recover quickly and effectively from crises. The Fig. 1 presented the conceptual model and research hypothesis, the bold and dotted lines indicates direct relationship and indirect relationship, respectively.

Situational crisis communication theory (SCCT)

Situational crisis communication theory (SCCT) was developed in 1995, refined, and renamed in 2002 [8]. The SCCT was motivated by the absence of a model to connects crisis to crisis response strategies (what crisis communicators say and do during a crisis) and crisis situations. The SCCT connects crisis and crisis response strategies and crisis types through the lens of attribution theory. Through crisis response, individuals seek to comprehend why a crisis event occurred. The work by [8] highlighted the importance of attributions, stating that they influence how people feel and react to an event. According to SCCT, crises are adverse events that cause people to judge the crisis management authorities, and a timely response safeguards the crisis management reputations [7]. The digital environment, mainly social media platforms, enables individuals to challenge crisis management [8] due to public engagement in crisis response via social media, which also aids in the recovery process. On social media, the crisis has an impact on how crisis response is formed and led. Thus, crisis response and social media interaction are used to address the situation when the crisis occurs. This demonstrated the effectiveness of crisis response and social media interaction in assisting people recovering from a crisis. Thus, the research framework (Fig. 1) indicates that crisis significantly affects resilience, social media interaction, and crisis response, as the following hypothesis suggests.

– Hypothesis 1 (H1): Crisis has a significant impact on crisis response.
– Hypothesis 2 (H2): Crisis has a significant impact on the crisis.
– Hypothesis 3 (H3): Crisis has a significant impact on social media interaction.

Additionally, crisis response refers to the response of stakeholders (both public and management) to a crisis. This is discussed in the social-mediated crisis communication model (SMCC), which focuses on the types of public, the sources of information, and the information format. The crisis response enables stakeholders to create content that expresses their views on/about the crisis or the entity managing it. Understanding the full range of public emotions enhances the effectiveness of crisis response strategies [38, 59, 64], all of which have an effect on the public's ability to recover. The crisis management literature frequently refers to three stages of crisis management as para-crisis, crisis, and post-crisis [4, 9, 38, 61]. As is the case with crisis responses, the nature of the para-crisis is considered to determine the para-crisis response that will most effectively mitigate the crisis risk [8]. Thus, crisis response has an effect

on resilience and social media interaction. Hence, the crisis-resilience relationship is mediated by crisis response and social media interaction. Therefore, this study implies that crisis response acts as a mediator between crisis and social interaction, as well as between crisis and resilience, as described in the hypothesis below.

– Hypothesis 4 (H4): Crisis response has a significant impact on resilience.
– Hypothesis 5 (H5): Crisis response has a significant impact on social media interaction.
– Hypothesis 7 (H7): The relationship between crisis and resilience is mediated by crisis response.
– Hypothesis 8 (H8): The relationship between crisis and social media interaction is mediated by crisis response.

Interactive crisis communication model (ICCM)

The interactive crisis communication model (ICCM), introduced by [4], is relatively new in the crisis communication literature, which is base on SCCT, SMCC, and traditional crisis communication strategies (CCS). The ICCM is built for social media, demonstrating and representing the total interaction of stakeholders in a digital environment. Since everyone participates in crisis response, the model reaffirms the SMCC classification of public engagement and interactions. The ICCM demonstrates the importance of social interaction by demonstrating its capacity to provide one of the four gratifications identified in the uses and gratification theory (UGT) [37, 66]. The entire ICCM is referred to as an interactive model, as it illustrates the fundamental elements of crisis management's interaction with the public. Similarly, the interaction is a fundamental component of the STREMII model [59]. The ICCM demonstrates why social interaction is critical in social media crisis response. According to the ICCM model, since social media is an object or environment that enables groups and individuals to collaborate, the content can take the form of text, visual, audio, or a combination of these, which referred to as the interaction's content [4, 38, 41, 59]. The contents are from two sources: crisis management and public response. The purpose of this study is to examine the effect of social interaction on resilience. Thus, this study implies that there is a relationship between social media interaction and resilience. As demonstrated in the hypothesis below, social media interaction serves as a mediator between crisis and resilience and crisis response and resilience.

– Hypothesis 6 (H6): Social media interaction has a significant impact on resilience.
– Hypothesis 9 (H9): The relationship between crisis and resilience is mediated by social media interaction.
– Hypothesis 10 (H10): The relationship between crisis response and resilience is mediated by social media interaction.

Social media disaster resilience (SMDR) model

The social-mediated disaster resilience (SMDR) model was introduced by [41], who demonstrated how social media usage is integrated into resilience building and discusses its potential for increasing hotel resilience. The study links resilience and disaster management literature using the revised 3Rs (robustness, rapidity, and redundancy) resilience model. Then, discussed social media as a robust technology to be used in crisis [68], to increase the speed of communication and information distribution (rapidity) [11, 30], and to redistribute the targeted information to a larger crowd via crowdsourcing (redundancy). In general, there is enough literature on how social media detects and document disasters [48], send and receive assistance [63], spread warnings [50], and solicit donations and volunteerism [50, 63]. Thus, the robustness of social media has enabled the public to participate in crisis communication discussions, establishing them as vital resources [31]. Additionally, the information can be quickly and widely distributed via social media crisis response and social interaction. While resistance is the first ideal outcome following a crisis, robustness, rapidity, and redundancy (3Rs) are critical for increasing resilience to the adverse effects of a crisis or disaster [41]. Hence, it is essential to investigate the impact of crisis management efforts since their role is to strengthen relationships and improves the community's resilience [38, 41]. Accordingly, crisis response and social media interaction mediates the crisis-resilience relationship as the following hypothesis suggest.

Resilience is the ability to mentally or emotionally cope with crises or to return to pre-crisis status quickly. Public resilience is important to understand the impact of crisis management (organization) effort in the advent of the crisis. Crisis management action is aimed to improve relationships and increase community resilience [38, 41]. The conceptual model (Fig. 1) indicates that crisis, crisis response, and social media interaction has a significant impact on the ability of people to recover from the crisis.

– Hypothesis 11 (H11): The relationship between crisis and resilience is mediated by crisis response and social media interaction.

Research method

Preliminary test

The questionnaire items were developed from the existing literature on crisis communication and the use of social media for crisis response. The items were revised to form the research instrument as an expert evaluation document for content validation. The expert evaluation form contains a detailed discussion of each construct with their corresponding items used in this research. Experts in crisis communication and information systems were used for expert validation in the first and second-round processes. The validity of the items was examined in each round, and 34 items passed the requirement of content validity index (CVI) and modified kappa statistics

used to compute the agreement between the experts [44, 45, 67]. The result of the expert validation and items used for the pilot test and subsequent study are presented in appendix A and B. Consequently, 32 responses were received during the pilot test to examine the instrument's reliability in the early phase of the study on the 5 point Likert scale. After the pilot test, the items were adapted and designed to form the final instrument use for the data collection.

Data collection

This study investigates the impact of social media-based crisis communication on the ability of people to recover from the crisis quickly, in this case, referred to as public resilience. Specifically, the research focuses to empirically examine how crisis, crisis response, and social media interaction affect public resilience. Therefore, the research aims are to allow the public affected by the crisis to express their views on social media-based crisis responses, engagement, and communication. Thus, this study provides a prospect to investigate the impact of crisis communication by the crisis management authorities and the public as stakeholders affected by the crisis. The study is conducted in Malaysia and the Covid-19 pandemic was used as an example of a crisis that impacted public resilience. The research applied a simple random sampling technique due to its unbiased feature that allows the probability of each member of the population to be selected and its simplicity [17]. Moreover, the study is cross-sectional, and the sample size was calculated by using G*Power statistics, and 119 were found as the minimum sample required for the study [13, 14]. All the measurement items are reflective and are measured on a 5 point Likert scale. The survey was conducted online through Google Form that resulted in 396 responses from people who regularly used social media during the crisis. A total of 3 responses were excluded due to the straight line issue [42]. The final responses consist of 393 observations which primarily consist of Malaysians between 21 and 40 years who have experienced Covid-19 lockdown and are observing social distancing rules either to avoid the crowded area, self-isolate or quarantine. Most of the respondents used social media during the Covid-19 movement control order (MCO) to engage virtually with friends and relatives and received updates from crisis management and communication authorities. The consent for voluntary participation was clearly stated in the questionnaire that offers the freedom for the participants to participate or not. The questionnaire was posted on Malaysian university's Facebook pages and WhatsApp groups periodically between 06/07/2020 to 20th/11/2020.

Data analysis

The study used Excel to store the data during the entire stages of the research, SPSS 26.0 was used in the preliminary stage for early reliability checking, and SmartPLS 3 was adopted to analyze the data in the final stage of the research. Specifically, the researchers utilized SPSS 26.0 to examine the pilot test data to evaluate the Cronbach's alpha, reliability of the instruments, model fit, and mediation before the final data collection. The SmartPLS 3 was used to perform confirmatory composite

Table 1 Demographic characteristics of the sample

		Frequency	Percent
Gender	Female	208	52.5
	Male	184	46.5
Age	Prefer not to say	4	1
	Under 18 years	2	0.5
	18–24 years	193	48.7
	25–34 years	110	27.8
	35–44 years	67	16.9
	45 and above	24	6.1
Level of education	Postgraduate	164	41.4
	Graduate	44	11.1
	Undergraduate	178	44.9
	Diploma and others	10	2.6
Country of residency	Malaysia	291	73.5
	Nigeria	63	15.9
	Somalia	9	2.3
	China	4	1
	India	4	1
	Iraq	3	0.8
	Libya	3	0.8
	UK	2	0.5
	US	2	0.5
	Saudi Arabia	2	0.5
	Philiphines	2	0.5
	Others (1 response each)	11	2.7
Social media usage	Yes	392	99
	No	2	0.5
	May be	2	0.5
If yes in above, select which is/are applicable (you can tick as many as you want)	Facebook	325	82.1
	WhatApp	389	98.2
	Twitter	226	57.1
	Instagram	288	72.7
	SnapChat	94	23.7
	Skype	61	15.4
	WeChat	50	12.6
	Quora	44	11.1
	Tumblr	14	3.5
	Viber	19	4.8
	Weibo	19	4.8
	Line	12	3
	QQ	5	1.3
	Tiktok	5	1.3
	Linkedin	5	1.3
	Telegram	8	2.1
	Others (Reddit, Pinterest, Zoom, Youtube, Imo)	12	3

analysis (CCA) to test the reliability and validity of the variables, test the hypotheses, and determine the structural model [20, 21, 27, 55]. Moreover, the PLS Predict algorithms were used to check the predictive power of the proposed model [12, 57], and IPMA was utilized to check the managerial usefulness of the construct under investigation [51].

Results and findings

Response rate

The demographics information and response rate are presented in Table 1. A total of three hundred and ninety-six (396) responses were received and recorded as valid data. The data was administered and collected in Malaysia, and the participants were expected to be residing in Malaysia during the data collection period. The demographic variables include gender, age, level of education, country of residency, social media usage, and the social media currently in use. The distribution of the gender was at 52.5% female and 46.5% male. The sample indicates an identical distribution of the gender variable. The age variables show that most of the participants are between 18 and 24 years (48.7%), followed by 25 and 34 years (27.8%). The postgraduate (41.4%) and undergraduate (44.9%) dominated the level of education variable. In addition, the sample has more participants residing in Malaysia (73.5%) than any other country, followed by Nigeria (15.9%). Ninety-nine percent (99%) of the participants are using social media. The analysis of the social media usage frequency indicates that WhatsApp (98.2%) and Facebook (82.1%) are the most used social media by the respondent, followed by Instagram (72.7%), Twitter (57.1%), and SnapChat (23.7%). The participants also indicated using other social media platforms such as Skype (15.4%), WeChat (12.6%), and Quora (11.1%). The breakdown of the demographics characteristics can be seen in Table 1, respectively.

Analysis of measurement models

All the measurement models are reflective. According to the literature, there must be a correlation between the items of reflective measurement models and the values of outer loading, emphasizing that they should be significant [22]. Therefore, the measurement models were evaluated based on the guidelines of reflective measurement [6, 22, 26]. The reliability and the validity of the constructs are analyzed. Thus, the evaluation of the measurement models revealed that the factor loading of all the measures is above the threshold for acceptance. The results of the reflective measures are shown in Table 2, and the discriminant validity is shown in Table 3. However, some items, CRI1, CRI2, CRE5, CRE6, SMI1, SMI2, SMI5, RES1, RES2, RES3, RES9, RES12, RES13, RES14, and RES15, were not considered in the analysis due to either low loading values (< 0.7) or its impact to their corresponding

Table 2 Reliability of the measurement models

Constructs	Indicators	Factor loading	(> 0.7)	rho_A	CR	AVE
CRI	CRI3	0.704	0.766	0.777	0.85	0.588
	CRI4	0.787				
	CRI5	0.818				
	CRI6	0.753				
CRE	CRE1	0.703	0.706	0.707	0.819	0.531
	CRE2	0.716				
	CRE3	0.716				
	CRE4	0.778				
SMI	SMI3	0.789	0.761	0.765	0.848	0.582
	SMI4	0.714				
	SMI6	0.76				
	SMI7	0.788				
RES	RES4	0.711	0.864	0.867	0.896	0.551
	RES5	0.697				
	RES6	0.753				
	RES7	0.786				
	RES8	0.782				
	RES10	0.715				
	RES11	0.747				

Table 3 Discriminant validity

	Fornell–Larcker criterion				Heterotrait–Monotrait ratio (HTMT)			
	CRE	CRI	RES	SMI	CRE	CRI	RES	SMI
CRE	0.729							
CRI	0.439	0.767			0.598447			
RES	0.501	0.381	0.742		0.627216	0.457059		
SMI	0.52	0.388	0.55	0.763	0.705608	0.498258	0.672945	

constructs to achieve a higher average variance extracted (AVE) values for convergent validity [21, 27]. The result indicates that the measures are reliable and valid. Specifically, all the Cronbach's alpha, coefficients rho A, and composite reliability have values above 0.7 [21, 26] and the discriminant validity based on the recommendation of [25] is supported both from Fornell-Larcker Criterion and the heterotrait-monotrait ratio of correlations (HTMT). Specifically, the assessment of HTMT indicated that the values are significant, which are below 0.85 [16] suggesting that the discriminant validity exists in the measures.

Therefore, based on the findings presented in Tables 2 and 3, all the models' indicators (measurement items) have higher loading corresponding to their constructs than any other loading of other constructs under investigation. Therefore, the

findings of this study meet the evaluation criteria of cross-loading. In addition, these findings provide enough evidence to conclude that the reliability and convergent validity of the measurement models are adequate.

Analysis of the structural models

The assessment of the structural model was done by explaining the predictive power of the constructs through R^2 value, path coefficient $\beta - values$, and the predictive relevance of the model. The proposed model (Fig. 2; Table 4) shows that there is a 37.8% explanatory power for resilience with $R^2 = 0.378$. Moreover, the results indicates that the relationship between crisis and resilience is positive and significant ($\beta = 0.127, t - value = 9.619; p = .000$), establishing support for H1. In addition, a positive and significant results is obtained for the relationship between crisis and crisis response ($\beta = 0.439, t - value = 2.450; p = .014$), establishing support for H2. In addition the relationship between crisis and social media interaction is significant ($\beta = 0.197, t - value = 3.986; p = .000$), establishing support for H3. Similarly, there is a significant relationship between crisis response and resilience ($\beta = 0.254, t - value = 3.799; p = .000$) and between crisis response and social media interaction ($\beta = 0.434, t - value = 8.276; p = .000$), establishing support for H4 and H5 respectively. Moreover, the results also indicates a significant relationship between social media interaction and resilience ($\beta = 0.369, t - value = 7.168; p = .000$), establishing support for H6.

Furthermore, the mediation results were obtained on whether the social media interaction and crisis response acted as mediators between the corresponding constructs. Bias-Corrected and Accelerated (BCa) Bootstrap was recommended by various studies as the best method for the detecting mediating effects [23, 46, 58, 60]. In addition, [60] added that a minimum of 10,000 bootstrap samples offers a powerful approach to better assess the statistical inference of the model. Thus, the mediation effects were assessed based on BCa bootstrap with 10,000 samples. The bootstrapping results (Table 5) indicated that the relationship between crisis and resilience is mediated by crisis response ($\beta = 0.111, t - value = 3.494; p = .000$), establishing support for H7, and likewise there is an indirect effect between crisis and social media

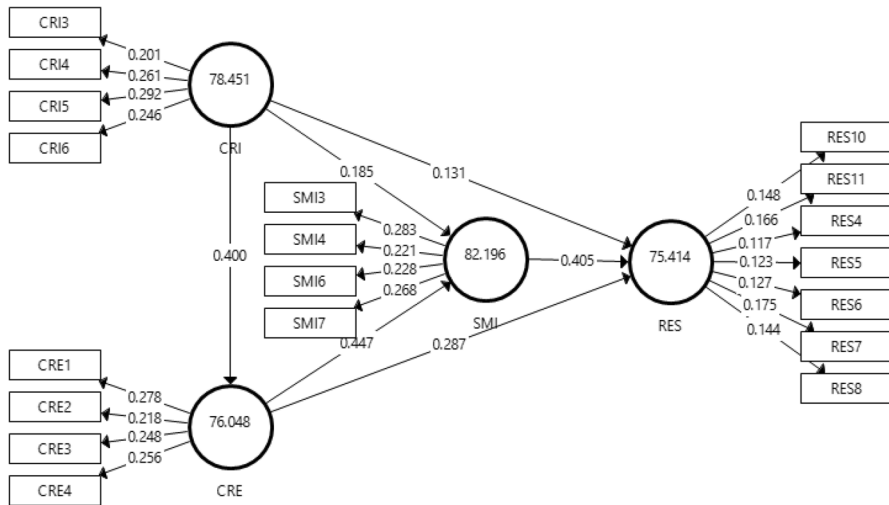| Table 4 Paths coefficient of the structural model	Confidence interval bias corrected			T and P values	
	Bias	2.50%	97.50%	T value	P values
CRI − > CRE	0.005	0.344	0.52	9.689	0
CRI– >RES	0.001	0.026	0.231	2.456	0.014
CRI − > SMI	0.001	0.095	0.294	3.954	0
CRE – >RES	0.001	0.114	0.379	3.753	0
CRE − > SMI	0.003	0.327	0.531	8.312	0
SMI − > RES	0.002	0.259	0.458	7.168	0

Fig. 2 Proposed model for social media crisis communication for building public resilience

interaction $(\beta = 0.190, t - value = 6.468; p = .000)$, establishing support for H8. Moreover, the mediating effects of social media interaction is significant between crisis and resilience $(\beta = 0.073, t - value = 3.455; p = .001)$, and crisis response and resilience $(\beta = 0.160, t - value = 5.645; p = .000)$, establishing support for H9 and H10 respectively. In addition, crisis response and social media interaction acted as mediators between crisis and resilience $(\beta = 0.070, t - value = 4.952; p = .000)$, establishing support for H11. Based on the results obtained, all the direct and indirect effect are significant at $t - values > 1.96$ and $p - value < 0.05$, as presented in Table 6.

Analysis of the predictive power of the models

The model's predictive power was evaluated by applying the procedure of PLSpredict based on recommendations from previous studies [12, 57].

Table 5 Mediation of the Structural Model

		Confidence interval bias corrected			T and P values	
		Bias	2.50%	97.50%	T value	P values
CRI – > CRE – > RES	0.111	0.002	0.049	0.174	3.494	0
CRI – > CRE – > SMI	0.19	0.003	0.137	0.25	6.468	0
CRI – > SMI – > RES	0.073	0.001	0.035	0.117	3.455	0.001
CRE – > SMI – > RES	0.16	0.002	0.107	0.218	5.645	0
CRI – > CRE – > SMI – > RES	0.07	0.001	0.045	0.1	4.952	0

Table 6 Hypothesis assessment of the direct and indirect effects

Hypothesis	Relationship	β	T value	P values	Decision
H1	CRI – > RES	0.127	2.456	0.014	Supported
H2	CRI – > CRE	0.439	9.689	0	Supported
H3	CRI – > SMI	0.197	3.954	0	Supported
H4	CRE – > RES	0.254	3.753	0	Supported
H5	CRE – > SMI	0.434	8.312	0	Supported
H6	SMI – > RES	0.369	7.168	0	Supported
H7	CRI – > CRE – > SMI	0.19	6.468	0	Supported
H8	CRI – > CRE – > RES	0.111	3.494	0	Supported
H9	CRI – > SMI – > RES	0.073	3.455	0.001	Supported
H10	CRE – > SMI – > RES	0.16	5.645	0	Supported
H11	CRI – > CRE – > SMI – > RES	0.07	4.952	0	Supported

According to the literature, the constructs measurement models must meet the relevant quality standards before initiating the PLSpredict model [16, 22, 25, 57]. In this study, the reflective measurement models exhibit satisfactory reliability, convergent validity, and discriminant validity. Thus, the PLS prediction algorithm (PLSpredict) was initiated to assess the predictive relevance of the PLS-SEM model and the naïve benchmark model (linear model; LM) by comparing root mean square error (RMSE), mean absolute error (MAE), and $Q^2_{predict}$ values (Table 7; Fig. 3). The results interpretation guidelines suggested that $Q^2_{predict}$ was examined at the initial stage, and the value must outperform the naïve benchmark model before assessing RMSE and MAE [12]. Based on the result obtained, the $Q^2_{predict} > 0$ are primarily positive, and both the RMSE and MAE are mostly negative values. That is, the errors of the proposed model are smaller than the linear model. Hence, the PLS-SEM predictions (the measurement and the structural models) outperform the LM benchmark, establishing a medium predictive power.

Model usefulness

The usefulness of the model was assessed through Importance-Performance Map Analysis (IPMA) (Figs. 4, 5) [51, 52]. This also helps the researchers understand the influence of the constructs and indicators and the significance of improving crisis management and communication decisions and efforts during the crisis. The performance is shown on the *x*-axis, and the importance is on the *y*-axis.

The IPMA analysis allows the researchers to examine the critical indicators of public resilience [22, 51]. Moreover, the IPMA compares the construct indicator level from the performance scale mean value against the importance of the indicators (i.e., total effects). From the result obtained, social media interaction (SMI) has a performance of 82.2%, but its importance is slightly below crisis and crisis response constructs. This indicates that the crisis management
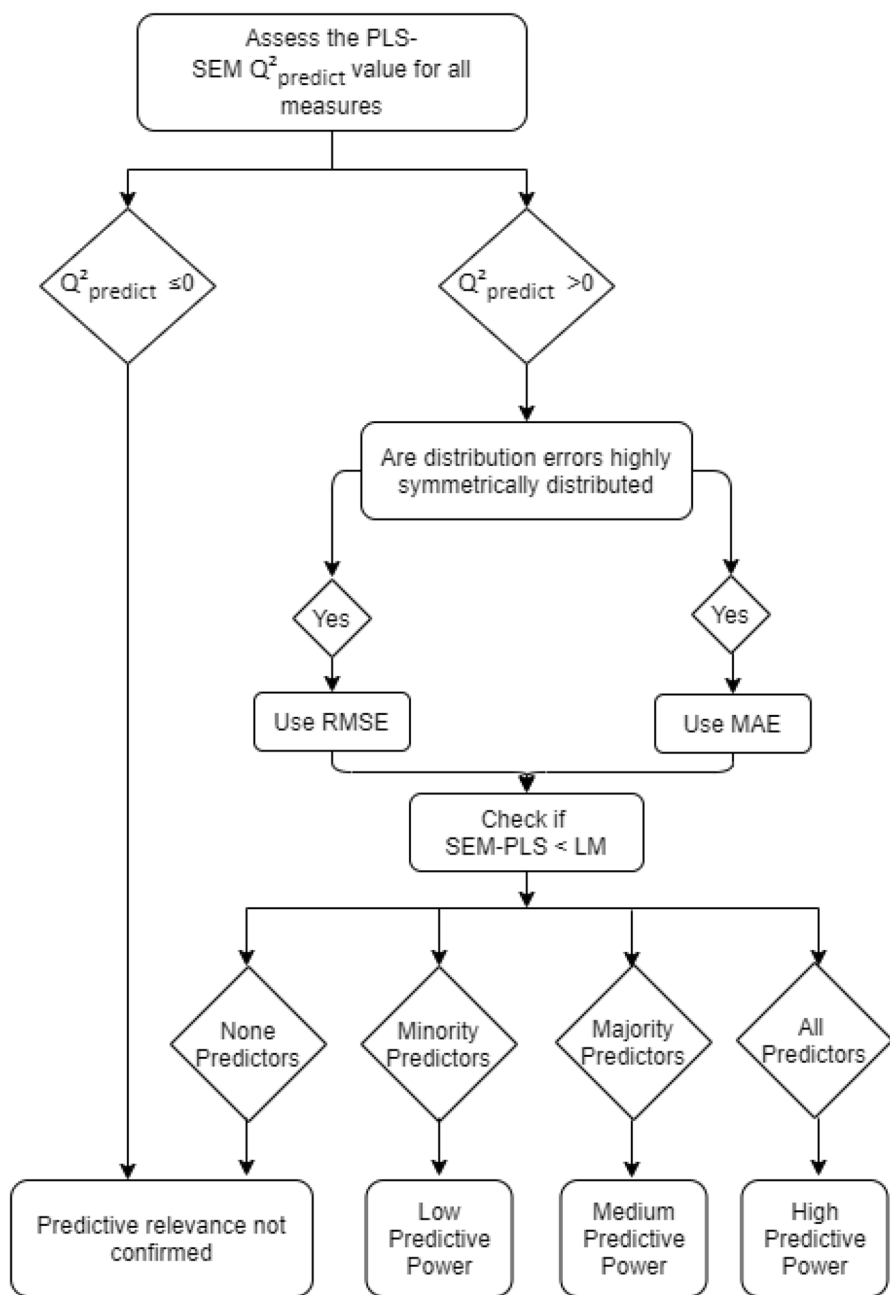
Fig. 3 Procedure for assessing the predictive relevance of the model [57]

Table 7 Result of PLSpredict showing predictive power of the model

PLS-SEM			LM			PLS-SEM - LM		
Indicators	RMSE	MAE	$Q^2_{predict}$	RMSE	MAE	$Q^2_{predict}$	RMSE	MAE	$Q^2_{predict}$
CRE1	0.629	0.495	0.074	0.629	0.503	0.075	0.000442	− 0.00708	− 0.0013
CRE2	0.683	0.526	0.072	0.69	0.535	0.055	− 0.00624	− 0.00866	0.017026
CRE3	0.602	0.461	0.147	0.605	0.463	0.14	− 0.0026	− 0.00156	0.007395
CRE4	0.649	0.519	0.099	0.653	0.523	0.087	− 0.00422	− 0.00407	0.011769
RES11	0.738	0.551	0.072	0.744	0.549	0.057	− 0.00589	0.002442	0.014886
RES10	0.678	0.495	0.078	0.68	0.493	0.074	− 0.00136	0.001761	0.003714
RES8	0.681	0.49	0.052	0.679	0.49	0.058	0.002049	0.000204	− 0.00569
RES7	0.628	0.475	0.098	0.626	0.476	0.103	0.001755	− 0.00101	− 0.00504
RES6	0.742	0.533	0.06	0.745	0.534	0.052	− 0.00292	− 0.00051	0.007422
RES5	0.805	0.611	0.089	0.813	0.624	0.072	− 0.00714	− 0.01281	0.016222
RES4	0.812	0.608	0.067	0.81	0.607	0.073	0.00227	0.00118	− 0.00521
SMI3	0.58	0.487	0.11	0.585	0.484	0.093	− 0.00527	0.002149	0.016246
SMI4	0.655	0.533	0.051	0.659	0.537	0.041	− 0.0035	− 0.00342	0.01017
SMI6	0.674	0.532	0.073	0.674	0.535	0.071	− 0.00042	− 0.00259	0.001167
SMI7	0.633	0.523	0.091	0.639	0.526	0.073	− 0.00627	− 0.00382	0.018092
						Overall Predictive Power	− 0.03934	− 0.03779	0.106868
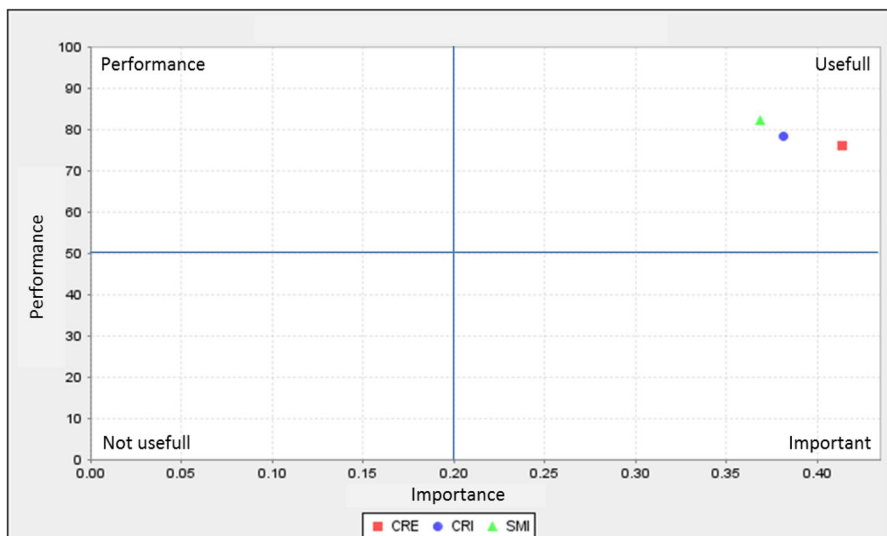
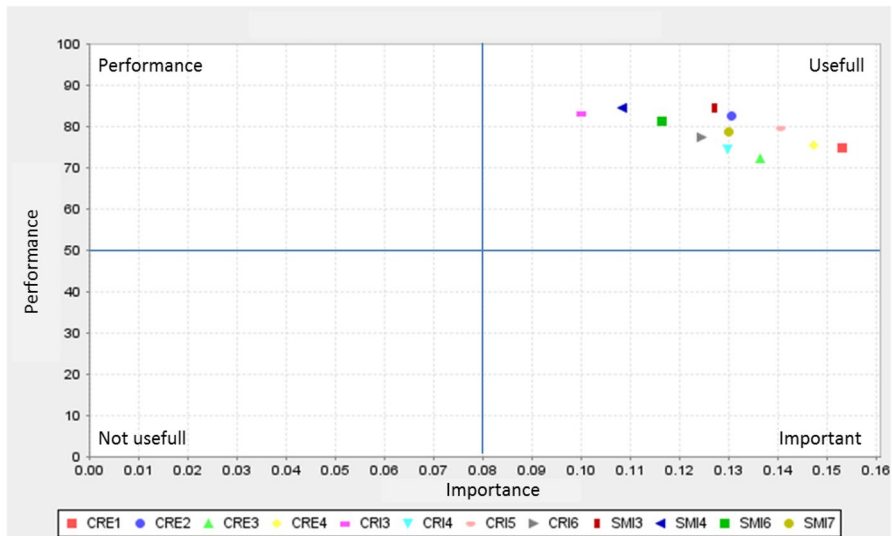

Fig. 4 IPMA for model's constructs

Fig. 5 IPMA for model's indicators

and communication authorities should be giving much importance to social media interaction. Second, the crisis has a performance of 78.5%, while the crisis response construct is the lowest-performing construct at 76.0%.

Additionally, the resulting IPMA for the constructs and indicators is divided into four parts; "useful", "important", "performance", and "not useful" equivalent to keep up, do better, education and no change [28, 52]; (Figs. 4, 5). The study in [52] reiterates that the partition of the graph quadrants is dependent on the performance and importance of the mean values [51]. The constructs and indicators that are found in the "useful" quadrant are essentially important and reveal good performance. Thus, any activity should be the focus on maintaining the constructs and indicators at the useful quadrant. The "performance" quadrant emphasized the need for attention since they portray high performance but low importance. The constructs and indicators that appeared in the "important" section of the quadrant are averagely above both importance and less performance.

In contrast, those found in the "not useful" quadrant indicate low performance and importance levels. In this study, none of the constructs or indicators have appeared in the "important," "performance," and "not useful" of the graph (Figs. 4, 5) section. Overall, the result indicates that all the constructs and indicators are useful for improving crisis management, communication, and future research endeavors.

Discussion

Social media crisis communication is becoming a factor in today's crisis management, especially now that the citizens are part of the crisis communication matrix [1, 33, 47, 48]. This study aimed to investigate the impact of social media crisis

communication on public resilience by adapting constructs from SCCT, ICCM, STREMII, and SMDR. Resilience is the ability of people to recover from a crisis quickly and effectively. In addition, the study examines the usefulness of crisis, crisis response, social media interaction, and resilience to improve crisis communication and management. The research employed PLS-SEM to study the relationship between these variables to improve the adoption of social media-based crisis response and communication worldwide. In this Chapter, the empirical result based on the PLS-SEM assessment of the quantitative data used to validate and verify the proposed model was presented and discussed.

The discussions and developments surrounding social media potentials to improve the stakeholder's relationship and building community resilience during or after crisis called for an empirical investigation of this research. As the central aspect of this work, the study proposed a social media crisis communication and resilience model that offer the basics to determine effective social media-based crisis communication and management. Particular importance in this section is based on the results and findings achieved from the evaluation of the structural model. According to the findings, all the research hypotheses were supported. This indicated that the public ability to recover from a crisis could be improved through social media-based crisis communication by meaningful engagement in crisis response and social interaction on social media. To be more specific, the result revealed that crisis response and social media interaction had the higher significant result (p-value = 0.000), as against crisis which was also significant at p-value = 0.014.

Accordingly, the path coefficient results established that social media crisis response and social interaction were the most significant public resilience predictors. Furthermore, the evaluation of the predictive power supports the path coefficient result by revealing that the overall predictive power of the proposed model is medium. However, the findings from IPMA suggest that the crisis construct is the crucial construct on resilience and weak concerning the performance effect on the model. These findings contribute to a new perspective about social media-based crisis communication literature, which previous studies have not investigated. Overall, the findings of this study provide highlights concerning the critical importance of social media-based crisis communication for effective crisis communication and management. Hence, crisis management organizations and stakeholders aiming for effective social media crisis communication for resilience building should consider enabling or improving social media crisis response and social interaction in their disaster or crisis management plans.

Besides, the analyses of the indicators' usefulness on the people's ability to recover from crisis revealed significant results across the independent variables. The IPMA investigates the usefulness of the constructs and indicators to prioritize which features require greater attention. The IPMA results indicate the most performing constructs or indicators as well as the most important. The findings revealed that the crisis is specifically essential in explaining resilience. This construct relates to social media engagement and crisis responses. In addition, social media interaction and crisis response are essential. The social media interaction relates to communication, situational awareness, and knowledge sharing,

while the crisis response relates to public response, knowledge, information, and expression. An improvement of the effectiveness of the constructs translates to the immediate improvement of crisis communication and management. Hence, the proposed model constructs are relevant for crisis management action, suggesting a hierarchy of important features to represent social media-based crisis communication knowledge, including social media interaction, crisis response, and crisis, in this order. Crisis management authorities should focus on these aspects to achieve significant improvement to the crisis management investments.

Subsequently, the findings of this study have strengthened the studies of [4, 41, 59] whose conceptualizations of social media-based crisis communication model emphasized the importance of crisis response and social interaction through social media usage for effective crisis communication. These studies have provided the basis for the model proposed in this study. Although, few studies investigated the impact of interactions of various stakeholders involved in crisis communication on social media [10, 24, 40] which focused on the identification of actors involved in the issue arena, knowledge exploration of stakeholders relationships, and crisis communication content. None of the studies has investigated the conceptualized variables concerning theoverall view of social media crisis communication and resilience building, and no empirical confirmation to validate their findings. Reasonably, this study may respond that indeed, the objective of crisis informatics is to understand the interaction between stakeholders involved in crisis communication [62]. Thus, this study provides a prospect to advance the use of social media for crisis communication by crisis management authorities and the public as stakeholders affected by the crisis.

Implications

Theoretical implications

The study used quantitative data to investigate the impact of social media crisis communication on community resilience. The report included an in-depth analysis that extended existing theories and vital new insights about the relationships between crisis, crisis response, social interaction, and resilience. The current study offered further information by presenting evidence that the lack of response on social media could lessen community resilience. Since the impact of social media crisis communication on people's ability to recover from a crisis has not been adequately addressed, which prompted this study. Therefore, a research framework through the lens of SCCT, ICCM, STREMII, and SMDR is introduced to assess the impact of the crisis, crisis response, and social media interaction on resilience. Notably, the framework was validated using structural equation modeling (SEM), prediction models, and the IPMA procedure. Hence, the study adds knowledge and understanding about the SCCT, the ICCM, the STREMII, and the SMDR.

Firstly, the SCCT promotes that a crisis's history, origin, and responsibility as a victim, whether accidental or preventable, is crucial. The information is shared on social media through crisis response and social media interaction to help

stakeholders deal with the situation. Crisis response and social media contacts are beneficial in assisting people to recover from the crises. The crisis is the initiator that encourages stakeholders to engage in crisis response, while social media serves as the medium for communication. Thus, the SCCT appears to have applicability in the social media environment for crisis communication. However, the theory does not appear to allow for the full potential of social media. Therefore, this study answers the call to investigate further and expand SCCT to include the social media context.

Secondly, the crisis and crisis response are the variables impacting stakeholder's formation on social media. According to [15], the unmet challenge of modeling qualitative and quantitative data to understand how interaction, leadership, and social structure are represented in electronic trace data is reflected in the formation of stakeholder groups on social media. Further, the ICCM reflects the online environments in which stakeholders interact on social media as a socio-technical interaction resulting from crisis responses. The crisis responders form groups and interact, mediating constant and significant associations and influencing peers. In crisis response, the ICCM stressed the need for cooperation amongst stakeholders. Third, the use of social media forstrengthening hotel resilience has been demonstrated in the SMDR model. As a result, this study adds to existing literature to explain the relationship between crisis, social media interactions, crisis response, and community resilience.

Moreover, previous research suggests that crisis management stakeholders use social media during a crisis to provide status updates and respond to public stakeholder's messages. The ICCM model demonstrated the significance of the interactive concept of social media crisis communication, as well as discuss the type of public stakeholders involve in social media crisis communication [1, 33]. Further, the STREMII model pointed out social media's dynamic nature, which covers information provision, ideas, questions, and entertaining messages. These researches focused and emphasized the interactive and dynamic features of social media; their research is the recent beginning point for understanding what types of stakeholders respond to a social media crisis. As a result, this study examines the relationship between crisis, crisis response, and social interaction to understand how this information is helping people to recover from the crisis.

Reflecting on the primary lessons learned from this research, crisis managers should be concerned that organizations may not understand crisis communication in a social media context. Given the rapid development and adoption of social media by organizations and stakeholders, there is a need for much more research in this field. Social media has distinct characteristics that make it appealing for crisis management and communication stakeholders to use for crisis communication. A few of these characteristics include reaching a large audience, being interactive, and allowing crisis managers to respond to stakeholder's messages. However, social media has made crisis communication more complicated since it allows publics stakeholders to co-create crisis messages and observe crisis managers' responses to the crisis [38, 53]. In addition, public stakeholders expect crisis managers to promptly communicate about emergencies using social media

[19]. This study shows the importance of social media interaction and crisis response to advance crisis communication efforts in the future.

Additionally, crisis management stakeholders must address crisis information as it evolves due to the dynamic features of a pandemic crisis, as the STREMII model insisted. In addition, the public responses, along with the pandemics crisis, change with time as well. Since crises progress from pre-crisis, during the crisis, and post-crisis, which shape public perceptions of risk and resilience. During Covid-19, there are multiple phases of outbreaks and messaging that need to be adjusted regularly to engage the public, reduce fear, and support ongoing preparedness and response. It is critical to prepare and respond to public audience demands and directly address sources of fear, anxiety, and misinformation to generate straightforward, clear, and suitable messages for effective communication. Monitoring social media communication channels is crucial, which is the concept of ICCM and STREMII models. Knowing what information is being communicated via social interaction might assist crisis management stakeholders in being proactive in discussing mitigation techniques and demonstrating empathy. This may not be possible without understanding the link between crisis response and social interaction with resilience building. As a result of Covid-19, the public outrage is strong, with major uncertainty about risk perception and the need for mitigation techniques [39]. Crisis managers must understand the significant impact of crisis response and social interaction on people's ability to recover from the crisis. In addition, this will help crisis management get prepared and allocate adequate resource to advance social media crisis communication for effective crisis management in reducing risk and saving lives.

Practical implications

Because of the advent of social media usage in crisis informatics literature, both industry and academia are paying close attention to crisis communication on social media. The public can use social media to generate content and quickly distribute it to their friends and followers, who can then share it with their own friends and followers. But despite the growing relevance of social media in crisis communication, there are enough argument to suggest that crisis management organizations do not entirely understand how to use social media to communicate during a crisis [33, 53]. Therefore, the lack of understanding may lead to ineffective crisis handling, jeopardizing the crisis management effort. By examining the impact of crisis response and social interaction, this study raises crisis management awareness and contributes to academic and management understandings on the subject. Moreover, this study emphasized the notion of crisis communication based on genuine and real-time public behaviors. To respond correctly and help citizens recover effectively, crisis managers must strengthen their monitoring of negative public opinion on social media and determine the attitudes and behaviors of the public [65].

The long-term impact of the Covid-19 pandemic is uncertain, but it is undoubtedly going to stay longer than expected [54]. One of the primary and immediate effects of the pandemic is how it has shaken the public relationship. Movements restrictions resulting from physical distance caused by the pandemic make people

stressfully know that their well-being depends on their associates. Social engagement probably affects individuals' ability to adapt during the pandemic. Yet, the physical distancing measures uncover and adjust the nature of the public relations, which causes depression that affects the immune systems. However, social engagement could bring about an irresistible infection by the virus. The pandemic has not just seriously hindered the capacity of individuals to be in actual close relationships with different people; it has severely impeded the extreme human needs for contact, discouraging and containing any other physical showcasing of affection and connection. The explosion of electronically-mediated interaction, primarily via social media, has helped people recover from the crisis in recent decades. This study promotes social media interaction and crisis response to maintain quality relationships and deep interpersonal connections.

Most significantly, the guideline of public activity under the pandemic has profoundly affected the experience of life. During the Covid-19, individuals have not been able to partake in the social lifestyle, including births, birthday events, engagement, graduations, marriages, and retirements. On the other hand, there have been numerous technology-based instances where such events can be conducted virtually, mainly through video-calling, text, and messages. Hence this study responds to the demand for more research to explore the need to investigate the short and long-time outcomes of decreasing, denying, or modifying the shared experience of fundamental life-course changes. Furthermore, the crisis and physical distancing can have immediate and long-term impacts on youngsters' relationships. Children are incredibly delicate to changes in their surroundings; however, they cannot wholly comprehend the situation. When isolation started, there was incredible discomfort about the infection entering and spreading through the families and households battled with how to show affection physically securely. During the lockdown, families are less stressed because they restrict contact with the rest of the world, only in essentials and those needing medical attention or visiting hospitals. Interestingly, social media activities have helped dramatically in these circumstances to manage physical distancing more effectively. Thus, this study shows future crisis managers can effectively use social media to help the affected citizens in such situations.

Moreover, at the point when schools are shut down, youngsters and teenagers cannot interact face to face with companions. Peer gatherings and fellowships are essential to identities exploration, especially for teenagers. They additionally crave enormous groups, a dense populace, and mobility. Social media allowed friendship continuity and engagement through social media interaction. However, lockdowns and school closures rendered further confinement among youngsters who are socially affected in different ways. Similarly, despite the availability of other platforms to reduce the impact of restricted movement of people, there were still questions concerning the publics' emotions, needs for fulfillment, and survival of relationships. Hence, this study has shown the significance of social media crisis communication to establish the foundation for effective crisis communication to address these questions. In addition, the pandemic eliminated numerous people from their working environments and, most importantly, their social networks, compelling them to team up and sustain associations remotely and distantly. Similarly, more work at home can colonize everyday life [56]. Working at home can also enable a surge in stress via instant accessibility, high requests, care

for kids, vulnerable family members, and work confusion. Remarkably, the relationships between the variables examined in this study could help crisis managers reposition their crisis communication strategy more effectively.

Additionally, social media has played a vital role in informing the public during the crisis, influencing public anger and, as a result, public perceptions of risks and mitigation [39]. Crisis managers, experts, and the general public used social media to convey information to many people quickly. People with social positions or experts such as medical doctors, engineers, etc., play a crucial role as trusted sources of information on social media. They are helping to share new information as it becomes available and responding to individual concerns as they arise, knowing that public perceptions of risk vary widely. Accordingly, individuals sharing ideas and news with like-minded followers on social media can generate an "echo chamber" of media attention, encouraging social interaction as well as community resilience [3]. Hence, this study is the first to link social media crisis response and social interaction with resilience building and tested their relationship with primary data.

Conclusions

Natural or human-induced crises or disasters have repeatedly exposed peoples to danger despite the growing efforts dedicated to crisis management and communication, especially before the crisis (preparation), mitigation, and recovery. While social media attract people worldwide to engage, interact, and communicate during and after such events. Therefore, a thoughtful knowledge of the main elements contributing to the intentional outcome of social media crisis communication is needed. Despite the existing research on social media crisis communication models toward social media usage and how this improves stakeholders' relationships or improves community resilience. Thus, it is worthy of pondering how crisis, social media interaction, and crisis response influence people's ability to recover from crisis easily and quickly, and similarly revealing the indirect impacts of socio-technical interaction and social media-based crisis responses. The study empirically investigates the relationship between social media-based crisis communication elements and their impacts on community resilience. All hypotheses for the direct and indirect relationship are validated, and the results are significant to advance the use of social media in crisis communication and crisis informatics researches.

Limitations

The limitation of this study includes the dissemination of the research instrument toward the direction of people with more probability of using social media. In addition, the participant mostly composed of people from Malaysia; carefully designed research to fully exploit the complexity of the sample may reveal different findings. Moreover, the study does not differentiate between news about deaths and false information. In addition, the survey questionnaire was mainly based on the understanding that it was related to Covid-19 and public health concerns. The answers would be different if the crisis were an earthquake or a flood.

Appendices

Appendix A Content validation results

Table 8

Table 8 Research items content validity index and modified kappa statistics

Construct	Item	Total Expert	Agreement	I-CVI	UA	S-CVI/Ave	Pc	M-Kappa (mK)
Crisis	Q1	3	3	1	3	0.99	0.125	1
	Q2	3	3	1	3		0.125	1
	Q3	3	3	1	3		0.125	1
	Q4	3	3	1	3		0.125	1
	Q5	3	3	1	3		0.125	1
	Q6	3	3	1	3		0.125	1
Crisis response	Q1	3	3	1	3		0.125	1
	Q2	3	3	1	3		0.125	1
	Q3	3	3	1	3		0.125	1
	Q4	3	3	1	3		0.125	1
	Q5	3	3	1	3		0.125	1
	Q6	3	2	0.67	3		0.375	0.47
Social Media Interaction	Q1	3	3	1	3		0.125	1
	Q2	3	3	1	3		0.125	1
	Q3	3	3	1	3		0.125	1
	Q4	3	3	1	3		0.125	1
	Q5	3	3	1	3		0.125	1
	Q6	3	3	1	3		0.125	1
	Q7	3	3	1	3		0.125	1
Resilience	Q1	3	3	1	3		0.125	1
	Q2	3	3	1	3		0.125	1
	Q3	3	3	1	3		0.125	1
	Q4	3	3	1	3		0.125	1
	Q5	3	3	1	3		0.125	1
	Q6	3	3	1	3		0.125	1
	Q7	3	3	1	3		0.125	1
	Q8	3	3	1	3		0.125	1
	Q9	3	3	1	3		0.125	1
	Q10	3	3	1	3		0.125	1
	Q11	3	3	1	3		0.125	1
	Q12	3	3	1	3		0.125	1
	Q13	3	3	1	3		0.125	1
	Q14	3	3	1	3		0.125	1
	Q15	3	3	1	3		0.125	1

Appendix B Research instrument

B.0.1 Crisis items

– 1-Crisis (Coronavirus aka Covid-19) threatens the social wellbeing of the peoples.
– 2-Crisis makes social or physical interaction with family or friends difficult.
– 3-Crisis makes individuals spend more time on social media.
– 4-Crisis makes individuals collaborate or engage with family or friends on social media.
– 5-Crisis makes individuals interact on social media.
– 6-Crisis makes individuals post, comment, likes, or share information with friends or relatives on social media.

B.0.2 Crisis response items

– 1-What peoples and authorities say on social media influence public engagement and colloboration.
– 2-What individuals say on social media help others to know more about the crisis.
– 3-The information about the crisis sometimes makes peoples want to reply and engaged on media discussion.
– 4-Peoples express their opinions to encourage the authorities to do more.
– 5-Peoples express many different emotions (e.g joy, pain, anger, fair) through posts and comments.
– 6-Warning messages are taken more seriously when the social position of the sender is the same with the receiver.

B.0.3 Social media interaction items

– 1-Publics actively seek information about a crisis on social media.
– 2-Publics actively exchange views about a crisis with others on social media.
– 3-Family or friends can communicate through social media text, voices, or videos during a crisis.
– 4-Individuals can create discussion forums or groups during a crisis.
– 5-Individuals can use social media to conduct conference calls, classes or virtual assignments during a crisis.
– 6-At times of crisis, authorities who give assistance, help, and protection make use of social media to provide strong guidance and information.
– 7-Collaboration and communication between peoples and authorities on social media help in educating the public about the crisis.

B.0.4 Resilience items

– 1-Collaboration and engagement with friends, relatives, and authorities on social media help people cope with stress and confusion.

- 2-Family and friends are used mostly as a trusted source of information on social media.
- 3-The interaction taking place on social media helps individuals adjust their social life as a result of the crisis.
- 4-The interaction taking place on social media helps individuals maintain lasting relationships and friendships during a crisis.
- 5-The interaction taking place on social media helps individuals emphatise with frustrations and misfortunes of a crisis.
- 6-The interaction taking place on social media helps families, friends or peoples assist one another during difficulty.
- 7-The interaction taking place on social media helps peoples to encourage each other and to have faith to overcome the problem.
- 8-Individuals get hope and courage to hear from their friends and relatives through social media engagement.
- 9-Individuals feel good spending time and energy with their family and friends on social media.
- 10-Individuals try to make sense of crisis situation with the help of social media information, engagement or interaction.
- 11-Diverse experiences, skills, and knowledge that others shared on social media give peoples hope and courage.
- 12-Positive post or comments such as people recovering gives hope and courage to others.
- 13-Negative post or comment such as deaths, fake information or failure of authorities creates more confusion and stress.
- 14-During stressful and challenging times, individuals can maintain effective relationships with those affected by the crisis on social media.
- 15-The video about Covid-19 patients on a hospital bed that is posted on social media helps individuals to prepare and protect their and love ones.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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