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Research on the Cross-Regional Traveling Welcome Short Messaging Service During the COVID-19 Pandemic: A Survey from Mobile Users' Perspective

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Abstract: Based on spatiotemporal sensing techniques, the cross-regional traveling welcome short messaging service (TW-SMS) has been adopted in China and has become popular, typically being used when travelers pass through or arrive in cities. In this service, governmental institutions in combination with telecom operators send welcome messages with the local characteristics. As a typical location-based service for mobile users, the TW-SMS includes reminders or alerts related to COVID-19 prevention and control. In this paper, we investigate the perceptions and behavior of mobile users regarding this special TW-SMS through mixed-methods research. An online survey was conducted among mobile users who engaged in intercity travel. After analyzing samples of TW-SMS data collected during the COVID-19 pandemic, we found that the respondents exhibited a relatively positive overall attitudes and recognized the necessity and helpfulness of the TW-SMS with its trusted content. For content analysis, we found that more than 70% of the messages transmitted by the TW-SMS were released by official departments (e.g., the COVID-19 Prevention and Control Office). Reminders about traveling registration and nucleic acid testing were assigned the highest importance, as they offer convenience in communicating the most up-to-date prevention and control information to mobile users during intercity travel. Through this study, we provide insights into epidemic prevention and control experiences during public health emergencies in cities.

Keywords: COVID-19 pandemic; cross-regional travel; short messaging service; mobile user; content analysis

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1. Introduction

As a typical application in the mobile communication age, Short Messaging Service (SMS) has become an essential channel for information transmission and expanding the scope of interpersonal communication. SMS has the characteristics of wider coverage, lower cost, faster transfer, timely feedback, easier operation, and more. As a result, both government and commercial institutions have adopted SMS to deliver various types of information to target mobile users [1,2], including content of public interest, promotional advertising, and verification codes. It is undeniable that the rapid popularization of over-the-top (OTT) applications (e.g., social media and instant messaging software) has led to them occupying the largest market share of two-way communication. Thus, the number of short messages sent worldwide is considerable. For example, the total number of SMS/MMS messages sent in America and China reached (roughly) 2000 billion and 1761.9 billion, respectively, in 2021 [3,4].

Relying on the high penetration rate of mobile phones and well-established telecommunications infrastructure, SMS messaging is able to reach a large number of mobile users instantaneously and can precisely cover target regions, including urban and rural areas in smart cities. Governmental institutions and telecommunications operators work together to deliver public interest information to both travelers and citizens in certain districts, making SMS a supplementary outlet to traditional channels (e.g., radio and television) and emerging OTT services. For non-netizens who do not use the internet, SMS could aid in the communication of necessary living service information through their own mobile phones. Therefore, SMS is a major information dissemination channel in e-government that cannot be ignored, and an important component in the digitalization of city services.

As a typical location-based service in China, SMS is also used to provide cross-regional welcome messages for individuals from other areas through the cross-regional Traveling Welcome Short Messaging Service (TW-SMS). When travelers pass through or approach the boundaries of a particular region (e.g., a district, city, or province), they automatically receive a short welcome message containing relevant local information from a telecommunications operator or the Department of Tourism within the local government. Often called roaming welcome messages, these can provide both traveling reminders and advertisements for local places based on a mobile user's location. An example is the following: "*Welcome to the City of Qingdao, which has red roofs, green trees, blue seas, and azure skies. The 12,345 hotline in the City of Qingdao is used for customer service at your disposal*".

With the outbreak of the COVID-19 pandemic, cross-regional travel restrictions and border closure measures were implemented in various countries to combat the spread of the disease [5]. Various methods of distributing public health information and travel advice have become popular for cross-regional travel [5,6]. Specific measures for travelers, e.g., screening, testing, diagnosis, and isolation [7], were implemented for the prevention and control of COVID-19.

In China, advanced technology such as telemedicine was adopted to dynamically monitor the status of the pandemic and the population's mobility. These included electronic vouchers on mobile phones, called "health QR codes" and "travel codes", which were used for contact tracing and to record the locations of travelers. For cross-regional travelers, it was necessary to learn about the epidemic prevention and control measures (e.g., nucleic acid testing and quarantine) in the areas being traveled to, which could help travelers to plan their itineraries and abide by the corresponding COVID-19 prevention and control measures. During the COVID-19 pandemic, the cross-regional Traveling Welcome Short Message Service (TW-SMS) was adopted to provide information about local prevention and control measures and health alerts for travelers when they passed through or arrived in the territory of a city. In this way, the local official institutions could distribute health information regarding the COVID-19 pandemic through mobile networks as a supplementary information transmission channel. An example is the following: "*Welcome to Zhejiang Province. A warm reminder: If you arrive in Zhejiang from other provinces, please take part in free nucleic acid testing (NAT) after arrival. If you have lived in or traveled to a medium-/high-risk region within the past 7 days, please ensure strict personal protection and report to the community. Moreover, please implement health self-management. Thank you for your support and cooperation!*". This was sent by the COVID-19 Prevention and Control Office in Zhejiang Province.

SMS messaging was also used to offer emotional and informative support to combat the infodemic while contributing to the guidance of public opinion during public health emergency and crisis. Although scholars have noted the important role of SMS during the COVID-19 pandemic, few studies have focused on the COVID-19-related aspects of the TW-SMS. In previous works, it has been shown that people expressed positive attitudes towards COVID-19-related SMS messages, although differences existed in different age

and gender groups [8]. Regarding usage behaviors, there were gender differences in India, where male adolescents were more likely to use mobile sources such as SMS to receive COVID-19 information [9]. A survey in Nigeria found that as respondents' education level increased, their perceived threat and perceived efficacy regarding COVID-19 increased as well [10]. In this exploratory study, we aim to explore the attitudes and group differences in mobile users regarding the TW-SMS by investigating usage behaviors among cross-regional travelers and identifying the reasons for users' high acceptance through a content analysis based on the source of information, specific content, language style, etc. Thus, a mixed-methods research approach was adopted, combining a questionnaire survey with content analysis to reveal the communication effects of the TW-SMS. The methodological structure is summarized in Figure 1.

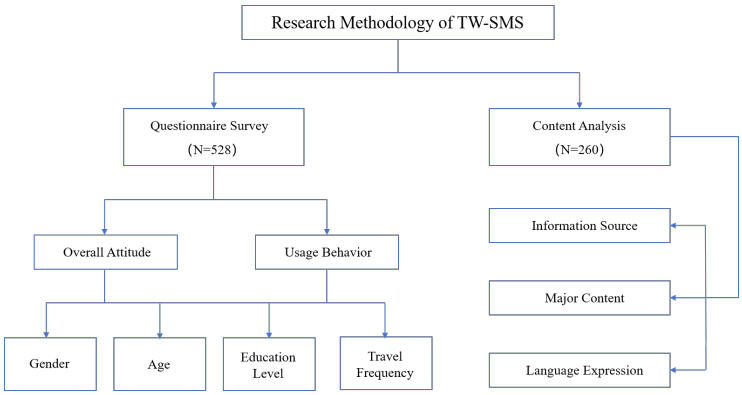


Figure 1. Structure of the methodology.

The research questions (RQ) are as follows:

- RQ1: (1a) What is the overall attitude towards the COVID-19 TW-SMS among mobile users? What are the differences in terms of demographic characteristics, e.g., (1b) gender, (1c) age, and (1d) educational level?
- RQ2: What are the differences in the usage behaviors (i.e., reading, forwarding) regarding the COVID-19 TW-SMS among different groups, e.g., (2a) gender, (2b) age, and (2c) educational level?
- RQ3: What are the differences in the evaluation (RQ 3a) and usage behaviors (RQ 3b) regarding the COVID-19 TW-SMS among groups with different travel frequencies?

The rest of this paper is structured as follows: Section 2 presents a literature review regarding the usage and applications of SMS and location-based services; Section 3 presents the online questionnaire survey and the descriptive statistical analysis; Section 4 presents the results of the independent *t*-test and chi-square test regarding the online questionnaire survey; Section 5 presents the content analysis according to the collected samples of TW-SMS messages; finally, Section 6 concludes the work and elaborates on its implications and limitations.

2. Literature Review

2.1. SMS Applications

In recent decades, with its advantages of higher accessibility and wider coverage, SMS has played a vital role in the fields of social governance [1,11], public emergency response [2,12], and medical care [13,14]. SMS can provide personal mobile information services in urban/rural areas in smart cities. As a citizen-centric application, SMS has been favored by governmental agencies. It can provide important information and announcements for the public in order to better serve citizens and maintain social order. In China, government agencies often send mobile users various types of public interest SMS

messages, including law and regulation reminders, emergency warnings, and science popularization promotions, with the aim of delivering content that is necessary for everyday life. In India, government services such as property registration are implemented through an SMS-based service. The public service Agri-Watch disseminates the latest agricultural information to citizens through mobile text messages. In Bangladesh, the government regularly provides citizens with messages via SMS, such as messages about the dates of income tax payments, announcements of the results of public examinations, information about vaccination, and other official government suggestions [1]. The South African National Department of Health has launched a flagship program named MomConnect. This service sends health information reminders to pregnant and postpartum women twice a week and provides accessible channels for queries and feedback. MomConnect improves the quality of maternal and child healthcare services and reduces mortality [13]. When responding to emergencies, the message transmission speed is fast and feedback is timely, which are significant advantages. In the United States, a popular state government service provides emergency alerts to citizens through mobile phone text messages titled NY-ALERT. Moreover, emergency power packs for climbers have been designed. When an accident occurs on a climber's trip, the SOS function button is pressed, and an emergency message is sent to the nearest rescue team via SMS [2]. The dissemination of information via SMS also helps in disease surveillance during emergencies. When a disease broke out in Kenya, a disease outbreak alert system based on SMS allowed health agencies to receive notifications and take countermeasures in a timely manner [12].

With the emergence of mobile medical care, SMS has been regarded as a low-cost and easy-to-use medium for providing remote medical and health treatment through timely text reminders. SMS reminders have become commonplace in the medical and health field. SMS reminders can play a positive role in raising public health awareness, in the early prevention of diseases, and in patient rehabilitation. Therefore, text messaging is used as an effective intervention method to assist individuals in health management and improve physical/mental health. Existing studies have shown that SMS can improve the health literacy of the public [15], and is also effective in solving practical health problems, including weight loss [16], quitting smoking [17], diabetes self-management [18], and physical fitness promotion [19]. SMS is also conducive to early disease detection and prevention, helping to prevent problems before they arise. Through messaging alerts, the coverage and timeliness of childhood immunization can be improved [20]. For pregnant women, timely reminders sent via SMS increase the likelihood of visiting the doctor to prevent diseases such as malaria during pregnancy [14]. In low-and middle-income developing countries, SMS is considered a feasible form of public health intervention with a low cost [11]. Text messaging can help to assist patients during their treatment and care. Fang et al. found that educational alert messaging was useful in enabling outpatients to adhere to prescriptions, and provided effective health education for all patients [21]. Postoperative patients' anxiety was decreased through text reminders, and the patients welcomed this intervention [22]. In another study, most patients expressed their willingness to accept SMS as an intervention to improve medication adherence [23].

2.2. Use of SMS During the COVID-19 Pandemic

In the era of Web 2.0, mobile users tend to obtain health information from social media applications or online platforms; WeChat, WhatsApp, and YouTube have all become popular choices [24,25]. However, the spread of COVID-19 disinformation via social media created confusion among both individuals and in governments around the world [26]. Therefore, during this unique period, SMS, as a direct information dissemination method, offered an effective supplement to other information transmission channels such as press

conferences and TV news. People could obtain relevant reminders and emotional support via the COVID-19 public interest SMS messages sent by Chinese governmental agencies. In this way, timely and reliable official information helped the public to manage their own health, leading to positive feedback from users [8]. Moreover, a randomized controlled experimental study in Turkey found that emergency nurses who received daily motivational text messages had significantly higher job satisfaction in the short term compared to the control group [27]. Meanwhile, the U.S. Department of Veterans Affairs used an automated SMS application called "Annie" to send educational and motivational text messages to veterans. Annie was also used to send health reminders regarding COVID-19 prevention measures, and had a positive impact on the emotions of veterans [28].

In terms of telemedicine, SMS can be used to provide remote consultations and reduce the pressure on the healthcare system. In conjunction with other COVID-19 home monitoring tools, SMS was used for the remote monitoring of COVID-19-positive outpatients [29]. An SMS communication program implemented by French doctors offered a means to track COVID-19-positive patients after discharge, enabling physicians to remotely assess a patient's recovery and provide medical advice via text message reminders [30]. Among patients with Duchenne muscular dystrophy, the majority indicated that SMS reminders would be most helpful for daily monitoring assessments [31]. Meanwhile, Jannati et al. found that different variables (e.g., age, gender, and education level) did not affect the overall satisfaction of patients who used SMS/voice assistance for teleconsultations [32]. As a low-cost and high-efficiency method, SMS can be used to assist hospital staff in regulating the flow of patients. In an observational study, text messages sent to ophthalmology outpatients one week in advance were successful in encouraging patients at risk of contracting COVID-19 to postpone their visits. SMS was also used to effectively reduce both the risk of COVID-19 transmission and the pressure on medical staff [33].

During the COVID-19 pandemic, community quarantines and lockdowns created obstacles for many people. As a digital tool, SMS can be used to aid community workers and researchers in data collection during quarantine and lockdown periods. In low- and middle-income countries, equipping community workers with digital tools, including text messaging, facilitated their day-to-day work. The use of short message services was found to help community health workers to optimize the operation of health services, helping to better complete the tasks of COVID-19 prevention and control [34]. The nonprofit organization LivingGoods integrated a COVID-19 protocol into its SmartHealth app and developed an SMS platform to be implemented in the community to combat the COVID-19 pandemic [35]. Moreover, SMS enabled the training of community workers in basic skills such as using text messages to collect data, and helped to expedite the response to COVID-19 [36]. For researchers, SMS facilitated non-contact remote longitudinal data collection, removed physical barriers, and reached a wider and more comprehensive interviewee population [37]. In sociocultural research involving hard-to-reach communities, SMS has been used to invite people to participate in surveys, and was regarded as an ideal method in scenarios where face-to-face communication was not possible during the COVID-19 pandemic [38]. In Somalia, Voices of Africa used a platform called "Imaqal" to collect residents' responses via text messages in order to understand how local residents viewed the COVID-19 pandemic in the early stages [39].

2.3. Location-Based Services

With the rapid development of ICT technologies, the use of spatiotemporal data has become popular in smart cities. Location-Based Services (LBSs) enable service providers to offer targeted information to mobile users based on their geographic locations in real time through tools such as global positioning systems, Bluetooth, and cellular network positioning [40].

Innovative applications have been described in the areas of user travel [41], urban dynamics [42], healthcare [43], and emergency response [44]. In their review, Niu et al. discussed the important role of location information data mining in tracking citizens' urban activities [42]. Meanwhile, a location-based detection system named the LocHNESs platform was developed by Telecom Italia to provide real-time urban dynamic information [45]. Song et al. collected relevant data via LBS for health risk assessment [43]. Forouhar et al. used LBS data to evaluate the recovery rates of urban central areas in the United States and Canada in the post-pandemic period, providing a reference for policy formulation [46]. Swanson et al. used mobile phone location data to evaluate changes in basic service facilities after natural disasters, develop more effective emergency response measures, and provide assistance for community recovery [44]. At the same time, personalization and ease of use are important factors in evaluating the success of LBSs, as they ensure that such services meet users' needs [47]. In recent years, location-based advertising (LBA) has achieved personalized, localized, and instant service provision [48]. In addition, the provision of personalized travel recommendations when users travel has become a popular topic. The HLTRS system proposed by Ravi et al. combines user portraits and other related information to provide users with travel planning services [41]. Adibi et al. emphasized the important impact of LBSs in the field of healthcare, suggesting that LBSs can enhance personalized medical interventions and significantly improve the efficiency and quality of medical services [49]. At present, mobile text messaging applications are already being used in combination with LBSs [50]. Aloudat et al. discussed the issue of location-based mobile phone emergency service applications in Australia, and proposed that the successful implementation of mobile government applications in the future will require greater interaction among governments, telecommunications operators, and the public [51]. Evans-Cowley suggested that spatiotemporal data information voluntarily provided by the public through mobile phones or social networking systems would be of great assistance in emergency management [52].

Differing from the above works, the major scientific contributions of our study can be summarized as follows:

- Through mixed-methods research, we aim to investigate the attitudes and overall evaluation of mobile users regarding the TW-SMS during the COVID-19 pandemic in China. This approach reveals the differences in usage behavior between various groups (e.g., gender, age, education level, and travel frequency). Moreover, the reasons for high acceptance among cross-regional travelers are uncovered through content analysis.
- Based on the results of our questionnaire and text data analysis, it was observed that the respondents assigned higher scores for the necessity, helpfulness, and trustworthiness of the TW-SMS. This showed that mobile users had a relatively positive attitude and higher acceptance extent regarding the TW-SMS, which was because its content was derived from reliable information sources and included the necessary prevention and control measures.
- The key findings of this study can provide a reference for service providers and local departments (e.g., cultural and tourism, health, and disease control) to further improve the communication effects of the TW-SMS through customized services and accurate dissemination.

3. Online Questionnaire Survey on TW-SMS

3.1. Data Collection

In this study, we distributed an online questionnaires during the period between 9 February to 5 April 2023 through two outlets: (1) links were shared via social media applications (e.g., WeChat, QQ) using the snowball sampling method; and (2) a questionnaire platform (e.g., Credamo) was used to recruit a wider range of participants through a

crowd-sourcing service, enabling us to randomly select samples based on the IP addresses of the participants. Each individual in the group had an equal likelihood of being selected, ensuring the representativeness of the sample [53]. We identified invalid responses based on the following criteria: (1) the completion time was less than 100 s or more than 1200 s; (2) the respondents never received COVID-19 TW-SMS messages; (3) the respondents received COVID-19 TW-SMS messages, but the messages were intercepted or the user chose to clear the screen immediately. Of the 704 questionnaires we obtained, 528 were deemed to be valid, for an effective recovery rate of 75.0%.

3.2. Descriptive Statistical Analysis

Using the 528 valid questionnaires, we conducted a descriptive statistical analysis to determine the demographic information and usage behavior.

The demographic information is shown in Table 1. It can be seen that male and female respondents accounted for 38.8% and 61.2%, respectively, and the ratio of male to female respondents was approximately 2:3. In terms of age, most of the respondents were 18–25 years old or 26–35 years old, accounting for 40.2% and 38.6%, respectively. Regarding the education level, the largest number of respondents were undergraduates, which represented 72.5% of the respondents. Regarding the number of trips in 2022, 36.7% of the respondents traveled 1–3 times and 38.8% traveled 4–6 times, while 7.8% of the respondents traveled 10 times. In addition, according to the geographical location data, the respondents to our survey came from 28 provinces in China, with people from East China representing 47.9%. South China and Central China followed, respectively accounting for 16.1% and 12.5% of the total respondents. Respondents from Northeast China (4.2%) and Northwest China (1.3%) were relatively scarce.

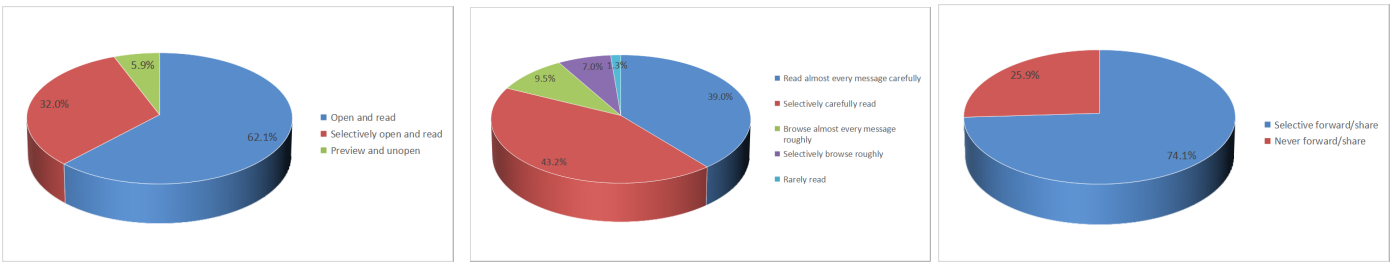
Table 1. Descriptive statistics of respondents.

Variable	Category	Num.	Percent (%)
Gender	Male	205	38.8
	Female	323	61.2
Age	17 years old and below	1	0.2
	18–25 years old	212	40.2
	26–35 years old	204	38.6
	36–45 years old	57	10.8
	46–60 years old	52	9.8
	Over 60 years old	2	0.4
Education level	Junior middle school and below	4	0.8
	Technical secondary/vocational/high school	29	5.5
	College	57	10.8
	Undergraduate	383	72.5
	Graduate or above	55	10.4
Travel frequency	1–3 times	194	36.7
	4–6 times	205	38.8
	7–10 times	88	16.7
	More than 10 times	41	7.8
Region	North China	47	8.9
	East China	253	47.9
	Northeast China	22	4.2
	Central China	66	12.5
	South China	85	16.1
	Southwest China	46	8.7
	Northwest China	7	1.3
	Other regions	2	0.4

The usage behavior is shown in Table 2. In particular, 94.1% of the respondents opened and read TW-SMS messages. Moreover, 80.2% of the respondents chose to read their text messages carefully (or selectively). In addition, most had experience in forwarding (or sharing) TW-SMS messages, accounting for 74.1% of the respondents. Figure 2 shows the proportions of different user behaviors.

Table 2. Usage behavior.

	User Usage Behavior	Num.	Percent (%)
Handling	Open and read	328	62.1
	Selectively open and read	169	32.0
	Preview and unopen	31	5.9
Reading	Read almost every message carefully	206	39.0
	Selectively and carefully read	228	43.2
	Browse almost every message roughly	50	9.5
	Selectively browse roughly	37	7.0
	Rarely read	7	1.3
Forwarding	Selectively forward/share	391	74.1
	Never forward/share	137	25.9



(**a**) Handling (**b**) Reading (**c**) Forwarding

Figure 2. Usage behavior.

4. Analysis of Online Questionnaire Survey Results

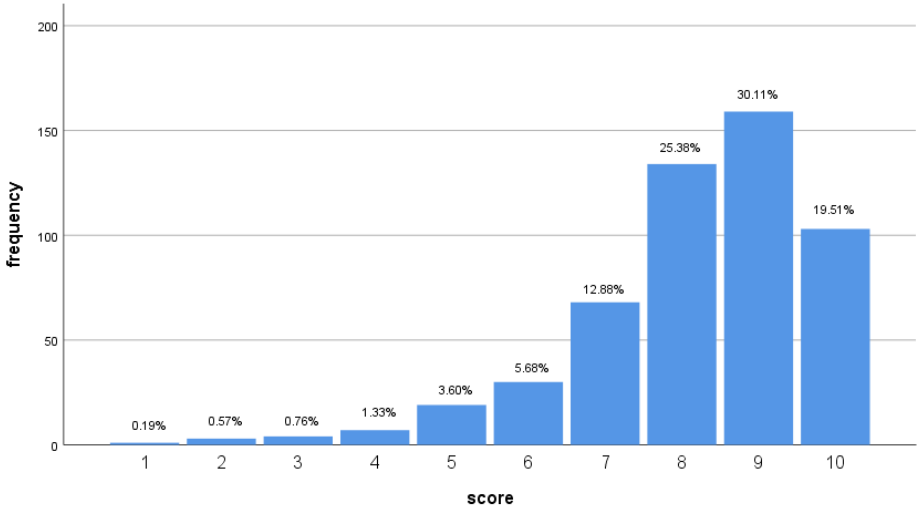
4.1. Overall Evaluation

In this study, the evaluation of the users' overall attitudes mainly includes two aspects: evaluation of the necessity for use, and evaluation of the user's overall opinion, ranging from "1 = not necessary at all/strong dissatisfaction" to "10 = very necessary/satisfaction". We used five-point Likert scales to evaluate the perceived trustworthiness and helpfulness of the COVID-19 reminder content sent via TW-SMS. In this study, an independent-sample *t*-test and chi-square test were used to evaluate the differences between the different groups, and the significance level was a *p*-value of 0.05.

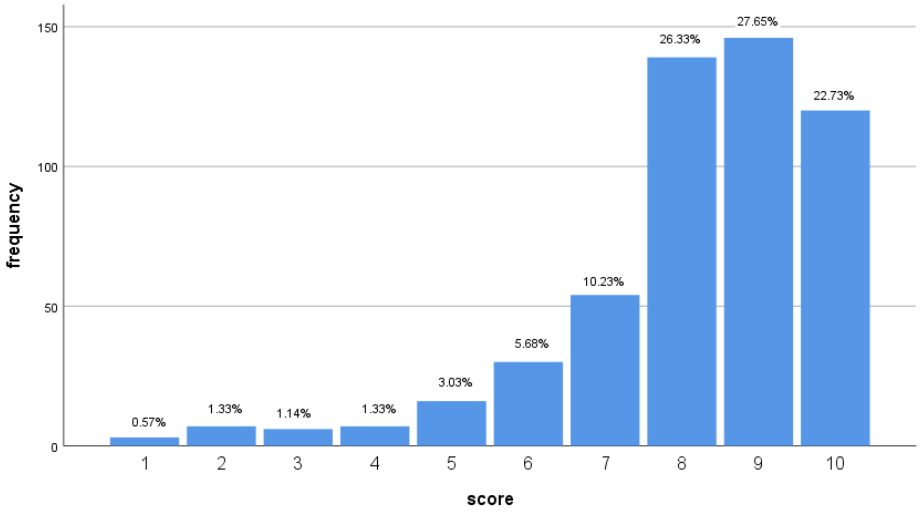
As shown in Table 3, in terms of necessity, the participating mobile users exhibited a high degree of recognition of TW-SMS (Mean = 8.20, Median = 9.00, SD = 1.734). In addition, the overall attitude score (Mean = 8.20, Median = 8.00, SD = 1.557) showed that they held positive attitudes towards the TW-SMS, which was found to help travelers during the pandemic. Figure 3 shows the frequencies of the users' attitudes. In this way, RQ 1a is answered. Similarly, Alem et al. found that users showed a high level of willingness and positive attitudes towards SMS reminders [54].

Table 3. Overall attitudes of users towards TW-SMS.

Evaluation	Num.	Min.	Max.	Mean	Median	SD
Necessity	528	1	10	8.20	9.00	1.734
Overall	528	1	10	8.20	8.00	1.557



(**a**) Necessity evaluation



(**b**) Overall evaluation

Figure 3. Users' attitudes.

Table 4 shows the trustworthiness and helpfulness evaluation of the TW-SMS by the respondents. It can be seen that the content of the TW-SMS was considered to be credible (Mean = 4.21, Median = 4.00, SD = 0.669). In terms of the helpfulness of the TW-SMS, the average scores were larger than 4.00, which indicates that the contents of the TW-SMS messages actually conveyed useful information to the mobile users. Moreover, the majority of mobile users felt that the reminders provided by the TW-SMS brought convenience to their trips (Mean = 4.16, Median = 4.00, SD = 0.774).

Table 4. Users' evaluation of the trustworthiness and helpfulness of the TW-SMS.

Item	Num.	Min.	Max.	Mean	Median	SD
Trust in content	528	1	5	4.21	4.00	0.669
Helpfulness of content	528	2	5	4.16	4.00	0.750
Helpful to learn about prevention and control measures	528	1	5	4.23	4.00	0.771
Helpful to raise awareness about prevention	528	1	5	4.16	4.00	0.773
Helpful for self-protection behavior	528	1	5	4.03	4.00	0.918
Helpful to implement prevention and control measures	528	1	5	4.29	4.00	0.716
Convenience	528	1	5	4.16	4.00	0.774

We used SPSS 26.0 software to conduct an independent *t*-test and chi-square test analysis, allowing the differences in the evaluation of the TW-SMS among the groups (e.g., gender, age, and education level) to be further explored.

4.2. Gender Differences

The results of the gender difference analysis are shown in Table 5. In terms of necessity, there is no significant difference in the attitudes of males and females, and the scores of both groups are above 8.00. Thus, gender did not affect users' evaluation of the necessity of the TW-SMS. In terms of the overall attitude, the scores of male users (Mean = 8.42, SD = 1.712) were slightly higher than those of female users (M = 8.06, SD = 1.435). There was a statistically significant difference ($t(528) = 2.521$, $p = 0.012 < 0.05$), and RQ 1b is answered. This outcome is consistent with the results of research on the attitudes of male and female respondents to COVID-19 public interest SMS messages in [8]. According to the chi-square test results shown in Table 6, there is essentially no difference in the use of reading and forwarding (or sharing) behaviors between males and females, which answers RQ 2a.

Table 5. Overall attitudes of different gender groups towards the TW-SMS.

Evaluation	Gender	Num.	Mean	Measure Scale	Sig. (Two-Tailed)
Necessity	Male	205	8.25 ± 2.008	1–10	0.560
	Female	323	8.16 ± 1.537	1–10	
Overall	Male	205	8.42 ± 1.712	1–10	0.012
	Female	323	8.06 ± 1.435	1–10	

Table 6. SMS usage behavior in different gender groups.

Item	Gender	Num.	Sig. (Two-Tailed)
Reading behavior	Male	205	0.143
	Female	323	
Forwarding (sharing) behavior	Male	205	0.327
	Female	323	

Reading: Two cells (20.0%) have an expected count of less than 5. The minimum expected count was 2.72. The Sig. results were derived from Fisher's exact test. Forwarding: 0 cells (0.0%) have an expected count of less than 5. The minimum expected count was 53.19.

4.3. Age Differences

Next, we determined whether differences exist between those aged 18–25 and those aged 36 or above in terms of attitudes towards the TW-SMS.

According to the results of the independent *t*-test shown in Table 7, it can be seen that there is a significant difference between the younger group, represented by those aged 18–25, and the group aged 36 or above ($t(323) = -3.058$, $p = 0.002 < 0.01$). Moreover, there is a significant difference in overall opinion ($t(323) = -4.460$, $p < 0.001$). Respondents aged 36 or above rated the necessity of the TW-SMS (M = 8.19, SD = 2.038) and their overall

attitude (M = 8.40, SD = 1.955) more highly than the younger group, thereby answering RQ 1c. The statistical results show that the older group perceived the TW-SMS messaging more seriously, perhaps because they believed that they were more vulnerable to COVID-19 [10]. Moreover, regarding the perceived severity of the COVID-19 pandemic, older travelers perceived it to be more serious [55]. Additionally, according to previous research by Öcal et al., the stress of COVID-19 and the overall emotional reaction both increase with age [56].

Table 7. Overall attitudes of different age groups towards the TW-SMS.

Item	Age	Num.	Mean	Measure Scale	Sig. (Two-Tailed)
Necessity	18–25 years old	212	7.52 ± 1.756	1–10	0.002
	36 years old or above	111	8.19 ± 2.038	1–10	
Overall	18–25 years old	212	7.52 ± 1.500	1–10	0.000
	36 years old or above	111	8.40 ± 1.955	1–10	

In addition, Table 8 shows the reading and forwarding (or sharing) behaviors related to the TW-SMS in the two age groups. The results of the chi-square test show significant differences between the two groups in terms of reading and forwarding (or sharing) behaviors. First, 48.6% of the middle-aged and elderly respondents read almost every text message carefully, and those who chose to read (or selectively read) TW-SMS messages accounted for 83.8% of the respondents in the "36 years old or above" group. Younger respondents aged 18–25 were more inclined to selectively and carefully read text messages based on the content and the current situation, which accounted for 52.6%. Second, 79.3% of the middle-aged and older respondents forwarded (or shared) the content of TW-SMS messages; in contrast, only 57.5% of the young respondents chose to forward (or share) TW-SMS messages. Thus, RQ 2b is answered.

Table 8. TW-SMS usage behavior of different age groups.

Item	Age	Num.	Sig. (Two-Tailed)
Reading behavior	18–25 years old	212	0.000
	36 years old or above	111	
Forwarding (sharing) behavior	18–25 years old	212	0.000
	36 years old or above	111	

Reading: Two cells (20.0%) have an expected count of less than 5. The minimum expected count was 2.41. The Sig. results were derived from Fisher's exact test. Forwarding: 0 cells (0.0%) have an expected count of less than 5. The minimum expected count was 38.83.

Regarding the helpfulness of the TW-SMS, the results are shown in Table 9. According to the independent *t*-test results, we found a significant difference between the two age groups ($t(323) = -4.242$, $p < 0.001$). Compared with the younger group, the mobile users in the middle-aged/older group tended to believe that the TW-SMS content was more helpful (M = 4.30, SD = 0.770). Specifically, due to their usage habits, the middle-aged and elderly respondents (36 years old or above) provided higher evaluations regarding the messages' helpfulness in learning about prevention and control measures (M = 4.39, SD = 0.765), raising awareness about prevention (M = 4.30, SD = 0.721), reminding about self-protection measures (M = 4.16, SD = 0.949), and implementing prevention and control measures (M = 4.41, SD = 0.718) compared to the younger group (18–25 years old). The difference was statistically significant.

4.4. Differences in Education Level

In addition, we explored how the contents of TW-SMS messages affected groups with different education levels. Table 10 presents the results of the independent *t*-test,

showing no statistical difference in the respondents' evaluation of the necessity of the TW-SMS ($t(528) = 1.567$, $p = 0.118 > 0.05$). Both groups showed relatively positive attitudes and believed that the TW-SMS messages were necessary. In the overall evaluation of text messages, the score of the group without a bachelor's degree (Mean = 8.61, SD = 1.660) was higher than that of the group with a bachelor's degree or above (Mean = 8.12, SD = 1.523), yielding a significant difference ($t(528) = 2.750$, $p = 0.006 < 0.01$). Thus, RQ 1d is answered. These results are different from the findings of Alem et al. [54]. Regarding the use of SMS reminders to promote drug adherence, they found that people had a positive attitude towards the TW-SMS regardless of their education level.

Table 9. Helpfulness evaluation of the TW-SMS in different age groups.

Item	Age	Num.	Mean	Measure Scale	Sig. (Two-Tailed)
Helpfulness of content	18–25 years old 36 years old or above	212 111	3.91 ± 0.797 4.30 ± 0.770	1–5 1–5	0.000
Helpful to learn about prevention and control measures	18–25 years old 36 years old or above	212 111	3.97 ± 0.834 4.39 ± 0.765	1–5 1–5	0.000
Helps to raise awareness of prevention	18–25 years old 36 years old or above	212 111	3.91 ± 0.832 4.30 ± 0.721	1–5 1–5	0.000
Helpful for self-protection behavior	18–25 years old 36 years old or above	212 111	3.71 ± 0.958 4.16 ± 0.949	1–5 1–5	0.000
Helpful to implement prevention and control measures	18–25 years old 36 years old or above	212 111	4.11 ± 0.786 4.41 ± 0.718	1–5 1–5	0.001

Table 10. Overall attitudes towards TW-SMS of groups with different education levels.

Item	Education Level	Num.	Mean	Measure Scale	Sig. (Two-Tailed)
Necessity	Below Undergraduate degree Undergraduate degree or above	90 438	8.46 ± 1.657 8.14 ± 1.747	1–10 1–10	0.118
Overall	Below Undergraduate degree Undergraduate degree or above	90 438	8.61 ± 1.660 8.12 ± 1.523	1–10 1–10	0.006

In Table 11, it can be seen that the TW-SMS messages were rated more helpful by the group with a lower education level in terms of raising prevention awareness ($t(528) = 2.129$, $p = 0.034 < 0.05$) and in implementing prevention and control measures ($t(528) = 2.451$, $p = 0.015 < 0.05$), while no significant differences existed in other areas. In addition, the chi-square test results in Table 12 indicate that the educational background variable had no effect on the reading and forwarding (or sharing) of text messages, which answers RQ 2c. It can be seen that for most of the helpfulness evaluation items there was no significant difference in the attitudes of the different education groups. Only a few items showed obvious differences, and these were not sufficient to suggest that users' attitudes in terms of helpfulness and usage behaviors were affected by their educational background.

Table 11. Helpfulness evaluation of the TW-SMS for groups with different education levels.

Item	Education Level	Num.	Mean	Measur Scale	Sig. (Two-Tailed)
Helpfulness of content	Below Undergraduate degree Undergraduate degree or above	90 438	4.22 ± 0.746 4.15 ± 0.751	1–5 1–5	0.381
Helps to learn about prevention and control measures	Below undergraduate degree Undergraduate degree or above	90 438	4.30 ± 0.694 4.22 ± 0.785	1–5 1–5	0.379

Table 11. *Cont.*

Item	Education Level	Num.	Mean	Measur Scale	Sig. (Two-Tailed)
Helps to raise prevention awareness	Below undergraduate degree	90	4.32 ± 0.732	1–5	0.034
	Undergraduate degree or above	438	4.13 ± 0.778	1–5	
Helpful for self-protection behavior	Below undergraduate degree	90	4.17 ± 0.864	1–5	0.117
	Undergraduate degree or above	438	4.00 ± 0.928	1–5	
Helps to implement prevention and control measures	Below undergraduate degree	90	4.46 ± 0.656	1–5	0.015
	Undergraduate degree or above	438	4.25 ± 0.724	1–5	

Table 12. SMS usage behavior of groups with different education levels.

Item	Education Level	Num.	Sig. (Two-Tailed)
Reading behavior	Below undergraduate degree	90	0.388
	Undergraduate degree or above	438	
Forwarding (sharing) behavior	Below undergraduate degree	90	0.376
	Undergraduate degree or above	438	

Reading: One cell (10.0%) has an expected a count of less than 5. The minimum expected count was 1.19. Forwarding: 0 cells (0.0%) have an expected count of less than 5. The minimum expected count was 23.35.

4.5. Travel Frequency Differences

Generally, people who travel often have more opportunities to receive TW-SMS messages. Therefore, we explored whether there were differences in attitudes between groups that traveled infrequently (1–3 trips) and those who traveled frequently (seven or more trips).

As shown in Table 13, in terms of necessity, the respondents who traveled more frequently (Mean = 8.63, SD = 1.173) scored the TW-SMS more highly than those who traveled less frequently (Mean = 8.08, SD = 1.801), and there was a statistical difference ($t(323) = -3.327$, $p = 0.001 < 0.01$). At the same time, in terms of overall attitudes, the respondents who traveled frequently also provided higher evaluations (Mean = 8.55, SD = 1.250); again, there was a statistically significant difference ($t(323) = -2.777$, $p = 0.006 < 0.01$). Thus, RQ 3a is answered. According to the investigation of Prapaso et al., travelers reported an overall moderate level of concern regarding the COVID-19 situation [57]. Therefore, the information provided by the TW-SMS is more essential for those who travel frequently.

Table 13. Overall attitudes towards the TW-SMS of groups with different travel frequencies.

Item	Trip Frequency	Num.	Mean	Measure Scale	Sig. (Two-Tailed)
Necessity	1–3 times	194	8.08 ± 1.801	1–10	0.001
	7 times and more	129	8.63 ± 1.173	1–10	
Overall	1–3 times	194	8.10 ± 1.638	1–10	0.006
	7 times and more	129	8.55 ± 1.250	1–10	

Regarding the reading and forwarding (or sharing) of TW-SMS messages, Table 14 shows that while the groups with different travel frequencies showed no significant differences in their TW-SMS reading behavior, there was a significant difference in their forwarding (or sharing) behavior. Specifically, 82.2% of the respondents who traveled more often chose to forward (or share) the content of TW-SMS messages to other travelers, which was higher than among the respondents who did not travel frequently (69.1%). Thus, RQ 3b is answered.

Table 14. SMS usage behavior in groups with different travel frequencies.

Item	Trip Frequency	Num.	Sig. (Two-Tailed)
Reading behavior	1–3 times	194	0.064
	7 times or more	129	
Forwarding (sharing) behavior	1–3 times	194	0.008
	7 times or more	129	

Reading: Two cells (20.0%) have an expected count of less than 5. The minimum expected count was 2.00. The Sig. results were derived from Fisher's exact test. Forwarding: 0 cells (0.0%) have an expected count of less than 5. The minimum expected count was 33.15.

5. Content Analysis of TW-SMS

In this section, first, we present the examined characteristics and the data collection process used for the TW-SMS content analysis, then classify the content into different categories. Second, we present a further content analysis from the perspectives of the information sources, major topics, and language expression.

5.1. Data Collection and Categories

During the distribution of the questionnaire, we invited the respondents to share COVID-19 TW-SMS messages that they received during their intercity travel in the previous three years. Moreover, the content of TW-SMS messages was provided by volunteers recruited on social media and offline cross-regional travelers, which enabled us to obtain a large sample from a range of regions in China. A total of 378 text messages were collected.

The World Health Organization (WHO) announced that the COVID-19 outbreak would be listed as a Public Health Emergency of International Concern (PHEIC) on 30 January 2020. On 5 May 2023, the World Health Organization announced that the COVID-19 pandemic no longer constituted a PHEIC. In China, the National Health Commission issued an announcement to rename the "novel coronavirus pneumonia" the "novel coronavirus infection" on 26 December 2022. In this study, eligible short messages received during the COVID-19 pandemic needed to exhibit the characteristics of TW-SMS messages. After data cleaning and sorting, 260 messages were obtained from the time period between 16 April 2020 to 25 December 2022, covering the timeline of the COVID-19 pandemic in China. These messages formed the data sample in this study. The sample contained 174 unique text messages from 25 provinces in China, as presented in Table 15.

Table 15. Location distribution of the collected TW-SMS messages.

Region	Unique Num.	Percent (%)	Total Num.	Percent (%)
North China	26	14.9	47	18.1
East China	92	52.9	140	53.8
Northeast China	2	1.1	2	0.8
Central China	24	13.8	32	12.3
South China	10	5.7	11	4.2
Southwest China	8	4.6	13	5.0
Northwest China	12	6.9	15	5.8

When collecting the TW-SMS messages, we sought to retain all information related to the text messages, including the time that the text messages were sent, the number of people who sent them, the place where they were received, the source of the information, and the entire content of each text message. When processing and analyzing them, we found that the collected text messages exhibited some duplication, suggesting that the respondents who provided them may have traveled to the same place at the same or similar time points. Therefore, we use the terms "total number" and "unique number" to distinguish them.

Among these, "total number" refers to the number of TW-SMS messages that met the conditions within the whole data sample, while "unique number" refers to the number of TW-SMS messages that met the conditions when only those with different content were considered. We quantified the information sources of the text messages and the content mentioned in them, then analyzed the language styles and expressions of the text messages.

5.2. TW-SMS Content Discussion

5.2.1. Information Sources

From the information sources presented in Table 16, it can be seen that the majority of the TW-SMS messages were sent from local official departments, e.g., the COVID-19 Prevention and Control Headquarters (Office) and the Centers for Disease Control and Prevention. Moreover, TW-SMS messages were jointly issued by other governmental agencies, e.g., the Bureau of Culture and Tourism or the local governmental affairs service platform. Although the individual names shown in the TW-SMS messages were slightly different (e.g., the COVID-19 Prevention and Control Headquarters, the COVID-19 Prevention and Control Office), a new mechanism was formed via the combination of the offices of related governmental institutions with the aim of jointly combating the COVID-19 pandemic and making effective decisions. Therefore, we believe that authoritative information sources are an important explanatory factor regarding users' high trust in TW-SMS messages and have a positive impact on users' acceptance of the TW-SMS.

Table 16. Major institutions responsible for the collected TW-SMS messages.

Institution	Unique Num.	%	Total Num.	%
COVID-19 Prevention and Control Headquarters	50	28.7	76	29.2
COVID-19 Prevention and Control Leading Office	36	20.7	45	17.3
Office of COVID-19 Prevention and Control Headquarters	24	13.8	29	11.2
Centers for Disease Control and Prevention	16	9.2	32	12.3
Bureau of Culture and Tourism	12	6.9	12	4.6
Government Affairs Service Platform	8	4.6	8	3.1
Health Commission/Bureau of Public Health	6	3.4	8	3.1
Others	6	3.4	7	2.7
Unspecified	27	15.5	42	16.2

5.2.2. Major Content

Regarding their content, the TW-SMS messages mainly focused on the COVID-19 prevention and control guidelines for intercity travel, including COVID-19 prevention measures, individual protection and health management reminders, etc. Specifically, the local prevention policies and protective behaviors mentioned in the TW-SMS messages were divided into eight topics: traveling registration, nucleic acid testing, NAT-negative certificate/travel/health code check, quarantine/health monitoring, avoiding unnecessary trips/gathering/dining together, avoiding taking public transportation, wearing a mask/washing hands frequently, and applying for health codes. The major topics according to the keywords or content descriptions in the text messages are shown in Table 17.

When individuals engage in intercity travel, this leads to cross-regional movement. During the COVID-19 pandemic, this undoubtedly increased the risk of transmission. For such travelers, it would be preferable to register their personal trajectories in their communities. As the epidemic spreads, this can be beneficial for tracking back and investigating the virus' source and those responsible for its transmission in medium/high-risk regions, which could facilitate the management of such communities.

Table 17. Major topics present in the collected TW-SMS content.

Topic	Unique Mentioned Num.	%	Total Mentioned Num.	%
Traveling registration	125	71.8	157	60.4
Nucleic acid testing	103	59.2	147	56.4
Avoiding unnecessary trips/gathering/dining together	37	21.3	54	20.8
NAT-negative certificate/travel/health code check	36	20.7	45	17.3
Quarantine/health monitoring	34	19.5	42	16.2
Avoiding taking public transportation	20	11.5	25	9.6
Wearing a mask/washing hands frequently	19	10.9	28	10.8
Applying for health codes	9	5.2	12	4.6

As the most basic and critical step in epidemic prevention and control, NAT is an important means of quickly identifying people affected by the virus and effectively reducing its transmission. In this way, NAT can be considered the first step in the process of "early detection, early reporting, early isolation, and early treatment". Therefore, travel history registration and NAT were high-frequency terms in COVID-19 TW-SMS messages. In addition, TW-SMS messages not only explained the relevant policies and provide reminders for mobile users, but also informed them about how to implement these requirements. An example is the following: "*According to the latest demands for COVID-19 prevention and control, please bring a NAT report within 48 hours and then report to the destination community (village) immediately. Please search for the 'Jining Registration' applet in WeChat to declare. If you don't have a WeChat account, you can ask someone else to declare on your behalf* ".

In order to reduce the risk of infection and transmission during intercity travel, effective health management from the perspectives of both the individual and community is vital. On the one hand, personal health management was a crucial aspect in the response to the COVID-19 pandemic. Individuals held the primary responsibility for their own health, and were required to take good care of themselves. Behaviors such as wearing a mask and maintaining social distancing could effectively interrupt the spread of the virus. The TW-SMS often persuaded mobile users to avoid unnecessary trips and avoid using public transportation. Moreover, gathering or dining together were unsupported activities. The contents of the TW-SMS messages provided guidance in encouraging the public with regard to their own safety and protection by providing specific and feasible suggestions, for example, "*Please maintain good personal hygiene habits, wear masks, wash your hands, ventilate frequently, and maintain a safe social distance of at least 1 meter*". On the other hand, at the level of community health management, TW-SMS messages communicated up-to-date local information about health monitoring or home quarantine measures, checking health codes, and NAT, which jointly helped to prevent the spread of the disease.

5.2.3. Language Expression

Regarding the characteristics of the TW-SMS contents, we found that approximately 50% of the collected samples included a warm welcome and greeting to the travelers at the beginning. Such expressions created a sense of intimacy and sought to ease their anxiety or tension during the COVID-19 pandemic. A warm and empathetic tone is considered the most likely aspect to influence behavior change [58]. Some TW-SMS messages emphasized the current situation and raised people's awareness. In order to facilitate dissemination, the number of words in a TW-SMS message is limited. Therefore, mobile users can spend less time reading and still obtain sufficient information. In addition, the sentences are mostly common expressions, and no professional vocabulary is involved. Thus, the contents are easy to understand and are suitable for all mobile phone users. This also makes them universal in terms of acceptance among users with different educational backgrounds. Simple and direct language helps in communicating the importance and seriousness of

the COVID-19 pandemic as well as in ensuring that the readers adopt a specific attitude and take action to ensure their own protection [59]. For text messages with relatively long text length, the use of auxiliary methods can effectively reduce the difficulty of reading. On the one hand, in long text messages the text is often presented in the form of sections, making it more organized and focused. On the other hand, many text messages provide additional service consultation channels (such as consultation service hotlines) to prevent users from misunderstanding the content and provide assistance to users in need, for example, "*For consultation and service, please call the 24-hour hotline... "*. The friendly expression, easy-to-understand language, and focused presentation methods of TW-SMS messages enabled mobile users to easily grasp the main points and improved the user experience. Therefore, in this study, most users showed a high degree of acceptance and provided positive comments in the survey.

6. Conclusions

In this study, we have investigated mobile users' attitudes and usage behavior regarding the Traveling Welcome Short Messaging Service (TW-SMS) during the COVID-19 pandemic in China through an online survey and content analysis. The respondents provided high evaluation scores regarding the necessity, helpfulness, and trustworthiness of the TW-SMS content, indicating that mobile users had a relatively positive attitude and high level of acceptance towards the TW-SMS. The subsequent analysis has been performed to investigate the differences in overall attitudes and usage behavior regarding gender, age, education level, and intercity travel frequency. Although there were no significant differences for most measurement items in terms of gender or education level, there were differences between different age groups, with the older age group showing stronger attitudes and more frequent reading and forwarding behaviors than the younger age group. At the same time, respondents who traveled more frequently showed more positive attitudes and higher evaluations of the TW-SMS, indicating that the TW-SMS included the necessary information to help cross-regional travelers learn about local prevention and control measures. The content of the TW-SMS messages mainly focused on the COVID-19 prevention and control guidelines in terms of intercity travel, local prevention measures, and personal health management. Through this type of e-government service, TW-SMS messages were able to reach a wide range of individuals and provide official suggestions to travelers from other cities.

The practical implications of this mixed-methods research can be summarized as follows. Regarding the usage of SMS during public health events, it can be seen that SMS is an efficient intervention method for providing health alerts, as well as for other potential e-government issues. We found that mobile users chose to read such text messages, and shared the content with their relatives and friends. In addition, we found that the attitudes and overall evaluations of TW-SMS messages among groups with high travel frequency were better than in the groups with lower travel frequency, indicating that TW-SMS messages can offer convenience for trips taken during public health emergencies. Moreover, it is worth noting that SMS is an important channel by which middle-aged and elderly people receive information. Thus, service providers may need to improve communication and change their forms of discourse in order to cater the needs of the younger generation in the future. In addition, our research preliminarily explored users' preferences in terms of the specific content of TW-SMS messages. This can provide a reference for policymakers regarding which content to emphasize when new policies are issued.

Nevertheless, this study has certain limitations. First, as an exploratory study, this work did not focus on a particular theory, although it can lay a strong foundation for

subsequent theoretical development. Second, the respondents to the online questionnaire survey were mostly concentrated in the eastern region of China, while the respondents from the northwestern, northeastern, and southwestern regions were more limited in number. Third, considering the multi-wave nature of the COVID-19 pandemic and differences in its severity in different regions, it would be useful to collect fine-grained TW-SMS content from certain areas and then analyze the differences in the content in line with the changing status of the prevention and control measures.

In future work, more attention should be paid to the content and interactive mode of TW-SMS messages. Depending on the user portrait and spatiotemporal trajectory, personalized advice can be generated using AI-generated content and chatbots. This would be beneficial in improving the communication effect of the TW-SMS. Moreover, as a cross-sectional study, this work explored users' attitudes and the impact of the TW-SMS on users' travel at a relatively fixed time point. Therefore, the long-term impact of the TW-SMS represents another potential direction for future research. Lastly, considering the different effects of the TW-SMS, it would be interesting to compare the effectiveness of this type of messaging with that of other communication channels.

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Abbreviations

The following abbreviations are used in this manuscript:

COVID-19	Coronavirus Disease 2019
SMS	Short Messaging Service
MMS	Multimedia Messaging Service
TW-SMS	Traveling Welcome Short Messaging Service
NAT	Nucleic Acid Testing
LBS	Location-Based Service
OTT	Over-The-Top

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