Research Square

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Evaluation of Preventive, Supportive and Awareness Building Measures among International Students in China in Response to COVID-19: A Structural Equation Modeling Approach

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Abstract

Background The Coronavirus Disease 2019 (COVID-19) with its high mortality, stigma and panic has compelled many cities and countries to complete lockdown. The worldwide student group is one of the most affected and vulnerable communities in this situation. Our current study aimed to assess the impact of the behavior change communication among international students in China in current COVID-19 crisis.

Methods In this paper, we have utilized partial least squares-structural equation modeling (PLS-SEM) to understand the health behaviour changes of international students in China in response to novel Coronavirus outbreak. We mainly analyzed the relationship among the three selected latent variables (preventive, supportive and awareness building) based on a survey among the international students (n=467) in China in February 2020. We obtained their valuable responses regarding level of awareness, satisfaction and trust in authorities (i.e., government, local authorities and institutions) during this emergency period.

Results We utilized 22 indicators in the conceptual framework model with the help of Smart PLS 2.0 version software. The lowest average variance extracted (AVE) for all the constructs of our paper exceeded the minimum accepted value of 0.5, representing the adequate convergent validity. Prediction of students' satisfaction, the key outcome degree of the model, was nearly moderate, with an R^2 = 0.507 whereas the prediction of trust in authorities was above substantial, with an R^2 = 0.797. Therefore, our PLS-SEM model showed a strong and significant positive association between preventive and supportive measures taken for the study population and gaining trust, awareness and satisfaction in authorities.

Conclusions Integrated partial least squares-structural equation modeling (PLS-SEM) can be a great way to measure the satisfaction and trust level of various population groups over government, local authorities, and institutions in public health emergency like COVID-19 crisis. We believe that our findings are important for travel and global health perspectives. Other countries can learn and take necessary initiatives for their international students and general public to halt this deadly epidemic with gaining their satisfaction and trust as well.

Introduction

The Coronavirus Disease 2019 (COVID-19) is the deadliest pandemic of this century having the most disseminated outbreak over a wide geographical area. Though the novel coronavirus (2019-nCoV) pneumonia infection was first detected in December 2019, at Wuhan, Hubei, China [1], the infection rapidly spread in China and many other countries around the world [2]. Since then, this deadly virus has disseminated from Hubei to another 34 provinces across China and 153 different countries [3]**.** The increasing number of infected persons caused a severe threat to public health status, including international students living in China. The World Health Organization (WHO) declared the 2019-nCoV

outbreak as the sixth emergency public health of global concern [4]. The COVID-19 is considered so destructive and contagious due to its rapid spread from a small city to global community.

In order to reduce the rapid spread and adverse health impacts, increasing public awareness in such conditions is of great importance. On January 26, 2020, China initiated a level-1 public health response for its 30 provinces [5] which means the provincial headquarters will organize and coordinate with the emergency response and will be working within its administrative territory based on a unified decision disseminated by the State Council during any severe public health emergency. Also, the Chinese government has been utilizing several communication methods to disseminate and update timely reports and provide preventive advice to the general public in such circumstances.

To a greater extent, the success of such initiatives depends on the change of health seeking behaviour and attitudes of the public. Again, the theory of planned behavior, people's perceptions and behavioral intentions are major critical factors affecting and understanding of their actual behavior [6]. The outcome of these initiatives is somewhat challenging to measure for the non-native people due to many factors like social, cultural, linguistic or building trust. Thus, the need of people's perceptions, especially the perceptions of international students living in China about COVID-19, are very crucial during the current epidemic situation. That is why, we focused our concentration on significant gaps in knowledge and existing perceptions among them towards this COVID-19 outbreak.

During epidemic conditions, taking preventive measures (such as reducing outdoor activities and wearing N95 masks) can diminish the threat to public health [7]. Along with these, supportive measures taken by the institution can significantly decrease disease contamination. Hence, it is essential to examine the factors associated with the intentions of international students to take up these preventive measures as well as supports provided by their respective institutions to provide safety and satisfaction during epidemic conditions. The following hypothesis is suggested based on the above-mentioned discussion:

H1: Preventive and supportive measures taken by students and/or provided by the respective institution or authorities are positively related to students' satisfaction.

H2: Preventive and supportive measures taken by students and/or provided by the respective institution or authorities are positively related to gain trust in authorities.

Personnel awareness levels in terms of knowledge concerning health hazards play a significant function in the management of risk communication research. Knowledge theory is a widely used framework for building awareness which indicates that individuals' response in terms of risk is conditioned by their knowledge level [8]. The better risk knowledge a person possesses, the more appropriate risk judgments can be gained during epidemic situations. A wealth of literature recommends that mass media plays a significant role in disseminating information to enrich public awareness of health and contingent circumstances [9]. The more people depend on mass media to get information, the more attention they will pay to the news generated by these media outlets, and thus the more likely their behaviors and attitudes will be changed or strengthened. Moreover, it was also found that the increasing awareness

level causes a notable decline in Ebola virus disease transmission [10]. Based on the above discussion, we suggest the following two hypotheses:

H3: Personnel awareness-building is positively related to students' satisfaction.

H4: Personnel awareness-building is positively related to gain trust in authorities.

Communication strategy is crucial for controlling the epidemic, affects the consequence of epidemic management, control, and public trust. Epidemic associated information must be conveyed to the citizens in such a way that construct, maintain and restore trust and respect to local cultures and country norms [11,12]. Therefore, we propose the following hypothesis:

H5: Students' satisfaction is positively related to gain trust over authorities.

Methods

We designed an online survey among 467 international students located in different provinces of China followed by a short discussion. Then we analyzed three major psychological issues of epidemic circumstances, using survey data of. We chose international students as our potential respondents because of their wider representativeness around the globe and their ability to use the communication technology and information gathering. These helped us to evaluate the relationship between preventive and supportive measures taken by international students and their respective institutions as well as their level of awareness that tends to influence their satisfaction level and trust over authorities during this outbreak. Following theories and model were utilized-

Theory of structural equation modeling (SEM)

In behavioral research, SEM is preferred by many researchers for explaining the complex phenomenon due to its ability to handle the estimation of composite and interconnected dependent variables in the distinct analytical model [13]. There are many instances where SEM has been applied to health system planning, disease containment or to measure various mental health variables [14,15]. SEM works with two categories of variables, namely, endogenous (dependent) and exogenous (independent) variables. Moreover, this approach helps the researchers to test an unobservable hypothesis directly; with an insight view of the effects of all variables which in turn provides a systematic explanation of each hypothesis. According to Golob [16], SEM is such kind of tactics that has a substantial capability to concentrate within the aspects of structural approaches, and this beneficial ability makes SEM more convenient and flexible than other statistically viable methods. The SEM Methodology is exercised in most of the recent epidemics and critically evaluated various factors to quantify a complex phenomenon. For example, Naim Mahroum [17] utilized the SEM modeling analysis to evaluate public reaction to Chikungunya outbreaks in Italy. Our theoretical framework, utilized in this research has been shown in **Figure 1.**

Integrated partial least squares-structural equation modeling (PLS-SEM)

Since the developments of the statistical framework, SEM has been simplified to familiarize distinct parts of questionnaire data at several levels. Alternatively, the partial least squares (PLS) model provides a comprehensive assessment in a more centralistic way to measures the coefficients of structural equations framework. However, the clarifications attained as dependable rather than covariance-based approaches. Along with these notions, fewer constraints also could evaluate the data with a small distribution and sample size. The integrated model of PLS and SEM is popularly known as PLS-SEM.

In a case study of DR Congo, Kavita *et al* [18] utilized PLS-SEM model-based analysis by integrating the use, impact, and perception of social media as latent variables in terms of disaster management. In order to address the unfussy malaria management, PLS-SEM was evaluated for assessing patients' attitudes, knowledge and practice[19]. Trisha et al. [20] used PLS-SEM based tactics to find the influence of communication factors (such as mass media, knowledge and interpersonal discussion) to notify Singaporeans about the epidemic and their risk perceptions as well as strategy to self-protection.

This outbreak condition is not only threats for Chinese but also is a global issue as addressed by WHO. The WHO also recommended a set of precautions to reduce the rate of disease transmission [21]. From that suggestion we designed our theoretical model. We have utilized SEM to evaluate the framework with data extracted from an online questionnaire. This study is followed by three dimensional tactics. Specifically, protective and supportive measures taken by governments and local authorities, along with the awareness gained by the students, and subsequent trust in authorities and the institutions.

Research model

The theoretical outline, which is portrayed according to the SEM tactic, is shown in **Figure 2**. The theoretical outline is mainly focused on the establishment and combinations of preventive and supportive measures, awareness building, and trust in authorities.

Questionnaire design, pretest, and sampling procedure

This article restrained each and every mechanism of the questionnaire on a seven-point Likert measure, where 1 is set for strongly disagrees and 7 for strongly agree. The study also accompanied a pilot test within a small group of the respondents to ensure clearer understanding of the questionnaire. The confirmed form of the questionnaire contained 22 indicators, which correspond to three constructs, including preventive and supportive measures (12 items), awareness building (7 items), and trust (3 items) presented in **Table 1**.

Variables	Excerpts questions of Indicators	Model
Preventive and supportive measures	I am satisfied with the proper use of mask and hand gloves that can prevent this infection	P&S_1
	I am satisfied with avoids public transport and gathering in the last one month that can prevent this infection	P&S_2
	I am satisfied with the use of hand sanitizer, alcohol, and chemicals that can prevent this infection	P&S_3
	I am satisfied with current food preparation and consumption that can prevent this infection	P&S_4
	I am satisfied with my regular exercise which is instructed by authorities to protect me from this infection	P&S_5
	I am satisfied with the preventive measure taken by me to avoid direct contact with the animal to protect from this infection	P&S_6
	I am satisfied to participate in online class supported by an institution that can prevent this infection	P&S_7
	I am satisfied with authorities support to restrict movement that can protect me from this infection	P&S_8
	I am satisfied with the establishment of the temporary market and regular supplies of food and medicine by the authorities	P&S_9
	I am satisfied with maintaining register book for body temperature during exit and entre point by the authorities	P&S_10
	I am satisfied with regular health update collected by the institution	P&S_11
	I am satisfied with extra care taken the authorities for the international student during this period	P&S_12
Awareness building	I am aware of regular hand washing during this period	AW_1
	I am aware of my health to protect from cold during this period	AW_2
	I am careful about not to frequent face touch	AW_3
	I am aware of building immunity system through physical exercise	AW_4
	I am aware of participating in awareness activities arranged by the institution to protect from this infection	AW_5
	I am aware of the rumour and symptom of this epidemic	AW_6
	I am aware of involvement in mass media regarding this epidemic	AW_7
Trust in authorities	Overall, I trust my institutions that they will protect me from this infection	TR_1
	Overall, I trust the local authorities that they will protect me from this infection	TR_2

	Overall, I trust on Chinese Government that they will protect me from this infection	TR_3

Table 1
The excerpts of the questionnaire utilized in this research.

Results

Demographic analysis

A total of 467 students have participated in this study (Table 2). Among them, 289 (61.88%) participants were males. The age group of 31 to 35 years was dominant, with a total of 186 (39.82%) entries, followed by the age group of 26 to 30 years, with 140 (29.97%) entries. The majority of the students were single, 272 (58.24%), followed by with partner, 117 (25.05%), and family with children, 78 (16.7%). On the basis of educational level, the study participants were categorized into four groups: (i) Post-Doctoral, 47 (10.06%); (ii) Doctoral, 186 (39.8%); (iii) Masters, 140 (29.97%) (iv) Bachelor, 94 (20.12%). Students from 21 countries participated in the study including more than half from Pakistan, 247 (52.89%).

PLS-SEM algorithm

The 22 indicators of the conceptual framework model were run with the help of Smart PLS 2.0 version software and the structural framework used in the hypothesis testing parts is illustrated in Figure 3. Note that the preventive and supportive measures' paradigm had twelve indicators, the awareness-building paradigm had seven indicators, and the trust paradigm had three indicators. The initial assessments encompass the metrics with measurement characteristics of the outer framework, which represents the paradigms and their construction described in the PLS-SEM framework [23]. Smart PLS comprises a set of standard metrics like indicator loadings, composite reliability, average variance extracted (AVE), path coefficients, inner construct correlations, latent variable scores, *t*-values, and so on. A structural procedure of investigating the loadings and eliminating indicators (with loadings < 0.70) was adopted [22]. The leading step during the evaluation of a PLS-SEM framework was to investigate the outer model to facilitate the exertion and validation of the model dimension. For this reason, inner-relationships among the paradigms and their indicators were measured. **Table 2** shows the composite reliability wide-ranging between 0.87 to 0.90 for the four paradigms, which are far greater than the minimum requirement of 0.7, as proposed by Hair et al. [22].

Construct	Indicators	Loadings	Composite Reliability	Average variance extracted (AVE)	R^2
Preventive and supportive measures	S&P_1	0.709	0.8981	0.731	
	S&P_2	0.712			
	S&P_3	0.729			
	S&P_4	0.800			
	S&P_5	0.678			
	S&P_6	0.769			
	S&P_7	0.789			
	S&P_8	0.783			
	S&P_9	0.689			
	S&P_10	0.792			
	S&P_11	0.809			
	S&P_12	0.705			
Students satisfaction			0.8956	-	0.507
Awareness-building	AW_1	0.709	0.8739	0.626	
	AW_2	0.710			
	AW_3	0.781			
	AW_4	0.714			
	AW_5	0.761			
	AW_6	0.719			
	AW_7	0.878			
Trust in authorities	TR_1	0.882	0.8923	0.781	0.797
	TR_2	0.781			
	TR_3	0.681			

Table 2

PLS-SEM average variance extracted composite reliability and R2 for endogenous constructs

The lowest average variance extracted (AVE) for all the constructs of our paper exceeded the minimum accepted value of 0.5 [24], representing the adequate convergent validity Furthermore, for convergent validity, the composite reliability is higher than the AVE values of each and every variable which represents the convergent validity of the current model. **Table 3** shows the AVEs of the diagonal and the

squared inner construct correlations off the diagonal. The Fornell–Larcker criterion [25] displayed that all AVEs were greater than the squared relationships of the inner construct.

	Protective and supportive measures	Awareness-building	Students' satisfaction	Trust in authorities
Protective and supportive measures	**0.731**			
Students' satisfaction	0.360	**0.626**		
Awareness-building	0.581	0.410	**Single item construct**	
Trust in authorities	0.474	0.563	0.529	**0.781**

Table 3
PLS-SEM Fornell –Larcker test for discriminant validity

The hypotheses aimed for the current research were also verified by the bootstrapping resampling procedure with 200 repetitions. Bootstrapping is a nonparametric method that makes no distributional notion of the variables, facilitates with an estimated value of standard errors and the assurance intermissions, and tests the study hypotheses. The hypothesis H1 (preventive and supportive measures taken by students and/or provided by the respective institution or authorities are positively related to students' satisfaction) had an acceptable strength ($\beta = 0.611$, $t = 9.679$, $p < 0.001$) and a positive direction (presented in **table 4**). The hypothesis H2 (Preventive and supportive measures taken by students and/or provided by the respective institute or authorities are positively related to gain trust in authorities) showed an acceptable strength ($\beta = 0.381$, $t = 5.653$, $p < 0.001$) and a positive direction. The hypothesis H3 (personnel awareness-building is positively related to students' satisfaction) had an acceptable intensity ($\beta = 0.295$, $t = 2.719$, $p < 0.001$) and a positive direction. The hypothesis H4 (personnel awareness-building is positively related to gain trust in authorities) generated an acceptable concentration ($\beta = 0.131$, $t = 1.986$, $p < 0.05$) and a positive direction. Finally, the fifth hypothesis (students' satisfaction is positively related to gain trust in authorities) had an acceptable intensity ($\beta = 0.435$, $t = 7.135$, $p < 0.001$) and a positive direction.

Hypothesis	Hypothesis Path	Path Coefficient	T-Values	Accept or reject the significance
H1	S&P→ Satisfaction	0.611	9.679	Accept***
H2	S&P→ Trust	0.381	5.653	Accept***
H3	Awareness → Satisfaction	0.295	2.719	Accept***
H4	Awareness → Trust	0.131	1.986	Accept**
H5	Satisfaction → Trust	0.435	7.135	Accept***
Critical *t*-values for a two-tailed test are: <1.96 ($p > 0.05$*), 1.96 ($p = 0.05$**), and 2.58 ($p = 0.001$***).				

Table 4
Result of hypothesis tests based on PLS-SEM based model

We also examined the R^2 values for the two endogenous paradigms, students' satisfaction and trust in authorities. R^2 can be categorized into one of three classifications for social science studies: weak (0.25), moderate (0.50), or substantial (0.75) [22]. Prediction of students' satisfaction, the key outcome degree of the model, was nearly moderate, with an $R^2 = 0.507$. Prediction of trust in authorities was above substantial, with an $R^2 = 0.797$. The extents of the R^2 values for endogenous and exogenous paradigms were measured significant for construal determinations within the study.

Discussion

The COVID-19 came into sight in Wuhan just one month prior to the spring festival of China and a huge population movement during this period caused significant challenges for prevention and controlled the spread of infections. Therefore, it spreaded rapidly from Hubei to whole China**.** The COVID-19 can spread from human to human, and no effective drug or vaccine has been invented yet. The most efficient preventive and control ways are to identify suspected and confirmed patients and virus transporters and prevent the transmission via isolation, disinfection, and personal protection. Hence, increasing protective measures and awareness levels is vital to control and reduce the high trend rate of infection during this epidemic.

In our study, the analytical method produced robust results and confirmed that the students' satisfaction found as a meaningful partial mediator. The results from the PLS-SEM analyses showed that a large amount of the variance in the endogenous construct trust (80%) is explained by the three constructs of preventive and supportive measures taken by students and respective authorities, personal awareness-building and students' satisfaction. Trust over government has long been considered as a vital factor of citizens' compliance with public health policies, particularly during epidemic conditions. This is in line with the previous study of Blair et al. [26].The study found that supportive measures and policies taken by the Liberia government to control the Ebola virus disease epidemic were positively associated with gaining public trust over authorities.

In terms of the strength of the relationships, the PLS-SEM model revealed a strong and significant relationship between preventive and supportive measures taken by students and/or provided by the respective institution or authorities which leads to trust in authorities (0.381) (**Figure 2; Table 4**). This could be due to the central and local governments of China have already taken a series of drastic measures. Firstly, Chinese health authorities performed an urgent investigation to characterize and control the disease, together with isolation of suspected patients, examining of clinical contact status of the patients, and developing diagnostic and treatment processes [27]. Moreover, on January 23, 2020, the local authorities of Wuhan declared the suspension of all kinds of public transportation, including highways, bus stations, railway stations and airports in the city, preventing further disease transmission. Consequently, most provinces in China declared a “Level I Emergency Response” by adopting a series of measures, for example, suspending all kinds of public transportation and setting up community isolations. In addition, the list of the first-level authorized hospitals was announced, and training for epidemic prevention to primary medical staff started early on. As fever is one of the typical clinical symptoms for this infection, temperature detection in entry and exit points of railway stations, bus stands and other public places have been implemented comprehensively to screen suspected cases as early as possible. Furthermore, many other compulsory measures controlling population mobility, for instance, cancellation of mass gatherings, online school teaching, work-from-home arrangements, were taken to decrease within-population contact rates [5].

According to the strength of relationships, the PLS-SEM model revealed a strong and significant relationship between personal awareness level and gained trust in authorities (0.13) (**Figure 2; Table 4**). The reason behinds this is, the Chinese government tried to increase the public awareness level to control the spread of infection by publicizing regular updates about surveillance and active cases on different websites as well as social media [8]. Increasingly, psychologists and psychiatrists using the internet and social media (e.g., WeChat, Weibo, etc.) to distribute strategies for dealing with psychological stress. For instance, experts from Peking University Sixth Hospital of China made several suggestions for the general people to manage mental stress. These involved judging the accuracy of information disclosed, developing social support systems (e.g., friends and families), eradicating stigma linked with the epidemic, maintaining a healthy life under safe conditions, and using the psychosocial service system, mainly telephone- and internet-based counselling for health-care staff, infected patients, family members and the public [28].

Satisfaction depends on whether one has sympathy for what the authorities do and whether one thinks what the authorities are doing is good for society. Trust and satisfaction are vital predictors of trust. In our results, the strength of the relationship between students’ satisfaction and trust in authorities was 0.42 (**Figure 2; Table 4**). The possible reason behind this may be that the international students living in China during this period found their respective authorities doing their best to control this epidemic and trying to keep them safe from becoming infected. Several other studies also concluded that a positive relationship exists between satisfaction and trust over the government [29,30].

Despite our sincere efforts, our study has some limitations. It is possible that communal desirability apprehensions can lead the responses to our questionnaire with some extend of misperception. We reduced these concerns by avoiding the use of a brief discussion and pilot test. Moreover, our findings are not considered identical because the respondents of our study are only foreign students. Most notably, we found some extensive-expression of conspiracy belief in our prospective set of respondents who has some extend of obligatory for the institutions and authorities. So, there might be some biased responses. We tried to minimize this by a close discussion with some respondents and compiled those in our analysis. The linkage between satisfaction and trust in terms of such epidemics has limited empirical pieces of evidence, and the interconnection is relatively complex. Lastly, future researchers should investigate whether these findings vary in various situations or formats. In this study, we do not test these variants in fear of losing focus on our core objectives and it also could lead theoretically assorted treatment based on sources satisfaction and trust. Moreover, these might have needed more critical statistical analysis. Notwithstanding these limits, this is the first study on COVID-19 which used SEM to assess behaviour change. We contribute to the broader literature on the coronavirus outbreak by stating two aspects.

Conclusion

The study illustrates how preventive, supportive and awareness-building measures for the recent outbreak of the COVID-19 portrayed the satisfaction and trust of international students over government, local authorities, and institutions. In terms of content, this study shows that preventive and supportive measures with awareness building are the two profound dimensions of satisfaction directly related to the trustworthiness for authorities. Many other countries facing the same situation should consider these three measures in order to effectively battle with this known enemy with unknown characteristics.

Abbreviations

PLS-SEM: Partial least squares-structural equation modeling

COVID-19: Coronavirus disease 2019

AVE: Average variance extracted

SEM: Structural equation modeling

WHO: World Health Organization

Declarations

Ethics approval and consent to participate

The study participants provided consent to participate

Consent for publication

Consent was taken from all participants to participate in the study and share the findings from this study.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

All authors participated in conceptualization and experiment design, data collection, analysis, data validation and manuscript preparation. The authors read and approved the final manuscript.

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Figures

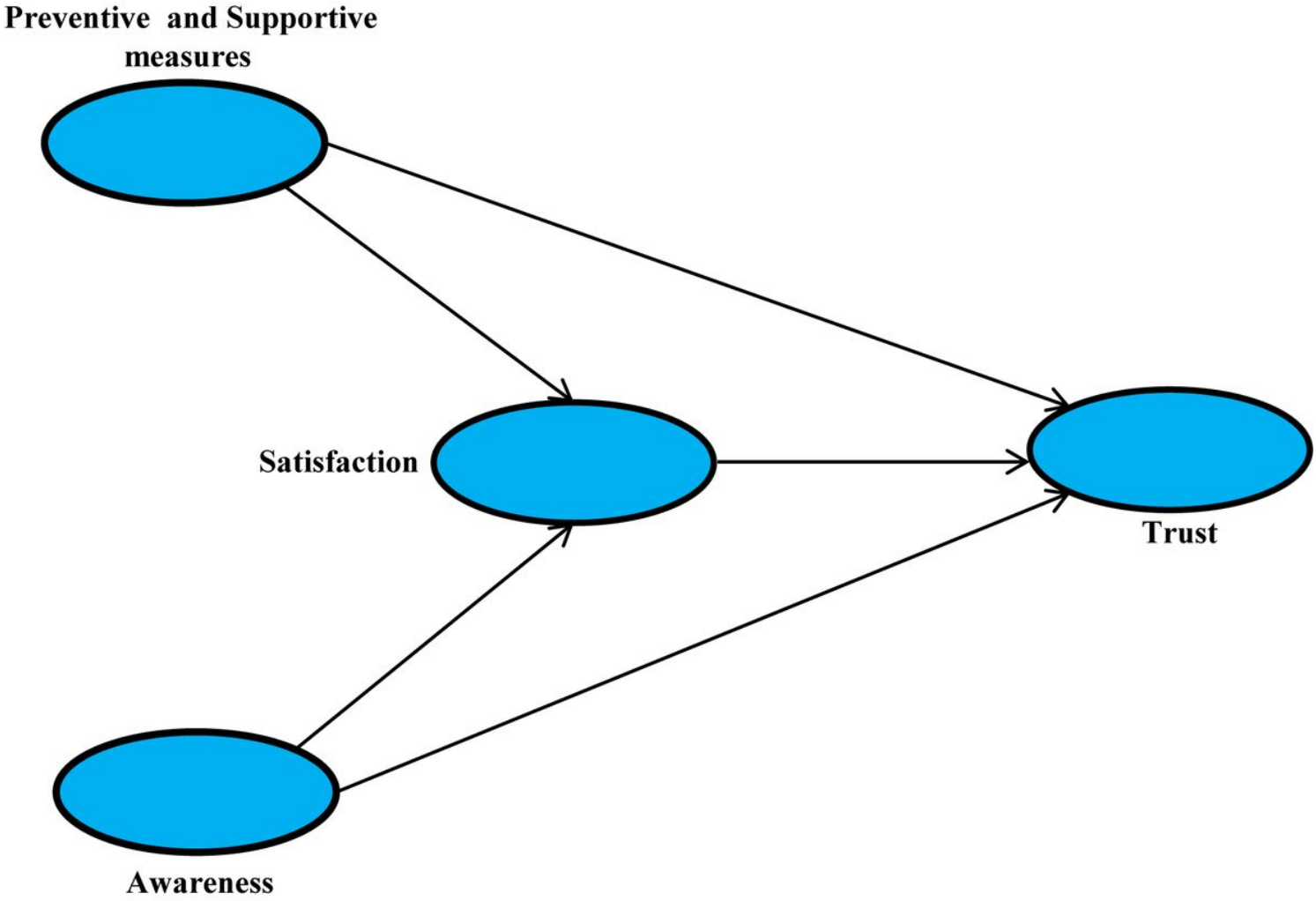

Figure 1

Figure 1

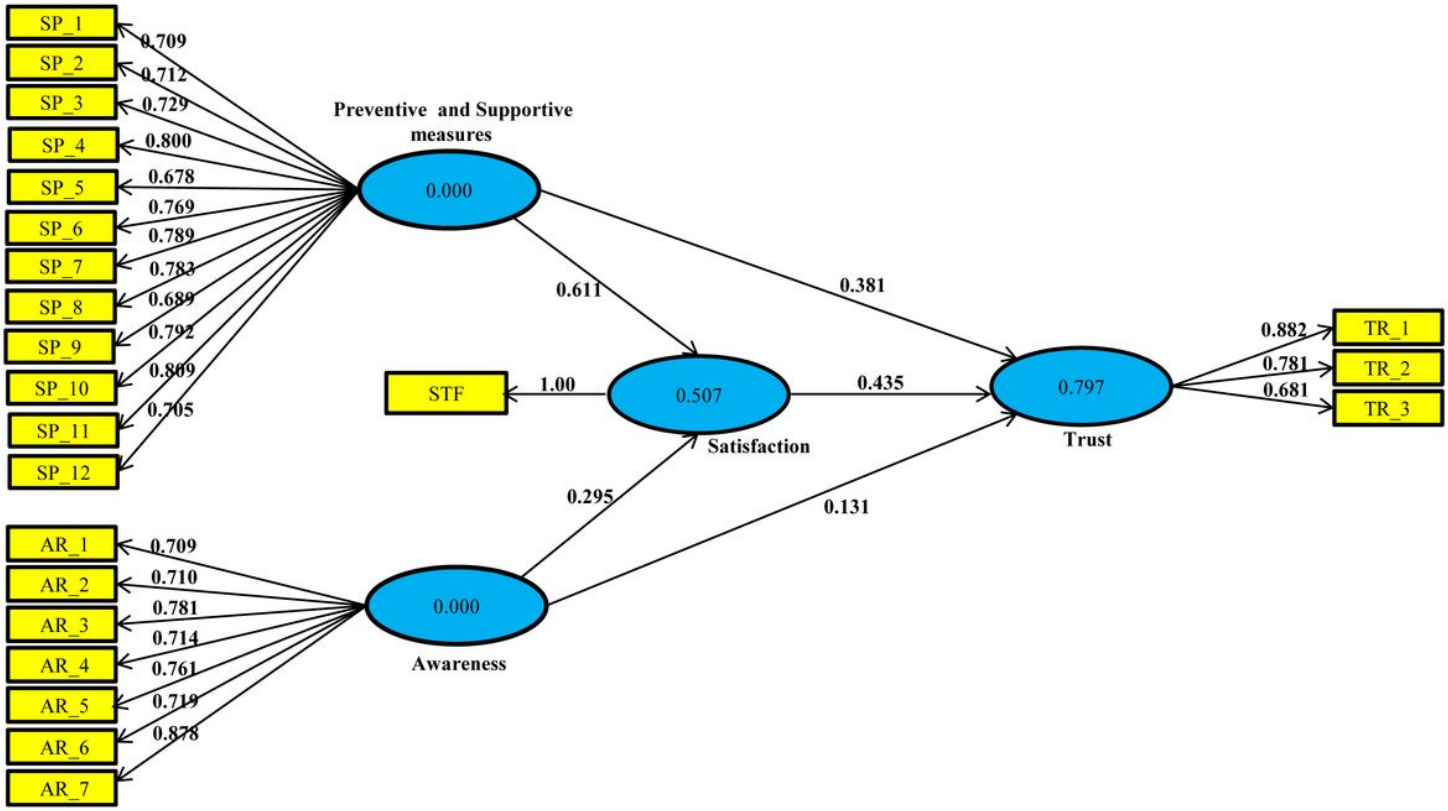

Figure 2

Figure 2