The Role of Coordination, Decision Making and Special Data Infrastructure on the Disaster Management in Pakistan: Moderating Role of Information System

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ARTICLE DETAILS

ABSTRACT

Disaster management in developing economies has become a significant issue due to the uncertain situation in the country and has attained the focus of upcoming studies and policymakers. Thus, the present research investigates the impact of coordination, decision making, and special data infrastructure on disaster management in Pakistan. This research also examines the moderating role of information systems among the nexus of coordination, decision making, special data infrastructure, and disaster management in Pakistan. This research has followed the quantitative data collection methods and used questionnaires for this purpose. This study also executed the smart-PLS to investigates the relationships between understudy variables. The results indicated that coordination, decision making, and special data infrastructure have a positive association with disaster management in Pakistan. The findings also indicated that information systems moderates among the links of decision making, special data infrastructure, and disaster management in Pakistan. This study is beneficial for the regulators while formulating the regulations on disaster management in the country.

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1. Introduction

Disaster is a serious interruption occurring over a short or long period of time that causes widespread material, human, environmental, the economic loss, which exceeds the capability of the affected society or area to cope utilizing its own resources. Especially developing countries bear the greatest costs when they are exposed to a disaster. More than 95% of all deaths occur due to hazards in developing countries, and the financial losses due to natural dangers are 20 times greater in the developing countries than in the developed countries (Gupta, Starr, Farahani, & Matinrad, 2016).
Whether it is a developed country or some developing one, the serious matter is they bring change in both social and economic life. There are different sorts of disasters like natural disasters, man-made disasters, and complex disasters. Natural disasters are a natural occurrence of physical phenomenon exposed by rapid or slow onset events having sudden and immediate influences on human health and subsidiary influences that results in sufferings or death such as earthquakes, landslides, volcanic activity, floods, drought, wildfires, epidemics, insect/animal plague (Ritchie & Jiang, 2019). Man-made disasters are the events that are caused by human activities and affect human health, technologies, environment, or human settlements like pollution, environmental degradation, and accidents. At the same time, complex disasters are caused by multiple hazards or a complex combination of both natural and man-made causes like epidemics, armed conflicts, extensive violence, and displacement of population, etc. However, all the disasters affect the health of people, environment, and infrastructure either directly or indirectly (Erdelj, Król, & Natalizio, 2017). The number of disasters that affected the Pakistan economy has been mentioned in Figure 1.

Thus, there is a need to keep a constant check on the causes of disasters and issues that created them. There is a need to manage the situation in such a way as to eradicate the roots of the disasters or to reduce the adverse impacts of these disasters, and this environmental, social, and economic need can better be fulfilled by a body of entities called as disaster management. According to the International Federation of Red Cross & Red Crescent Societies, disaster management is the organization and management of resources or responsibilities to deal with all the humanitarian aspects of emergencies, especially in disaster prevention, particular preparedness, response, and recovery to reduce the impacts of disasters (Wang & Ye, 2018). Disaster prevention is the right avoidance of adverse influences of hazards and related disasters. In this stage, the disaster management is engaged in such activities as intend to avoid the occurrence of disasters. Though not all disasters can be avoided, such planning can be made by disaster management to avoid the loss of life. Disaster preparedness is the second essential stage of disaster management. In this stage, activities like the acquisition and processing of knowledge from related entities and development of capabilities to efficiently anticipate, respond to, and recover from, the influences of possible, visible, or current hazard events (Akter & Wamba, 2019). The third stage of disaster management is the disaster response or relief, which is providing urgent services and public aid during or immediately after a disaster to save lives, minimize health influences, ensure public safety and accomplish the
needs of the people affected like rescue, relocation, provision of water and food, provision of health care, etc. The last stage is disaster recovery. After the initial crisis is over, it often continues to be weak. Disaster recovery includes rebuilding infrastructure, health care, and rehabilitation, development activities, and policies or practices to avoid situations in the future (Seaberg, Devine, & Zhuang, 2017).

There are several factors that assist disaster management organizations, volunteers, and authorities in the different stages, like prevention, preparedness, response, and recovery. The aim of this study is to examine the influences of coordination and cooperation among different authorities, volunteers, and the organization, spatial data infrastructure, and decision making on disaster management in Pakistan. Pakistan is a developing country where some natural and man-made disasters have been occurred and have disturbed the environment, society, and economy at the same time (Shah, Ye, Abid, Khan, & Amir, 2018). Since 1935, many times, Earthquakes / Tsunami, floods have occurred in several areas of Pakistan. Pakistan is the most seismically active country in the world, as it is crossed by major faults. As a result, earthquakes in Pakistan occur frequently and are destructive. The flood occurs in Pakistan almost every, and sometimes it is most severe. These floods occur due to many reasons; river overflows, heavy rains, strong winds, tides in coastal areas, ice-melting, and dam breakage. There is high temperature in Pakistan, sometimes it goes to the highest peak, and it damages the health of the people, causes ice-melting, tropical cyclones, tornadoes, and drought (Shah et al., 2019). Besides these, industrial activities also cause pollution, like the use of non-renewable energy causes greenhouse gas emission. Disaster management is active in Pakistan. National Disaster Management Act, 2010 was passed by the Parliament of Pakistan in 2010. It was sanctioned by the president in December 2010. This act is applicable to all areas, including tribal areas of FATA. It has strengthened the disaster management system. National Disaster Management Authority (NDMA) is an independent, constitutionally established federal authority mandated to deal with the whole of disasters and to manage it to the largest possible extent. It was formed in august 2007, and its head-quarter is in Islamabad. The NDMA forms different disaster policies and enforce them at federal and provincial levels and collaborates with several ministries, military forces, and United Nations organizations to coordinate efforts to conduct its disaster management, search and rescue, several humanitarian operations in the country and abroad (Rehman, Sohaib, Asif, & Pradhan, 2019).

2. Literature Review

Almost in every country, several natural and man-made disasters occur, though in different degrees. These disasters create much havoc in the country, especially in developing countries where financial sources are weak, and technologies are of high quality. These disasters can be overcome with proper management of all matters related to disasters in the country. Almost all the countries have a special disaster management act and disaster management authority that deals with the whole of the catastrophes and try to overcome them to the largest possible extent. This authority forms disaster policies and enforces them to overcome the havoc created by these disasters (Ahmad & Afzal, 2019). It has several stages to handle disasters like disaster prevention, preparedness, response, and recovery. It takes necessary steps at all stages to minimize the adverse impacts of disasters on human health, physical resources, infrastructure, and the environment. Several factors, such as decision making, coordination among several private and government organizations, spatial data infrastructure, and information systems, affect disaster management within the country. Several studies have addressed these factors and their contribution to the effectiveness of disaster management (Azhar, Malik, & Muzaffar, 2019). Our study cites from past literature to explain its
Coordination and cooperation among the different authorities, volunteers, and humanitarian organizations are useful to disaster management in some specific region or area (Nawaz et al., 2020). Coordination among the authorities and organizations makes it possible to share knowledge about different technologies and ways how to prevent the occurrence of natural and man-made disasters, such as the knowledge to control the temperature within the country, which may cause ice-melting and floods (Menya & K’Akumu, 2016). The coordination among different private and government sectors at local, provincial, national and international level makes it possible to share the different strategies and policies which are helpful to develop capabilities in organizations, communities, and individuals especially those which are near the expected point of disaster to be prepared to face the sudden occurrence of disasters so that they can fight against the occurrence of disasters and minimize the adverse impacts of these events. The coordination among the government organizations and humanitarian agencies within a country or among different countries enables the sharing of aids in the form of services and resources in the areas which are hit by some disasters (Nawaz et al., 2021). It helps the disaster management authority not only to respond to the disaster but also to enable them to recover from the damages (Martin, Nolte, & Vitolo, 2016). Thus, **H1**: Coordination is linked with disaster management in a positive manner.

Spatial data is the geographical data, the data of some location or area and related characteristics which is useful in anticipation of some disaster, identifying its causes, and find out the ways how to save human health, natural resources, and other infrastructure. Spatial data infrastructure is the data infrastructure applying a structure of geographic data, other related data, users, and instruments that are interactively linked to use spatial data in a flexible and effective way to mitigate, prepare for, respond to and recover from the natural or man-made disasters (Giuliani et al., 2017). Spatial data infrastructure is an attempt aimed at providing an environment where a large variety of users can produce, access, retrieve, and share spatial data and related information in an easy and secure way. It allows the circulation of geographical information, which is extremely useful in disaster management as it helps in saving resources, time, and efforts that could be utilized in giving attention to the necessary activities to save the environment, infrastructure, and human beings from the adverse impacts of disasters. The access and sharing of spatial data and related information is helpful in decision-making at the different stages of disaster management (Akter & Wamba, 2019). Based on the above discussion, we can hypothesize: **H2**: Spatial data infrastructure is linked with disaster management in a positive manner.

Decision-making is very significant in disaster management as it is needed all in all activities in disaster management before, during, and after a destructive event (Papathoma-Köhle, Cristofari, Wenk, & Fuchs, 2019). In disaster management, decision-making is an activity whose purpose is to reduce the adverse consequences of a disaster, whether it is a natural disaster or a man-made disaster. The disaster situations where the disaster management authority and all the stakeholders make the right decisions at the right time, the negative impacts of the disaster can be reduced. While if ineffective decisions are made in a serious catastrophic situation where immediate actions are needed to be taken, it may lead to great losses (human losses, environmental destruction, infrastructure losses, etc.). The act of making the right decisions at the time of formulating disaster management policies would be helpful in controlling the occurrence of disasters or reducing the negative impacts of the disaster afterward (Horita, de Albuquerque, Marchezini, & Mendiondo, 2017). The effective decision to use communication channels among different regions or countries to
collaborate with different government and private organizations results in the sharing of information or resources with the affected areas. Where an earthquake occurs, the decision to shut off utilities, and vacate the building if it becomes necessary, is helpful in saving human beings. But, a wrong decision at this time may result in loss of life (Horita et al., 2017). Hence:

**H3:** Decision-making is linked with disaster management in a positive manner.

An effective information system is very helpful in building collaboration with the desired authorities, organization, communities, or individuals, implementation of spatial data infrastructure, and decision-making, and thus, in the overall disaster management by particular disaster management authorities. When there is used effective information technology, including computers and digital plate-forms to collect, access, store, share, and process information (Sun et al., 2020), it becomes easy for disaster management to perform different activities to prevent disaster occurrence, to make different organizations and communities ready to face any disaster and response to and recover from the disaster (Alamdar, Kalantari, & Rajabifard, 2017). An effective information system helps build collaboration between organizations, humanitarian agencies, communities, and individuals, which is essential to save resources, infrastructure, and human health in times of disaster. An effective information system makes it easy to adopt a good quality spatial data infrastructure which is helpful in finding the hazards and removing the effects of these hazards. Similarly, at all the stages of disaster management like prevention, preparedness, response, and recovery, several decisions are made. For the right decision-making, exact and adequate information is needed, which is possible under an effective information system (Beydoun, Dascalu, Dominey-Howes, & Sheehan, 2018).

**H4:** Information system is a moderator between coordination and disaster management.

**H5:** Information system is a moderator between spatial data infrastructure and disaster management.

**H6:** Information system is a moderator between decision-making and disaster management.

### 3. Research Methods

This study investigates the impact of coordination, decision making, and special data infrastructure on disaster management and also examines the moderating role of information system among the nexus of coordination, decision making, special data infrastructure, and disaster management in Pakistan. This research has followed the quantitative data collection methods and used questionnaires for this purpose. The officials that are linked with disaster management in the country are the respondents of the study. The purposive sampling has been followed by the study to select the respondents and distributed the surveys to them by personal visit. A total of 490 questionnaires were sent, but only 280 were returned and used for analysis representing about 57.14 percent response rate.

This study also executed the smart-PLS to investigates the relationships between understudy variables and also test the discriminant and convergent validity. This research has adopted the smart-PLS due to the complex framework, and also hypotheses testing is the purpose of the research (Hair Jr, Babin, & Krey, 2017). This research has taken disaster management (DSM) as the predictive variable that has four items, and information system (IS) has been taken as the moderating variable with five items. In addition, three independent variables have been used, such as coordination (CO) with five items, decision making (DM) with three items, and special data infrastructure (SDI) with four items. These constructs are shown in Figure 2.
4. Findings

This study has examined the correlation among the items that are known as convergent validity. The statistics have been highlighted that the Alpha and CR values are not smaller than 0.70, and loadings and AVE values are not lower than 0.50. These values are indicated a high correlation between items and valid convergent validity. These values are highlighted in Table 1.

Table 1: Convergent Validity

| Constructs                  | Items | Loadings | Alpha | CR   | AVE  |
|-----------------------------|-------|----------|-------|------|------|
| Coordination                | CO1   | 0.834    | 0.863 | 0.899| 0.642|
|                             | CO2   | 0.739    |       |      |      |
|                             | CO3   | 0.804    |       |      |      |
|                             | CO4   | 0.787    |       |      |      |
|                             | CO5   | 0.839    |       |      |      |
| Decision Making             | DM1   | 0.848    | 0.775 | 0.821| 0.606|
|                             | DM2   | 0.760    |       |      |      |
|                             | DM3   | 0.721    |       |      |      |
| Disaster Management         | DSM2  | 0.778    | 0.827 | 0.898| 0.747|
|                             | DSM3  | 0.912    |       |      |      |
|                             | DSM4  | 0.897    |       |      |      |
| Information System          | IS1   | 0.874    | 0.890 | 0.924| 0.752|
|                             | IS2   | 0.812    |       |      |      |
|                             | IS3   | 0.904    |       |      |      |
|                             | IS5   | 0.876    |       |      |      |
| Special Data Infrastructure | SDI1  | 0.792    | 0.773 | 0.803| 0.511|
|                             | SDI2  | 0.513    |       |      |      |
|                             | SDI3  | 0.746    |       |      |      |
|                             | SDI4  | 0.773    |       |      |      |
discriminant validity. The statistics have been highlighted that the Heterotrait Monotrait (HTMT) ratios are not higher than 0.85. These values are indicated a low correlation between variables and valid discriminant validity. These values are highlighted in Table 2.

Table 2: Discriminant Validity

|     | CO  | DM  | DSM | IS  | SDI |
|-----|-----|-----|-----|-----|-----|
| CO  |     | 0.557 |     |     |     |
| DM  | 0.745 |     | 0.691 |     |     |
| DSM | 0.691 | 0.623 |     |     |     |
| IS  | 0.595 | 0.611 | 0.623 |     |     |
| SDI | 0.665 | 0.697 | 0.700 | 0.689 |     |

Figure 3: Measurement Model Assessment

Finally, the findings section also highlighted the relationships among the variables by using path analysis. The results indicated that coordination, decision making, and special data infrastructure have a positive association with disaster management in Pakistan and accept H1, H2, and H3. The findings also indicated that information system moderates among the links of decision making, special data infrastructure, and disaster management in Pakistan and accept H5 and H6. However, the findings also indicated that information system insignificantly moderates among the
links of coordination and disaster management in Pakistan and reject H4. These relationships have been highlighted in Table 3.

Table 3: Path Analysis

| Relationships | Beta  | S.D. | T Statistics | P Values | L.L. | U.L. |
|---------------|-------|------|--------------|----------|------|------|
| CO -> DSM     | 0.396 | 0.034| 11.541       | 0.000    | 0.336| 0.470|
| CO*IS -> DSM  | -0.031| 0.039| 0.782        | 0.436    | -0.109| 0.047|
| DM -> DSM     | 0.231 | 0.033| 6.989        | 0.000    | 0.163| 0.295|
| DM*IS -> DSM  | 0.064 | 0.030| 2.103        | 0.038    | 0.011| 0.126|
| SDI -> DSM    | 0.122 | 0.030| 4.014        | 0.000    | 0.074| 0.178|
| SDI*IS -> DSM | -0.086| 0.036| 2.431        | 0.017    | -0.147| -0.017|

Figure 4: Structural Model Assessment
Figure 5: CO*IS

Figure 6: DM*IS

Figure 7: SDI*IS
5. Discussions and Implications

The study results have revealed that the coordination among different private and government authorities has a positive relationship with disaster management. The study implies that disaster management performs efficiently and shows effective results in avoiding the risks and minimizing the negative impacts of all sorts of disasters. These results are in line with the past study of Yanmaz, Yahyanejad, Rinner, Hellwagner, and Bettstetter (2018), with shows that the coordination in the disaster management among private and public sectors and organizations at the local, provincial, national, and international level are necessary and vital to avoid the negative impacts of any disaster on the health of living beings, natural resources, all sorts of infrastructure, and buildings and fields. The study results have also revealed that the spatial data infrastructure has a positive relationship with the performance of disaster management. The study describes that the spatial data infrastructure enables the sharing and usage of geographical information (location and other related information) and thus, helps the disaster management to take essential steps to anticipate, and avoid the occurrence of disasters, evaluate the losses caused by the disasters, and reduces their adverse impacts. These results are in line with the past study of Coleman, Rajabifard, and Kolodziej (2016), which reveals that spatial data infrastructure is the structure of strategies, institutional arrangements, data, technologies, and people that enable the sharing of geographical information and its effective usage. This study concludes that the spatial data infrastructure is very useful in implementing disaster management practices and achieving its goals.

The study results have also indicated that decision-making is linked with the effectiveness of disaster management in a positive manner. These results are supported by the past study of Simões-Marques and Figueira (2018), which states that decision-making is a significant act in disaster management as it appears in all management functions before, during, and after the occurrence of the disaster. The study results have also revealed that the information system is not an effective moderator between coordination among different private and government sectors in the time of disaster and the performance of disaster management. These results are in line with the past study of Inan, Beydoun, and Pradhan (2018), which suggests that the effective coordination among the different authorities and private entities or among different countries become weak in case they have an effective information system. In this situation, disaster management practices cannot better be implemented. The study results have also shown that the information system is a significant moderator between the spatial data infrastructure and disaster management. These results are supported by the past study of Haworth (2018), which shows that an effective information system improves both the spatial data infrastructure and the performance of disaster management. Moreover, the study results have shown that the information system plays a significant moderating role between decision making and disaster management. These results are in line with the past study of Alamdar, Kalantari, and Rajabifard (2016), which shows that the effective information system assists the relevant authorities and the general people in the time of the disaster, which will be helpful in making strategies and their implementation by the disaster management.

The current study makes both theoretical and empirical implications. It has great theoretical significance because of the large amount of contribution into the literature on the environment, society, and economic protection. This study talks about the performance of disaster management in overcoming all sorts of disasters. In this regard, it deals with the three factors contributing to the effectiveness of disaster management, and these factors are coordination among different people, organizations, and authorities, the effective implementation of spatial data infrastructure, and effective decision. This study contributes to the literature with an introduction of information
systems as a moderator between coordination, spatial data infrastructure, and decision making. This study has a great significance in practical life as it guides all the responsible authorities on how to control the situation in case a country has to face a natural, man-made, complex, or any other disaster. A disaster and its negative impacts can be overcome through constant and effective coordination and cooperation between government or private authorities, volunteers, or humanitarian agencies, the implementation of spatial data infrastructure, and the right decision making in the time of need.

6. Conclusion and Limitations

The focus of our study is on the performance of disaster management in controlling the adverse impacts of disasters. The study examines the influences of three factors like coordination, spatial data infrastructure, and decision-making on the performance of disaster management. The coordination among the volunteers, government organizations, and humanitarian agencies in sharing knowledge and resources will be helpful to disaster management in dealing with any catastrophic event. Similarly, the implementation of spatial data infrastructure improves the performance of disaster management. In order to control the disasters and remove their adverse impacts effectively as soon as possible, the sharing and usage of geographical information are needed, which is possible under the adequate spatial data infrastructure. Decision-making is vital to disaster management in undertaking all the activities at different stages, mitigation, preparedness, response, and recovery. Effective decision-making improves the performance of disaster management organizations. The study also elaborates that the effective information system within the country is very helpful to disaster management. An effective information system improves the coordination and cooperation between several authorities, makes effective the spatial data infrastructure, and improves the decision making, which further improves the performance of disaster management.

Just like many other studies, the current study bears several limitations that must be given serious attention and removed in the future. Firstly, for this study, the quantitative data related to disasters and the performance of disaster management has been collected from a single source. Thus, the data may be unable to cover all aspects needed and lose comprehensiveness. It is recommended to scholars in the future to collect data for their study from multiple sources. Moreover, the author has analyzed the disaster control and performance of disaster management in Pakistan, which is a developing lower-middle-income country whose financial sources are lower than and geographical characteristics are different from some developed countries. Thus, the study based on the statistics from a developing country cannot be equally valid in the developed countries. So, the scholars in the future must also analyze the influences of coordination, spatial data infrastructure, and decision making on disaster management performance both in developing and developing countries for better validity.

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