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The Roles of Technology Compatibility and Relational Boundary on the Performance of Rescue Frontliners

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Abstract
Purpose: This paper examines the relationship between technology compatibility, relational boundary, and rescue frontliners' performance.
Design/methodology/approach: The quantitative method was used to achieve the research objectives. This study was done on selected search and rescue teams in Malaysia, and data were collected from 100 team members.
Findings: Technology compatibility and relational boundary were found to have a significant relationship with rescue frontliners' performance.
Research limitations/implications: First, the quantitative method used unable the researchers to explore beyond the variables tested. Thus, exhaust understanding could be limited, particularly in enhancing the voice of the frontliners on the team performance. Secondly, the study collected responses from a single SAR team in Malaysia. Thus, the findings could not be generalized to other SAR teams.
Practical implications: The findings of this study provide practical implications for the rescue frontliners in Malaysia in terms of knowledge regarding the relationship between technology compatibility, relational boundary, and rescue frontliners' performance. Team selection should always be based on appropriate knowledge and skills, creating a higher sense of empowerment among team members.
Originality/value: The study on rescue frontliners' performance is uniquely fascinating, where a practical framework based on these criteria can be developed and thus will be useful as a guideline in the context of rescue frontliners.

Keywords: team performance, rescue frontliners, technology compatibility, relational boundary.

Introduction

Rescue frontliners are the first responders who attend incidents as it happens. They bring hope to the victims, and with their skills and urgency, search and rescue missions can be successful. Heggie (2008) refers to search and rescue as an operation commenced by emergency services to find individuals believed to be in distress, ill or injured, and possibly lost in remote areas or areas that are difficult to access. SAR operation is generally coordinated by a rescue coordination centre using available personnel and facilities to locate persons in distress, retrieve them, provide for their initial medical needs, and transport them to a safer place (ICAO, 2004). SAR operations' standards cover the personnel, equipment, and procedures relevant to the performance of search and rescue (SAR) operations. Amyan (2016) revealed a statistically significant effect of training on the SAR team's performance, highlighting the importance of well-designed training programs to enhance its performance. Berawi et al. (2019) suggested that several decision-making models are applied in disaster management to ensure efficient SAR personnel operations, especially those regarding emergency resource allocations. According to Kleiner et al. (2005), effective communication and team coordination are critical during the rescue mission to minimize damage. Unnecessary, unqualified SAR team members, or deployment of too many teams, resulted in a burden on the task (Okita & Shaw, 2020).

In Malaysia, the central coordinator of SAR is the Malaysian Emergency Response Services (MERS), which is an integrated system that combines five emergency services comprising the Royal Malaysian Police (PDRM), the Fire and Rescue Department of Malaysia (FRDM), the Ministry of Health (MOH), the Malaysian Maritime Enforcement Agency (MMEA), and the Department of Civil Defence of Malaysia (JPAM). The agencies are coordinated in an Information Communication Technology (ICT) platform to handle and transmit emergency calls and information through a 999 number. In most situations, FRDM acts as the recipient of emergency information (MAMPU, 2020).

The performance of SAR teams is dependent on many factors, including but not limited to team communication, leadership, team motivation, team trust, technological compatibility, and relational boundary. This paper will examine the roles of technology compatibility and relational boundary on the performance of rescue frontliners.

Literature Review

Frontliners' Performance and Technology Compatibility

In today's contemporary world, technology usage is a common practice in many social organizations. With rampant innovation, technology offers benefits to reduce human mistakes and help expedite the work processes (Liu et al., 2017). However, rescue frontliners, such as SAR teams, cannot adopt just any technology since technology incompatibility might increase the operation risk. Technology compatibility refers to a team's belief in technology's usefulness, user-friendliness, and awareness of the risk underlying usage (Sijabat, 2020; Bélanger & Carter, 2012). Traditionally, SAR teams use simple technology such as cameras, listening devices, and even search dogs' services to locate victims (Ko & Lau, 2009). All of this simple technology has its limitations. For example, the efficacy of the camera and search dogs is only within 4 to 6 meters.

The idea of using robotic technology in SAR operations was enacted in the 1980s but was only realized in the 1990s. The main aim is simple, to assist SAR operations and reduce casualties from both victims and rescuers. The adoption of technology into the operation usually depends on a few criteria, such as usefulness (Anouze & Alamro, 2019; Humbani & Wiese, 2019); user-friendly (Sijabat, 2020; Hubert et al., 2019; Camilleri, 2019); efficacy to achieve operation's goals (Humbani & Wiese, 2019; Hubert et al., 2019); and quick information transfer to the team (Mozaffari et al., 2017).

Besides, technology such as rescue robots has become a popular innovation in the SAR field. Engineers have initiated many designs that could work in a natural or human-made disaster. Designs that save rescue time by avoiding being trapped in rubbles and brief analysis of the situation are beneficial for SAR teams (Liu et al., 2017). In another situation, a technology that can track and communicate with the victims would help SAR teams to plan the rescue operation more effectively (Półka et al., 2017). The technology employed an app in mobile phones to locate victims, reducing SAR costs and saving lives without compromising the first responder's services' integrity and security.

In a harsh environment, the visualization of the affected area is essential in SAR planning. According to Ko and Lau (2009), the construction of a disaster area visualization could be done using a robot that equips with a system that generates maps and can explore without the explicit need for communication. It helps the rescue team envision the rescue location and prepare the necessities. Another latest invention is unmanned SAR, a partnership between humans and robots in a rescue operation (De Cubber et al., 2017). One of the benefits of this command and control equipment is that robotic SAR would assist the human SAR team by giving a better view of the disaster situation, which is impractical for the human SAR. Unmanned SAR could be in the form of a drone giving a birds-eye-view to the location and increasing situational awareness to the team. According to the author, the unmanned SAR can gather accurate data, economic, quick operation, thus increasing the victims' survival. However, in many circumstances, its usage is limited in deciding to use this type of tool. For example, the operation usually has limited autonomy and self-sustainability and insufficient support and training available for the end-users.

Heat and remote sensing detection are also famous inventions for SAR technology. Ko and Lau (2009) suggested that victims' discovery can be undertaken with a heat sensor of their body temperature using a wireless sensor network prototyping system for tracking mobile SAR robots. Meanwhile, Zhao et al. (2017) posit that the SAR robot system equipped with remote sensing of the underground can help in a coal mine environment. With the explosion and waterproof function, the robot can collect data in the environment using a remote control. It sends an alarm warning to the rescuers when it detects danger, potentially protecting the SAR team.

Frontliners' Performance and Relational Boundary

Relational boundary is "the combination of agencies and other agencies joining together for interdependent problem solving that focuses on improving services to the public" (Duggan, 2011). In short, it is the relationship between the team with other teams, units, departments, organizations, and cultural sub-groups. Sometimes, relational networks can cause teams to create members based on experience, knowledge, working style, and motivation. SAR operations and emergency preparedness involve activities that organizations will carry out; therefore, a clear organizational framework is essential to accomplish the process.

The other term which is equally important to know is Emergency Medical Services (EMS), also known as ambulance services (including cars, motorcycles, boats, and aircraft) or paramedic services. EMS is a public safety system responsible for the pre-hospital stabilization and transport of seriously injured patients. Such systems aim to respond adequately to population calls by providing first aid services and transferring patients to the appropriate hospital's emergency department. Various tools (e.g., simulation, mathematical programming, and team performance framework) have improved EMS performance. EMS organizations may substantially vary between different countries and geographic regions, and one can identify a typical scheme common to most such systems. Hence, EMS operations typically consist of: (1) "Central operations" that aim at providing phone support and deciding the proper response for each call and (2) "External operations" that aim at performing adequate pre-hospital care to patients.

The coordination between agencies and relevant counterparts in SAR operations is vital in ensuring the success of a mission. Not only will coordination increase the probability of mission success, but it will also enhance the utilization of resources in rescue operations. The inter-agency networking will magnify rescue efforts via effective decision-making and interdependency between units and departments (Duggan, 2011). More often than not, the joint effort between units and agencies will optimize frontliners' time and energy.

Relational boundary also reflects on the effectiveness of teamwork in handling rescue missions. Bardach (2001) suggested that there are four categories of relational boundary; networking, cooperation, partnership, and collaboration. These categories are significant to the success of operations via the interdependence and team working of the units and agencies. When the teams' objectives are gathered, solid, and well-directed, performance behaviors will increase, increasing the chances of mission success.

The Roles of Technology Compatibility and Relational Boundary on the Performance of Rescue Frontliners Research Model

Figure 1 depicts the model of this study. The model suggests that technology compatibility and relational boundary play an essential role in the performance of rescue frontliners. Berawi et al. (2019) asserted that technology assists in two ways; (1) to assist teams in detecting victims of a disaster by creating a system that enables rescue teams to locate them when they are trapped, and (2) to help rescue teams to determine the location and amplitude of an incident in real-time in order to increase the chances of life. Besides that, many studies have been done to purport the importance of technology in team operations. For instance, Kleiner et al. (2005) and Huo, Dong, Lu, Xu, and Yuen (2018) suggested that the use of technology complemented human efforts in search and rescue missions, especially in hostile and dangerous conditions.

Figure 1: The Performance of Rescue Frontliners Model

Besides technology, inter-unit collaboration is also essential in ensuring the success of rescue operations. Cooperation and networking between teams, departments, organizations, and agencies are crucial in the critical times of life and death (Huo et al., 2018). In SAR operations, partnerships between various divisions happen when FRDM units such as HAZMAT, STORM, K9, PPDA, and ERMS combine efforts in mission handling. Rescue operations also involve inter-agencies synchronization (such as the Royal Malaysia Police (PDRM). Malaysian Armed

Forces (ATM), People's Volunteer Corps (RELA), Malaysia Civil Defence Force (APM), and other non-government agencies) (JBPM, 2021).
Based on the notion mentioned above, this study predicts that technology compatibility and relational boundary will have a significant relationship with rescue frontliners' team performance.

Method

The quantitative method was used to achieve the objectives of this study. This study was done on selected search and rescue teams in Malaysia, where data were collected from 100 SAR team members. Self-administered questionnaires were distributed to team leaders and their respective members in a non-fixed setting.
This research used the purposive sampling technique. This technique was selected to focus on the target group, i.e., frontliners' teams that carry out SAR missions.

Measurements

Team performance consisted of 14 items and was adapted from Morgeson et al. (2005). The technology compatibility scale consisted of 6 items and was adapted from Riopella et al. (2003). Meanwhile, the relational boundary scale was adapted from Duggan (2011) and consisted of 10 items. The reliability of each measurement is listed in Table 1.

Table 1: Reliability Analysis of Research Instruments

Instruments	Reliability	Source
Team performance	0.91	Morgeson et al. (2005)
Technology compatibility	0.77	Riopelle et al. (2003)
Relational boundary	0.76	Duggan (2011)

Findings

Data analysis, respondents' demographics, and descriptive data such as percentages and frequencies were analyzed using the Statistical Package for Social Sciences (SPSS) Version 26 software for Windows. For more in-depth analysis and hypothesis testing, data in this research was analyzed using the Structural Equation Modelling (SEM) technique using partial least square analysis by SmartPLS Version 3 (Ringle et al., 2005). The model's strength was also evaluated via R^2 and Q^2 statistics (Cohen 1988; Chin 1998).

Demographic Profile

Most respondents were between 31-40 years old and represented 41.0% of the total number of team members. This was followed by members within the age range 20 to 30 years old, representing 35.0% of the total number of team members. Following this were team members aged 41 to 50, representing 16.0% of the total number of respondents. Finally, 8% were team members aged 51 to 60. The majority of the team members were male, 99.0% of the total number. Meanwhile, only 1.0% of the team members were female. Most of the team members were Malays, 92.0% out of the total, and the other races amounted to only 8.0%.

Assessment of the Measurement Model

To assess the measurement model, the convergent validity was first examined. The examination included indicator loadings, average variance extracted (AVE), and composite reliability (CR). Based on the results presented in Table 1, most outer loadings of each construct were accepted at above 0.50, as suggested by Fornell and Larcker (1981). The AVE of each construct exceeds the 0.50 cut-off value as recommended by Fornell and Larcker (1981) and supported by Hair, Hult, Ringle, and Sarstedt (2016). The items used for technology compatibility, relational boundary, and performance had an acceptable level of convergent validity.

Table 2: Outer Loading Values, Composite Reliability (CR), and Average Variance Extracted (AVE) of Technology, Relational Boundary, and Rescue Frontliners Performance

Construct	CR	AVE
Technology compatibility	0.869	0.528
Relational boundary	0.948	0.651
Rescue frontliners performance	0.963	0.655

Following the examination of convergent validity, the discriminant validity of the measurement model was tested. Discriminant validity was examined to ensure that each construct was unique and different from the others. Hence, the variables could measure what was intended. The discriminant validity was established by examining the correlation among the constructs. It was found that each construct was smaller than its AVE square rooted. Table 3 presents these values. The square root values of AVE are presented in the diagonal. Besides, cross-loading of each indicator was examined to ensure that the loading of each indicator was the highest for the constructs.

Table 3: Correlation Values for Technology, Relational Boundary, and Rescue Frontliners Performance.

	Technology	Relational boundary	Rescue frontliners performance
Technology	0.726		
Relational boundary	0.638	0.807	
Rescue frontliners performance	0.610	0.701	0.809

Hypothesis Testing

The relationships between the independent variables (exogenous variables) and the dependent variables (endogenous variables) were determined. Table 4 exhibits the path coefficient values between the independent variables and dependent variables. The nonparametric bootstrapping method was used to test the path coefficients for significance. In SmartPLS Version 3, T-values come with P-value. $T > 1.96$ is equivalent to $P < 0.05$. T-values were acquired and are presented in Table 3. Technology and relational boundary had a significant positive relationship with rescue frontliners performance even though T-value = 2.581 and 6.303 so $T < 1.96$, but this is significant because P-value= 0.010 and 0.000, $P<0.05$. Thus, hypothesis 1 and 2 was supported.

Table 4: Path Coefficient for Technology Relational Boundary and Rescue Frontliners Performance

Relationship	T-value	P-value
Technology → Rescue frontliners performance	2.581	0.010
Relational boundary → Rescue frontliners performance	6.303	0.000

Discussion and Conclusion

This paper examines the relationship between technology compatibility, relational boundary, and rescue frontliners' performance. Based on the findings, there is a significant relationship between technology compatibility, relational boundaries, and rescue frontliners performance. In this context, the SAR team is well-known for its high alertness and fast rescue action. Their rescue mission often competes with time where the first 72-hour is critical to ensure the lives can be saved. Despite their knowledge of rescue and tactical skills, technological usage is acknowledged to help them in the rescue mission. Technology is a tool to assist their rescue mission, and the confidence of using the tools in everyday work occurs when the technology has proven its usefulness (Choi et al., 2010). Such confidence would increase the technology compatibility in the SAR team. For example, Mozaffari et al. (2017) highlighted that communication technology had assisted the team leader in giving fast and accurate instructions to the team on the site. This fast communication conveyed is crucial, where the risk to the team members could be minimized. It boosts team motivation that leads to team performance (Gabrielle, 2003). According to Humbani and Wiese (2019), technological compatibility leads to team performance where trust in technology prevails. On the same note, technology adopted that are user-friendly, easy to operate, and high advanced invention are qualities that described technology compatibility (Sijabat, 2020; Camilleri, 2019; Huo et al., 2018).

Working with diverse rescue groups would be a competitive advantage of the SAR team (Sulaiman et al., 2019). In the SAR context, this relational boundary would be a successful collaboration when the teams have clear job roles, accountability, active information sharing, and a shared understanding of the situation (Shoaf et al., 2014; Eide et al., 2013). This newly formed structure would expedite the planning and decision making, thus speed up the rescue mission (Amyan , 2016). This resulted in a rise in team performance.

The study has several limitations. First, the quantitative method used unable the researchers to explore beyond the variables tested. Thus, exhaust understanding could be limited, particularly in enhancing the voice of the frontliners on the team performance. Secondly, the study collected responses from a single SAR team in Malaysia. Thus, the findings could not be generalized to other SAR teams.

This study suggested few recommendations on the government and other stakeholders. The results have significant evidence on the vitality of the investment in the technology, where it is proven to enhance the search and rescue mission. Training should be undertaken periodically consistent with the changes in technology. Secondly, the collaboration between other SAR agencies determines by mutual relationships and mission goals, besides developing a structure that each agency agreed. A fair and just reward system should be given to all agencies involved in keeping the motivation high and performance.

In a nutshell, the study had proven that the frontliners' performance, particularly the SAR team, could be enhanced by technological compatibility and relational boundary. Both variables are identified to mutually reinforce the team's performance that offers assistance in smoothing the rescue mission.

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