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Research Article

Command and control system management: a perspective of disaster response actors in Brazil

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Abstract

Paper aims: This paper analyzes Command and Control (C2) Systems and identifies the level of knowledge on the subject by actors involved in disaster response operations in Brazil, besides assessing the evolution in this area since the disaster of the Serrana Region of Rio de Janeiro in 2011.

Originality: The concept of C2 is still little explored academically, especially in disaster management systems. This study contributes to the understanding of the dynamics of different C2 Systems operated in Brazil, as well as identifying the level of knowledge on the subject and its evolution since 2011.

Research method: This is an exploratory survey in which data was analyzed using descriptive statistics techniques.

Main findings: We conclude that the actors involved in real disaster situations have little formal training in C2. The findings indicate that the performance of a simulated exercise helps in disaster preparedness, but the participants observed deficiencies concerning C2 training besides the lack of local community involvement in the simulated exercise.

Implications for theory and practice: This study contributes to the disaster management literature, showing empirical evidence that the results obtained in a simulated exercise can boost the specialization of professionals in C2 systems in the area of disasters.

Keywords

Command and control. Command and control systems. System management. Disaster response.

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1. Introduction

Between 2000 and 2019, 7,348 disasters were recorded worldwide, affecting more than 4 billion people and accumulating economic losses of approximately 2.97 trillion dollars. Such numbers show an increase in registered events compared to 1980-1999 (Mizutori & Guha-Sapir, 2020). In 2020, such losses totaled 171.3 billion dollars (Mizutori & Guha-Sapir, 2020), and the forecast is that, by 2050, this cost will reach 300 billion dollars per year (Lavell, 2003). The scenario is no different in Brazil: between 1991 and 2012, there were 38,996 natural disasters. In this context, humanitarian operations gained prominence due to their essential role in disaster response (Thomas, 2003).

Disaster response operations are multidisciplinary and involve both public and private sectors, besides the society (Akhtar et al., 2012). Consequently, coordinating these stakeholders with different profiles, cultures, interests, and methodologies is critical (Fontainha et al., 2017; Khodarahmi, 2009; Lettieri et al., 2009). In sudden-onset disasters, such as earthquakes and tornadoes, the lack of coordination causes many actors to compete to access scarce resources. The duplication of efforts becomes a constant, leading to a loss of process efficiency (Tomasini & Van Wassenhove, 2009).

Furthermore, the absence of a single coordination system to synchronize and integrate humanitarian activities and efforts is the cause of most conflicts between organizations/ agencies in the post-disaster period (Thomas, 2003; Tomasini & Van Wassenhove, 2009). Although different actors and operational sectors have specific response processes aligned with each agency's competencies, skills, and attitudes, some procedures are standard and need to be coordinated (Oliveira, 2010; Brasil, 2014).

In an effort to manage stakeholders and mitigate possible conflicts, the command and control (C2) system is now recognized as a mean of mobilizing, organizing, and managing the various actors (Alkire et al., 2018) to integrate roles, rules, responsibilities, and authorities in disaster response tasks (Tomasini & Van Wassenhove, 2009). Such system enables coordination between issuing orders and guidelines, as well as obtaining information on the evolution of the situation and its actions (Brasil, 2014), allowing thus decision-making on time and assertively. Thereby, the definition of a C2 structure and its dissemination among the actors involved in disaster response contributes to the operation's coordination, especially in the response phase.

In this context, this paper assesses Operations Command Systems (OCS) and the disaster management systems used by the main disaster response actors in Brazil. They follow the orientations and guidelines of the Brazilian Ministry of National Integration through the National Civil Defense (NCD).

Furthermore, through a survey research carried out during the Joint Exercise in Support of Civil Defense (ECADEC), we identify the level of knowledge about C2 by the main stakeholders working in disaster response operations in Brazil. We assess the evolution of C2 in disaster response operations in Brazil since the mega disaster in the Serrana Region of Rio de Janeiro in 2011, considered the greatest natural disaster in Brazil's recent history and a milestone in risk and disaster management policies in Brazil.

After this introductory section, Section 2 presents the theoretical foundation of the research on the concepts of C2 and OCS, focusing on the case of Brazil. Section 3 describes the research methodology. Section 4 brings the research results. Finally, Section 5 highlights the conclusions and future research directions.

2. Theoretical foundation

This section presents the command and control system (C2) concepts and the operation command systems (OCS) in Brazil.

2.1. Command and Control (C2) and Operations Command System (OCS)

The concept of C2 has military origins, being widely discussed after the Korean War, in the 1980s, under the definition that command and control is the exercise of authority and direction by a duly appointed commander over an assigned and linked forces in carrying out a mission (Brehmer, 2005). The most used definition, presented by Alkire et al. (2018), considers C2 as a mean of synchronization and integration for the Armed Forces' activities to support information, communication, and detection technologies to achieve better results with the least possible effort. This definition of C2, integrated into the Boyd Cycle, Boyd (1987) or OODA (Observation, Orientation, Decision, and Action), is the most accepted and dominant among the military and disaster response institutions by the Member States of the United Nations (Brehmer, 2005; Warden III, 1995).

C2 systems aim to structure an operation processing model, emphasizing decision-making processes (Zambrano et al., 2017). Given the need for rapid mobilization and the organization of multiple actors in disaster response, centralized coordination becomes highly effective. Hence a C2 system can be of great relevance at this stage of the operation. Tomasini & Van Wassenhove (2009) consider that, due to the high pressure and intensity of tasks in disaster response, using C2 in such situations can favor benefits, efficiency, and speed of response in serving beneficiaries.

Each central stage of the disaster cycle (acceleration, sustain, and deceleration) requires a type of coordination based on the objectives and stakeholders involved (Tomasini & Van Wassenhove, 2009). In acceleration, a stage characterized by critical time and urgent need to remove bottlenecks, coordination by command is necessary. That is a centralized approach in which a coordinator gathers resources, tasks, and information, generating solutions

implemented by individual agencies. The next stage, sustainment, is characterized as a phase of intervention in a concessional environment, in which respective agencies must sign off on acceptable coordination solutions. Hence this stage requires coordination by consensus when organizations have access to compatible or shared communication equipment, liaison meetings between agencies, and pre-mission assessments. The last stage, deceleration, involves collecting and disseminating information through frequent contact among stakeholders, requiring light coordination, so-called because of its hands-off nature (Tomasini & Van Wassenhove, 2009). Figure 1 shows each stage and its proper coordination. Therefore, we conclude that in the humanitarian context of disaster response, C2 must be integrated into the life cycle of the disaster to meet the unique needs of each specific coordination.

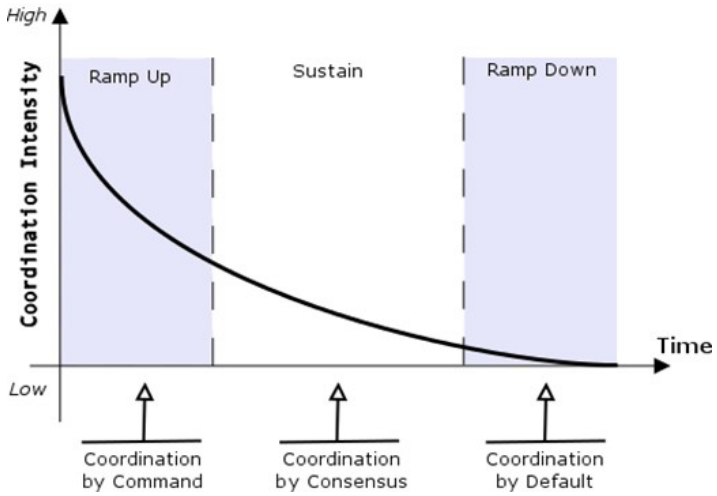

Figure 1. Life cycle of coordination. Source: Adapted from Tomasini & Van Wassenhove (2009).

In Brazil, C2 is considered a command chain process in three components: legitimately invested authority, systematic decision-making process, and response structure (Brasil, 2007). This concept assesses the exercise of authority and coordination that the leaders must exercise over those under their subordination in carrying out an activity or task (Oliveira, 2010; Brasil, 2014). In this context, manuals in Brazil structure the C2 to respond to disasters from command and control systems. A C2 system is a set of facilities, equipment, communications, doctrines, procedures, and personnel essential for the coordinator to plan, direct and control the response actions to achieve a particular purpose (Brasil, 2007).

The most used C2 systems in Brazil are (i) Incident Command Systems (ICS), adopted in the Federal District; (ii) Military Command and Control Doctrine (MD31-M-03), employed by the Armed Forces; (iii) Operational Command and Control System (OCCS), an operations management tool, proposed by the Ministry of Justice, National Secretariat of Public Security, focusing on the performance of the Military Firefighter and currently employed by the Military Fire Department of the State of Rio de Janeiro; (iv) Public Health Emergency Operations Center (PHEOC), adopted by the National Health Surveillance Secretariat; and (v) Operations Command System (OCS) (Brasil, 2007; Oliveira, 2010), adopted by the National Civil Defense (NCD) as the standard system for responding to emergencies and critical situations, structuring the organization, and managing disasters. Section 2.2 compares the essential characteristics of Brazil's five command and control systems based on the OCS.

2.2. Comparative analysis between OCS and other command systems in Brazil

The OCS is a management tool that aims to train, plan, organize, direct, and control acting groups in response actions, that is, relief and humanitarian assistance to disaster victims, mainly when aid is provided by multiple agencies, jurisdictions, or teams (Oliveira, 2010). It allows users to adopt an integrated organizational structure with different actors to face the demands of a critical situation without prejudice to their competencies.

The primary characteristics of the OCS are (i) standardization of conduct; (ii) command of operations; (iii) planning and organization; (iv) facilities, access areas, and logistical resources; (v) information management; and (vi) professionalism (Oliveira, 2010). Adapted from Oliveira (2010), Table 1 compares the essential characteristics of the OCS of five command and control systems adopted in Brazil.

Table 1. Basic OCS features and organizational structure of command systems in Brazil (Adapted from Oliveira, 2010).

OCS features	OCS	ICS	OCCS	PHEOC	MD31-M-03
Standardization of conducts	Common Terminology	x		x	
	Standardized forms		x		
Operations command	Formal transfer of command			x	
	Chain and Command Unit	x			x
	Single or unified command	x	x		
Planning and organization	Modular and flexible organization	x	x	x	x
	Administration by objectives			x	
	Use of action plans	x	x	x	
	Adequate range of control	x	x	x	x
Facilities, access areas, and logistical resources	Standardized facilities and areas	x			
	Integrated resource management	x	x		x
Information management	Integrated communications management	x		x	x
	Integrated information and intelligence management		x	x	x
Professionalism	Personnel control				
	Mobilization/demobilization control		x		
Basic organizational structure					
Command	Single				
	Unified				
Staff/ command advisory	Safety	x	x		x
	Connection	x	x		
	Public information	x	x		
	Secretary				
General Staff	Operations	x		x	x
	Planning	x	x	x	
	Logistics	x	x	x	x
	Administration/finance	x	x	x	x

The standardization of conduct facilitates communication among people and organizations involved in operations through common terminology and standardized forms. It favors the recording of information, consolidation of action plans, and documentation of the event. These factors help in consolidating the command chain and unity. It is observed, through Table 1, that the use of common terminology also occurs in the ICS and PHEOC, while the adoption of standardized standards is only used in the OCCS.

Regarding operations command, only the OCS and PHEOC adopt the formal transfer of command. However, the absence of an operations command has severe consequences. It can lead to duplication of tasks since there is no proper knowledge of the activities carried out by other agencies. This fact is aggravated when several agencies participate in managing an event individually instead of adopting a unified command.

As for planning and organization, Table 1 shows that modular and flexible organizations, adequate to the range of control, are adopted by all analyzed systems. The modular and flexible organization allows the structure to be expanded according to the needs. In this way, there is no unnecessary application of human and material resources, adopting contingent logistics. However, administration by objectives (ABO) is adopted only by the PHEOC and the OCS. According to Oliveira (2010), this administration model makes it possible to convert common objectives and goals into specific and individualized goals to achieve common/collective priorities. Uniquely, the ABO can be defined as a form of administration that aims to relate collective/ organizational goals with the individual capacity of its actors.

Regarding the standardization of facilities and access areas and logistical resources, these features only appear in the OCS and ICS, doctrines which guide that the facilities and access areas must be well signposted in safe places. Names and symbols should be used commonly to identify them. The lack of knowledge of the standardization of these structures makes teams' performance difficult and may even put the actors involved in disaster response operations at risk of death.

In turn, integrated communications management is differentiated by the magnitude of the disaster. However, whatever the dimension of the event, internal and external information must be disclosed. Regarding inside information, lack of data accuracy can lead to unnecessary use of resources and risks. On the other hand, communication to the external public can even lead to panic and new disasters when it is not made clear. We highlight that 40% of the systems presented in Table 1 do not have communications integration guidelines, and 20% do not have instructions for integrating information and intelligence.

From these comparisons, we conclude there is a lack of standardization between the analyzed systems. Of these systems, the one that most resembles the OCS in terms of basic characteristics is the ICS with 60% similarity - followed by OCCS and PHEOC, with 53% similar activities. The MD31-M-03 has only 33% of similar activities to the OCS. Among the basic activities proposed by the OCS, only the single or unified command and the adequate range of area are common to the five systems. A critical point is the lack of standardization of forms, facilities, and areas and demobilization. Personnel control is only practiced by the OCS, and it is unclear whether this control of actors corresponds to professionals working in the response phase or to disaster victims.

Table 1 also presents the basic organizational structure of the OCS, which is formed by: (i) command, (ii) command staff, and (iii) general staff. It is observed that the logistics and administration/finance staff are represented in all studied command systems. Again, the ICS is the system that most resembles the OCS in its organizational structure, with 70% similarities. Despite being based on the OCS, PHEOC has a 40% similarity in its administrative structure. Likewise, MD31-M-03 administratively resembles the OCS in only 40% of its core functions. From the above, joint action will be weakened in its organizational structure, favoring the duplication of activities in a scenario of scarce resources.

3. Research methodology

This research aims to compare the OCS adopted by the National Civil Defense (NCD) to the forms of command and control systems practiced by the main disaster response actors in Brazil and identify the level of knowledge about C2 professionals working in these organizations. In addition, we place the evolution in C2 since the disaster in the Serrana Region in the State of Rio de Janeiro in 2011.

Therefore, we conduct an exploratory survey to understand how Brazil's main disaster response actors understand and operate command and control systems. In this way, it was possible to know how these collaborators recognize the response organization as an essential link in the C2 chain, understand how information is synchronized in C2, and understand how the organization should act on a chain of C2. Therefore, this research assesses how actors perceive the usefulness of C2 in post-disaster response operations, their level of knowledge of the command chain management process, and how they interact in the command chain.

ECADEC, the unit of analysis selected for this research, was organized in August 2017 by the Ministry of Defense (MD) and the Ministry of National Integration together with the Armed Forces to provide integration and joint training to all agencies of the National Civil Defense System in support operations to civil defense in Brazil. It took place in Petrópolis, State of Rio de Janeiro, and was attended by 100 participants, representatives of the Defense Ministry (DM), Ministry of National Integration (MI), Ministry of Health, National Center for Risk and Disaster Management, Brazilian Navy (BN), Brazilian Army (BA), Brazilian Air Force (BAF), National Civil Defense, State Civil Defense (Rio de Janeiro, São Paulo, and Minas Gerais), and County Civil Defense (Nova Friburgo, Petrópolis, and Teresópolis), State Health Department of Rio de Janeiro, Civil and Military Police of the State of Rio de Janeiro, São Paulo, Minas Gerais, and Santa Catarina, Military Fire Department of the State of Rio de Janeiro (MFDSRJ) and Minas Gerais, Operational Superintendence of Civil Defense of the State of Rio de Janeiro, School of Civil Defense, Rio de Janeiro Geological Service, Health Secretariat of Teresópolis and Petrópolis, Brazilian Red Cross, Rio de Janeiro State Red Cross, and Brazilian League of Emergency Radio.

For the interviews, the population of the ECADEC participants (170) was selected, and only those who voluntarily accepted were included in the sample. The final survey sample is composed of 51 respondents. The survey considers primary data sources, with data collected directly from the questionnaires applied during ECADEC (Appendix 1). The collection instrument adopted in the research consists of 25 questions (19 closed and 6 opened questions), structured in three blocks: (i) characterization of the target audience (5 closed and 3 opened questions); (ii) general knowledge about C2 (9 closed and 2 opened questions); and (iii) identification of C2 in the Serrana Region disaster in 2011 and its evolution since then (5 closed and 1 opened questions). The inclusion of this third block was motivated by the fact that ECADEC is structured from the Scenario Simulation. In 2017, the simulation was based on the disaster that occurred in the Serrana Region.

A pilot study allowed us to identify and eliminate potential problems and improve the research instrument, testing the content of the questions, statements, sequence, format, and layout, the difficulty of questions and instructions (Malhotra, 2001). Since the development of the research instrument is conducted in this study, which is exploratory, construct and criterion validity cannot be assessed. We then analyzed the apparent and content validity of the research instruments, verifying understanding of questions and closeness of the vocabulary with that of the respondents. The instrument was initially validated by three academics from the humanitarian logistics area and one from the disaster management area. In a second stage, a questionnaire was distributed to five military personnel with experience in disaster response operations who answered the questionnaire.

The researchers pointed out doubts and made suggestions regarding its apparent form and content. Furthermore, the instrument's reliability was tested using Cronbach's Alpha for the two main blocks of the questionnaire:(i) general knowledge about C2 (0,72); (ii) identification of C2 in the Serrana Region disaster in 2011 and its evolution since then (0,75) (Hair Junior et al. 1998).

Data were collected through face-to-face interviews during ECADEC and consolidated and organized with the Minitab software version 17.1.0. Answers to open questions were tabulated with Excel and content analysis was used to assess them. Coding for this type of answers was defined a posteriori.

4. Data analysis and discussions

This section presents the results and discussions comparing actors' understanding of C2 and the OCS.

4.1. Respondents' Profile

Among the 51 respondents, 10 are female, aged between 33 and 58 years, and 41 are male, aged between 29 and 65. Respondents were from 16 different organizations, considering civilians, military, health sector, and Civil Defense, with the number of participants per organization being less than four employees.

The sample consisted of police, firefighters, and Armed Forces officers (Brazilian Army, Brazilian Navy, and Brazilian Air Force), with 19 respondents of the 51 interviewees. However, the absence of participation of members of the local community in the simulated exercise was observed, which is considered an opportunity for improvement since the first response in disasters, in most cases, is given by community members until the arrival of government agencies (Bealt & Mansouri, 2018).

4.2. General knowledge about Command and Control (C2) and Operations Command System (OCS)

Prior knowledge of contingency plans and disaster preparedness is a significant differential to improve the efficiency of the response. For this, everyone involved must be aware of their respective roles and forms of action, reinforcing the need for the continuous organization of simulated exercises and participation in C2 courses. However, 90% of respondents participated for the first time in a joint interagency exercise, and only 8% had previously participated in C2 training in their organization.

In addition, 41% of respondents were unable to answer which C2 system their organization adopts. Of the respondents, 21% reported using the OCS and 14% the ICS. Another 12% reported using their C2 system, and 2% said they adopt military command and control doctrine. Furthermore, in a universe of 17 Armed Forces members (AF), only one could identify that the C2 system adopted by the AF is MD-30-M-01. Thus far from being a consensus, the C2 theme presents divergences and a lack of knowledge among the actors involved in disaster response operations, highlighting the need for alignment between the theme in the different agencies.

The number of respondents who do not have training in C2 (76.46%) is much higher than the number of people who have training in C2 (23.54%); of the 51 respondents, only 20 respondents (39.22%) have worked in at least one disaster response operation and, of these, 75% have no knowledge or training in C2.

When stratified only respondents who have at least one experience in disasters with participation in joint exercises (39.22%), we observe that 30% were participating for the first time in a joint exercise, 40% had already experienced in the last two years, 15% in the previous three years and 10% participated in at least one exercise three years ago or more.

In summary, we conclude that people who work directly in response to disasters do not receive proper C2 training. This inference is confirmed by analyzing responses from those who have worked in at least one disaster and their training in C2 through Pearson's linear correlation. The result of Pearson's correlation (correlation equal to 0.258 and P-value = 0.067) indicates that the existence of a relationship between participation in at least one disaster and training in C2 is extremely low or almost non-existent. Consequently, there is a need to provide more training and encourage the participation of these actors in exercises and simulations, such as ECADEC. The participation of civilians should also be encouraged, since every respondent agrees on the importance of their participation in disaster response operations. Civil Defense, government institutions, health workers and NGOs were the civil organizations most cited among respondents.

4.3 Perception of the evolution of C2 after the disaster in the Serrana Region in 2011

Respondents who acted on the response operation to the 2011 floods in the Serrana Region and also participated in the ECADEC were further interviewed to identify their perception on the evolution of C2 since the disaster.

Among the organizations participating in ECADEC, it is noted that MFDSRJ and NCD are the government institutions with the most considerable number of people that participated in the disaster response actions in the Serrana Region and with training in C2 (66.7% interviewees) (Figure 2), which makes it possible to question the evolution of C2 in the country since the disaster.

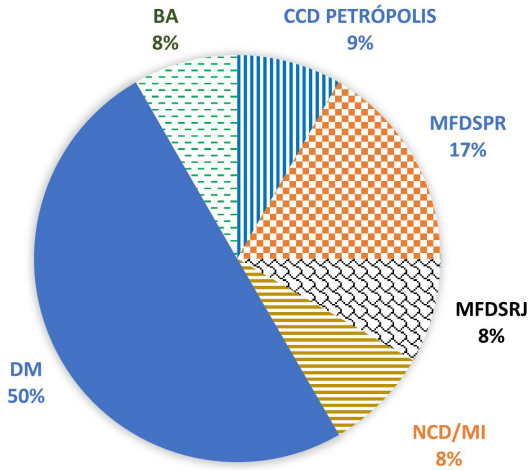

Figure 2. Percentage of participants by agencies trained in C2 who acted in the 2011 disaster. Source: The authors.

When respondents were asked whether they observed improvements in the different functions of the OCS (Table 1), 26% of respondents stated that they perceived improvement in terms of operational planning; 15% about the connection with other agencies and concerning the command of the operation; 11% were optimistic about improvements regarding the disclosure of information to the public and the safety of the operation; while 7% reported gains in the logistical process and the performance of the operation, in general.

After questioning the observation of improvement in the distinct functions of the OCS, each respondent rated, on a 1 to 5 Likert scale (with 1 being extremely negative and 5 being extremely positive), the current level of performance of their respective agency concerning acting in the disaster in the Serrana Region in 2011 (Figure 3). It was observed that, in general, there was a positive perception by the interviewees.

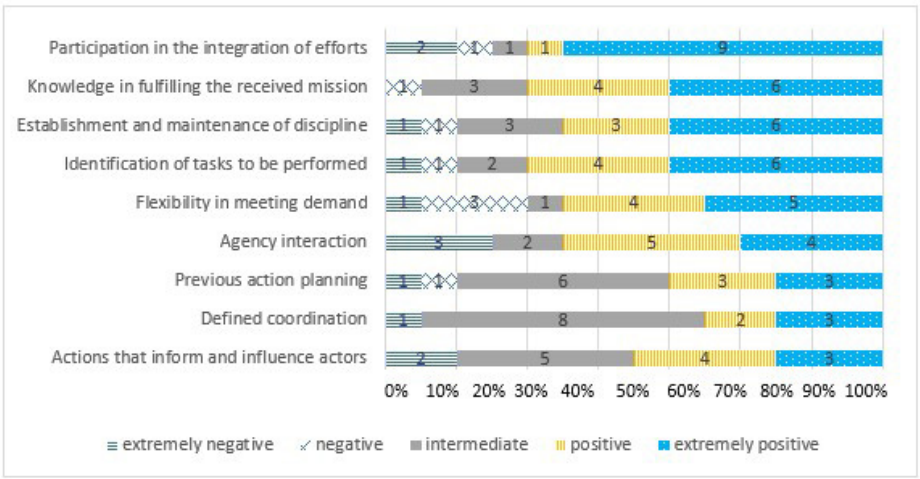

Figure 3. Agencies' performance level compared to the performance in the 2011 disaster.

According to 64.2% of respondents, the effort between agencies has improved in their organizations since the 2011 disaster and it has become more positive, pointing to the effectiveness of joint exercises (such as ECADEC) and training. Respondents also emphasize the importance of knowing their attributions, the way to carry them out, and the maintenance of discipline. For Rajib Shaw et al. (2011), continuous education in disaster care is the best way to achieve dynamic and orderly assistance in real disaster situations. In addition, the flexibility to meet demand stands out as a positive point, where flexibility is C2's ability to modify its organization and functionality to meet constantly changing needs (Brasil, 2015).

In this context, an overall assessment for ECADEC was asked for the interviewees at the end of the questionnaire. Among the most frequent statements, respondents point out the need for a broad C2 discussion and for sharing positive and negative experiences from each agency in previous disaster response operations. Respondents rated the concept and form of coordination of the joint exercise as "intermediate", with 21% of respondents indicating that ECADEC was "very positive". It is noteworthy that the integration between civilians and the military should be encouraged. However, in ECADEC, it was noticed that the number of civilians was quite reduced.

4.4. Discussion

From the survey, we conclude that the number of government agencies that participated in the simulated exercise was significant, representing reality with proportionality and equity. However, it is still possible to increase the integration between the civil and governmental segments in training and joint exercises. One suggested way is to empower local authorities through standards and funding to coordinate with civil society, communities, and indigenous and migrants in disaster risk management at the local level, as indicated by the UN (2015) in the Sendai Framework.

The organizations involved in ECADEC had the opportunity to apply their capabilities and test procedural protocols for assistance to victims and damage control in the event of disasters. Actions were integrated and supported by a simulation software developed by the Brazilian Armed Forces. However, of the 51 respondents, only 7.8% set in the ECADEC the same function in which they worked in the 2011 disaster in the Serrana Region, thus losing learning continuity. The unanimity of actors who acted in the 2011 disaster and who were at ECADEC reported improvements in disaster management and attributed gains to increased investment in Civil Defense, as well as increased training, joint exercises, and the creation of legislation nº 12.608 of April 10, 2012, which makes explicit the municipal obligation to carry out simulated exercises regularly.

During the interviews and data stratification, we could observe that people still have little knowledge and understanding of C2. Thus, we conclude that the leading disaster response agencies in the country have significant gaps in training and capacity building in C2, with few agencies training and participating in joint and integration exercises. It is known that the development of agencies in C2 goes far beyond joint exercises, and, as such, it is essential to develop public programs that generate skills for professionals at the end of the response.

Moreover, the female presence at ECADEC was negligible. However, it is essential to note that the 2015 Sendai Framework suggests a broader, people-centered approach to preventing disaster risks. Disaster risk reduction practices need to be multi-sectoral and oriented towards various hazards and must be inclusive and accessible if they are efficient and effective. Recognizing their leading, regulating, and coordinating role, governments should involve stakeholders, including women, children and youth, people with disabilities, poor people, migrants, indigenous, volunteers, health professionals, and the elderly, in policy design and implementation, plans, and standards (UN, 2015). Therefore, the intensification of women's integration in Brazilian joint training and exercises is suggested. As for public and security policies, it is emphasized that women comply with evacuation protocols with more determination than men (West & Orr, 2007).

5. Conclusion

This paper discusses C2, a research topic little-explored academically in disaster management systems. The absence of a single coordination system to synchronize and integrate humanitarian activities and efforts is the cause of most conflicts between organizations in the post-disaster period. So, this research contributes to the disaster management literature by empirically analyzing how agencies respond to disasters in Brazil using different C2 systems.

We conclude that Brazil has various command and control systems with diverse definitions, terminologies, and protocols without integration. In this sense, intervention is necessary to establish an adequate method of material screening, standardization, and appropriate criteria to create a single response system applicable to any disaster. At this point, several opportunities arise for using Organizational Management tools and integrating academia with the National Civil Defense Coordination.

ECADEC demonstrates the importance of integrating the various systems of the command chain by providing the agencies involved with the opportunity to apply their capabilities and test procedural protocols for victim care and damage control in a disaster. The number of government agencies that participated in the simulated exercise was significant. However, civil society representatives were not involved in the simulation, which suggests an opportunity to improve the integration between civilians and government agencies through joint training and exercises, in addition to the creation of public policies for integration, including the participation of women, since the low presence of this segment was observed.

The actions in ECADEC were integrated and used simulation software to support the decision-making process. Some agencies had difficulties following the simulated exercises due to a lack of knowledge or limited knowledge of the procedures and basic response protocols used during the activities.

The absence of C2 training programs in Brazil stands out, given the difficulty of respondents in defining and explaining the various C2 activities in the post-disaster. Continuous education is required in disaster response operations as the best way to achieve dynamic and orderly assistance in disaster situations, as suggested by Rajib Shaw et al. (2011). It is noteworthy that the knowledge produced by community members at risk is essential in planning actions in Civil Defense and Protection. In this sense, it is necessary to intervene nationwide with mandatory C2 training programs for government agencies, private initiatives, and communities. Finally, this paper confirms that the level of knowledge about C2 by the leading agencies in Brazil that work in disaster response operations is low and has not evolved much in integration since the mega disaster in the Serrana Region of Rio de Janeiro.

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Appendix 1. User profile of the command and control system.

QUESTIONNAIRE – ECADEC

SECTION 1 – CHARACTERIZATION OF THE TARGET AUDIENCE

1. In which organization do you work on? _____

2. Gender: () Male () Female () Rather not say

3. Age: _____

4. In how many humanitarian operations have you ever worked on?

( ) No previous experience

( ) 1

( ) 2

( ) 3

( ) 4

( ) > 5

5. In how many joint interagency exercises have you ever taken part in?

( ) No previous experience

( ) 1

( ) 2

( ) 3

( ) 4

( ) > 5

6. Do you have any previous training in Command and Control (C2) system?

( ) Yes ( ) No

7. In which activity will you take a part in the ECADEC joint interagency exercise?

Command		
Staff/ command advisory	Safety	
	Connection	
	Public information	
	Secretary	
General Staff	Operations	
	Planning	
	Logistics	
	Administration/finance	

SECTION 2 - GENERAL KNOWLEDGE ABOUT C2

8. Which C2 system does your organization adopt?

( ) Incident Command Systems (ICS)

( ) Military Command and Control Doctrine (MD31-M-03)

( ) Operational Command and Control System (OCCS)

( ) Public Health Emergency Operations Center (PHEOC)

( ) Operations Command System (OCS)

( ) I cannot indicate which system is adopted.

9. Can you differentiate/identify a cold, hot and warm zone?

( ) Yes ( ) No

10. How many employees do you have under your direct supervision? _____

11. What is the maximum number of employees that one can have under his/her direct supervision according to C2?

( ) Up to 7.

( ) Up to 10.

( ) Up to 15.

( ) Up to 20.

( ) There is no limitation.

( ) I cannot tell.

12. Civilians should act in disaster management?

( ) Yes ( ) No

13. If you answered Yes to question 12, which civilians do you believe that should act in disaster management?

_____

_____

14. If you answered Yes to question 12, why do you believe civilians should act in disaster management?

_____

_____

15. Do you clearly understand all the roles that must be performed in a disaster response operation according to the C2 system?

( ) Yes ( ) No

16. What may cause confusion in the operability of the C2 system?

( ) Not knowing the command chain

( ) Not being confident of the role to be performed

( ) Not having all roles clearly defined/explained

( ) Not having the required technical knowledge.

17. Does your organization have capacity the capacity to act continuously?

( ) Yes ( ) No

18. In the case of a joint interagency operation, how is the command defined?

( ) The highest ranking officer coordinates the operation.

( ) Each agency has one coordinator, so the operation has multiple coordinators.

( )The person with the greatest technical capacity coordinates the operation.

19. In your organization is there someone responsible to provide information to the population and to the media?

( ) Yes ( ) No

SECTION 3 - C2IN THE SERRANA REGION DISASTER IN 2011 AND ITS EVOLUTION SINCE THEN

20. Have you taken part in the response operation to the Serrana Region Disaster in 2011?

( ) Yes ( ) No

21. If you answered Yes to question 18, in which moment after the disaster stroked did you work on?

( ) First 24 h

( ) First 48 h

( ) First week

( ) Second week

( ) First month

( ) After the first month

22. Regarding a disaster response operation, since 2011, you can observe improvements in the:

Operational planning ( ) Yes ( ) No ( ) I cannot tell.

Connection with other agencies ( ) Yes ( ) No ( ) I cannot tell.

Command of the operation ( ) Yes ( ) No ( ) I cannot tell.

Disclosure of information to the public ( ) Yes ( ) No ( ) I cannot tell.

Safety of the operation ( ) Yes ( ) No ( ) I cannot tell.

Logistical process ( ) Yes ( ) No ( ) I cannot tell.

Performance ( ) Yes ( ) No ( ) I cannot tell.

23. Considering you experience in the 2011 disaster response operation and in the ECADEC exercise, in a 1 to 5 scale (with 1 being extremely negative and 5 being extremely positive) do you agree that there were improvements regarding:

Participation in the integration of efforts ( ) 1 ( )2 ( )3 ( )4 ( )5

Knowledge in fulling the received mission ( ) 1 ( )2 ( )3 ( )4 ( )5

Establishment and maintenance of discipline ( ) 1 ( )2 ( )3 ( )4 ( )5

Identification of tasks to be performed ( ) 1 ( )2 ( )3 ( )4 ( )5

Flexibility in meeting demand ( ) 1 ( )2 ( )3 ( )4 ( )5

Agency interaction ( ) 1 ( )2 ( )3 ( )4 ( )5

Previous action planning ( ) 1 ( )2 ( )3 ( )4 ( )5

Defined coordination ( ) 1 ( )2 ( )3 ( )4 ( )5

Actors that inform and influence actors ( ) 1 ( )2 ( )3 ( )4 ( )5

24. Do you believe that the effort between agencies has improved in your organization since the 2011?

( ) Yes ( ) No

25. If you answered Yes to question 22, to what changes do you attribute such improvements?_____

_____