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ERGONOMICS AND RESILIENCE ENGINEERING IN THE FORMULATION OF GUIDELINES FOR THE SERVICE OF SAMU VESSELS 192

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Abstract

This article presents an application of ergonomics and the Resilience Engineering framework to the formulation of guidelines for regulating the watercraft component of the Mobile Emergency Care Service - SAMU 192 in Brazil. The study was based on an ergonomic analysis conducted in five of the six regional coordination offices of SAMU 192 in the country that offer ambulance boat services authorized by the Ministry of Health. The water ambulance service - called ambulance boats - of SAMU 192 is responsible for providing emergency care to riverside and coastal communities in Brazil. The study is part of a research project whose objective was to evaluate and support the regulation of the SAMU 192 watercraft service. Data collection was carried out in a participatory manner, through semi-structured interviews and work observation. The data collected during the field visits were coded and analyzed using content analysis using an inclusion matrix, with the analysis categories defined based on the theoretical framework of Resilience Engineering. As a result, normative specifications were produced for the implementation and maintenance of the service, grouped by the following themes: composition and training of the vessel and regulation teams, uniforms/PPE of the teams, decentralized waterway base, means of communication, service protocols, biosafety and intersectoral actions in the management of the ambulance boat component, and project specifications. The results of the study provided guidance for the incorporation of the ambulance boat component into the National Emergency Care Policy.

Keywords: Ergonomics. SAMU 192. Resilience Engineering.

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1. INTRODUCTION

The Mobile Emergency Care Service (SAMU 192) was created in 2003 and was made official through Decree No. 5.055, of April 27, 2004, proposing a model of care that was standardized throughout Brazil.

SAMU 192 works by calling the Emergency Regulation Center - CRU, through free telephone dialing, throughout the national territory, to the number 192, the calls are received by the TARM - Medical Regulation Service Technician, who writes down the description of what happened and the patient's health conditions, and then passes it to the regulating doctor who accesses the information and will verify the severity of the case and the need to send or not a USB - Basic Health Unit, without a doctor, or a USA - Advanced Health Unit with the presence of a doctor.

The SAMU 192 vessel modality operates in riverside and coastal areas, and the vessels are called ambulanchas. This type of service faces challenges and peculiarities such as the variability of navigability conditions, the hiring and retention of qualified labor and adverse geographical conditions. The purpose of this article was to use the resilience framework to develop a proposal for the specification of the ambulance service with a focus on the resilient performance of the system.

The use of this approach allowed us to understand the misalignments between demand and capacity in the system, and how the adaptations act in the work-as-performed to fill these misalignments, revealing the focal points for intervention in the system to improve the alignment between capacity and demand, in addition to facilitating necessary adaptations to improve the quality of the service.

Thus, this study sought to describe the dynamics of action in this system, making it possible to understand its functioning and propose regulations that can support the municipalities in the implementation and maintenance of services, as well as an adequate structuring of this component within the urgency and emergency framework already regulated by the Ministry of Health.

This research was approved by the Ethics Committee of the Oswaldo Cruz Institute of the Oswaldo Cruz Foundation and respects the principles established by resolution 466/2012.

2. CONTEXT OF THE RESEARCH

This study is part of a research project whose objective was to evaluate and subsidize the regulation of the SAMU 192 vessel service, responsible for enabling the access of riverside

and coastal communities in Brazil to the Emergency Care Network. To carry out the study, five of the six regional coordinators of SAMU 192 where this service is implemented and enabled by the Ministry of Health were visited: Baía de Ilha Grande, in Rio de Janeiro, Salvador and Bom Jesus da Lapa, in Bahia, Manaus and Alto Solimões, in Amazonas, totaling nine municipalities visited that have SAMU 192 ambulance service currently enabled.

Throughout the research, field visits were carried out with the objective of observing the work and conducting semi-structured interviews, covering a total of 101 participants, including Municipal Health Secretaries, SAMU 192 managers, professionals from the Regulation Centers and vessel teams, as well as professionals and managers from other levels of Health Care with direct interface with the SAMU 192 vessel service. The research comprised about 270 hours of fieldwork carried out over 34 days, in visits to all the municipalities participating in the study. In this way, it was possible to know in detail the functioning of the service processes, as well as the main difficulties and challenges for the teams that work in the operation of the service.

The research was divided into two stages. The first stage involved the diagnosis of the service in different regional coordinators of SAMU 192, covering almost all the municipalities that have the service enabled in the Brazilian territory. In this stage, the characterization of the operation of the service in each regional was carried out, including the production of regional maps of performance as well as the characterization and technical drawings of the vessels in operation.

The second stage addressed the formulation of proposals for the incorporation of the ambulancha component into the National Policy for Emergency Care. At this stage, guidelines were produced for the implementation and maintenance of the service divided by the following themes: composition and training of the vessel and regulation teams, uniforms/PPE of the teams, decentralized waterway base, means of communication, service protocols, biosafety, intersectoral actions in the management of the component, and project specifications for the vessel itself, including technical drawings with minimum guidelines for physical arrangement and standardization spatial.

This study details and presents the results of the second stage of the research. To this end, the project carried out the diagnosis of the main difficulties and challenges in the mobile river emergency care service - SAMU 192 through the analysis of the municipalities that already have this modality of care enabled by the Ministry of Health throughout the national

territory. The method used to evaluate the units in operation was ergonomic analysis, based on observations and semi-structured interviews with key actors and workers.

Figure 1 demonstrates the research effort and the results achieved.

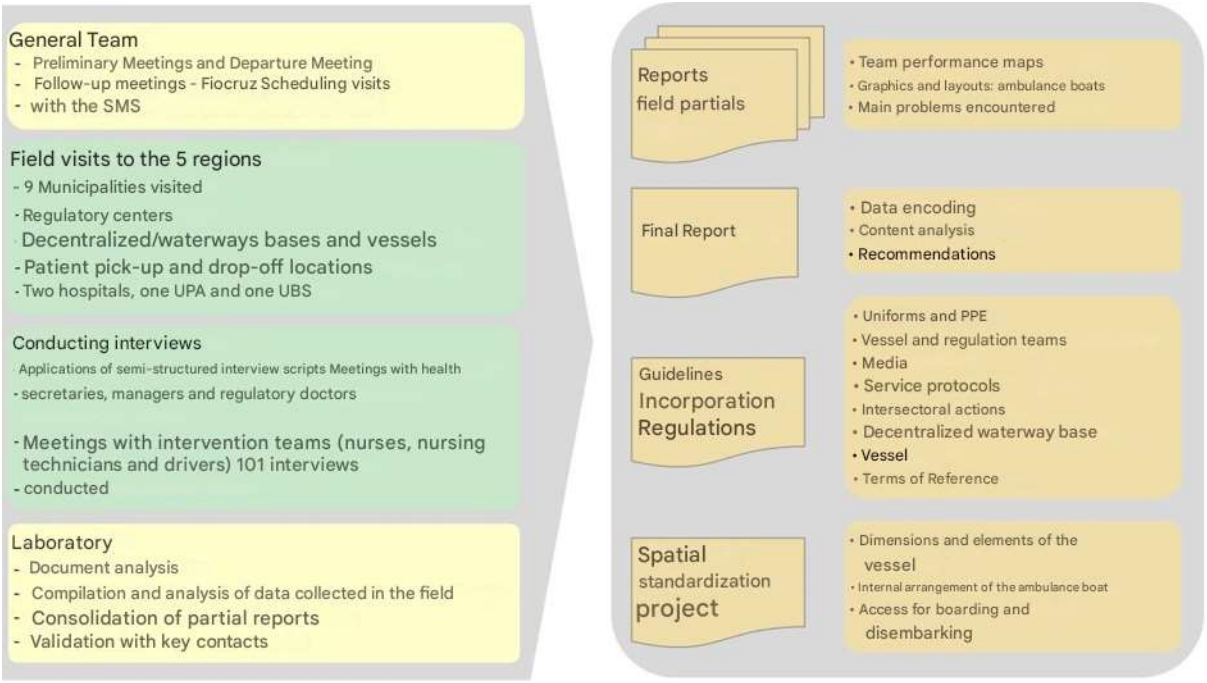

Figure 1. Research effort and productions generated in the Project (Prepared by the authors, 2020)

3. METHOD

The material collected during the field visits was coded in a content analysis, and for this purpose the inclusion matrix tool (MASCUL; VIDAL, 2011), following the content analysis model of Minayo et al. (1994) and Minayo and Costa (2019). Thus, the collected material was worked according to the following steps that make up the method: (1) organization of the analysis material and definition of the unit of record; (2) categorization of discourse elements; (3) contextualization and comprehension highlighting consensus, controversies and contradictions; and (4) final analysis of the results, seeking trends, characteristics and interpretation of the data.

The establishment of the categories sought to obey the principles described by Bailey (1994); Minayo et al. (1994) and Selltiz (1974), highlighting: (a) formalization - uniqueness in the criteria for establishing the categories, allowing for a clear definition of the categories and cohesive rules of inclusion and exclusion; (b) exhaustiveness - comprehensiveness of the

categories on the totality of the elements of discourse to be classified; (c) exclusivity – mutually exclusive categories (maximization of inter-group variance); and (d) homogeneity – categories that are internally as small as possible (minimization of intra-group variance).

The unit of registration within the testimonies was defined as the phrase/clause described by the interviewee. Then, the categories were listed in order to allow the alignment of the analysis with the objective of the present study, also considering that a significant part of the registration units dealt with the alignment or misalignment between the demands imposed on the ambulancha service and the capacity available for its operation. Subsequently, and in line with the theoretical framework of Resilience Engineering, the definition of categories was carried out in two large groups, called Capacity and Demand (ANDERSON; ROSS; JAYE, 2016; DEKKER, 2011, chap. 7), each with a focus question that worked as the only criterion for aggregating their categories. For the Capacity group, the defined focus question was "*What should be the elements to be regulated for the ambulancha component of SAMU 192?*". For the Demanda group, the focus question defined was *"What are the elements that impact SAMU 192 indicators regarding the ambulancha component?*", with the indicators being those applicable to the ambulancha service that are provided for in the National Policy for Emergency Care.

Then, inspired by the Situation-Problem-Improvement (SPM) (MANLY; VIDAL, 2011, chap. 13), a tool was formulated to systematize the findings from the application of the Resilience Engineering framework, identifying crossings in the field data coded in demand and capacity elements and proposing guidelines for the regulation of the ambulancha service as solutions to cope with the misalignments verified. In this way, it was possible to see which pressures incident (demands) on the mobile waterway emergency care system were not well met by which resources were made available for the operation of the system (capacity).

Finally, in order to support the regulation of the waterway component of SAMU 192, proposals for the specifications of the ambulancha service were constructed, seeking to align capacity with demand and facilitate adaptations when necessary. The following section describes the results obtained in this methodological process and summarizes the proposals prepared - originally formulated in the format of normative items - for all elements of the service, with the exception of the vessel itself, since the proposals for it included the preparation of a spatial project, deserving to be detailed in a dedicated article.

4. FINDINGS

During the content analysis, the capacity categories (resources made available to fulfill the system's mission) established were: means of communication; waterway base; service protocols; vessel teams - composition and training; regulation teams - composition and training; uniforms and PPE, vessel acquisition, development or chartering procedure; biosafety; and intersectoral actions. Table 1 details the results, originally presented in the form of normative items.

Table 1. Main categories defined from the registration units and consequent definitions (Prepared by the authors, 2020)

ITEM	SITUATION		MISALIGNMENT OF DEMAND X CAPACITY	SPECIFICATION PROPOSALS FOR AMBULANCHA SERVICE
	ABILITY	DEMAND		
MEDIA	"Blind" navigation for most of the route; total or partial lack of cell phone signal; inoperative operators; radio signal that does not reach the entire route of the expedition	Full communication of the on-board team with the SAMU Regulation, both for the regulation itself and for the reporting of problems or incidents in the expedition and rescue request	Impossibility of conducting regulation during patient care and transport, and of requesting rescue in case of incidents or accidents	Promotion of the installation of signal retransmission antennas; availability of cell phones with chips from all operators for the vessel team; implementation of EPIRB (Emergency position-indicating radio beacons) equipment, to be activated in need of rescue, sending location signal from anywhere to registered central
WATERWAY BASE	Absence or existence of a base without habitability conditions	Presence of the team close to the vessel and in dignified conditions; vessel protected from robberies and thefts; suitable place for disembarking victims and maintenance of ambulancha	Theft of fuel, engine and equipment; loss of time in commuting and expenses with motorcycles and fuel, often paid for by the team itself; difficulties in disembarking victims and in the access and maintenance of the vessel; Team fatigue	Minimum regulation of waterway bases in five rooms plus nautical hangar with lifting system for repairs in dry environment; suggestion of the installation of a joint base with other river teams such as Civil Defense, Fire Department and Special Secretariat for Indigenous Health (SESAI).
ACQUISITION, DEVELOPMENT OR CONTRACTING OF THE VESSEL	Bidding terms prepared locally and without prior guidance or guidelines	Specifications for the vessel and implementation process aligned with the demands and local-regional particularities regarding the operation of the ambulancha service	Underspecified vessel and implementation process with gaps in the necessary expertise, generating difficulties in the operation of services and maintenance of vessels, impacting the provision of service	Formation of a working group to prepare the Terms of Reference of the bids, with the participation of the vessel and regulation teams, managers, vessel maintainer and naval engineer; inclusion of a vessel maintenance plan with definition of maintenance locations, parts forecast and temporary replacement plan for components
SERVICE PROTOCOLS	For the basic life support (BLS) team - without a nurse or doctor on board - medications and many procedures need to be authorized by the Regulation Center; absence of specific protocols such as rescue of the team in case of incidents and the applicant's own displacement	Shortage of doctors and nurses in regional offices far from the capitals, generating a lack of doctors on board; long distances traveled with victims in serious condition without signal to communicate with the regulation; need to reduce response time by meeting requester and team Vessel halfway	In the absence of a communication signal, which can last several hours on an expedition, BLS teams have to decide between acting without legal support or watching the victim's condition worsen; the need for teams to have personal contacts or passing vessels for rescue in case of incidents; Risk of mismatch halfway between applicant and boat crew	Adequacy of the protocols for the performance of basic support teams in regions with proven absence of doctors and scarce communication signal, formalizing procedures such as "pre-regulation" in the prescription of procedures and medications; guidelines for the development of new protocols aimed at rescuing teams and aligning with the particularities of the occurrences attended by ambulanchas.

ITEM	SITUATION		MISALIGNMENT OF DEMAND X CAPACITY	SPECIFICATION PROPOSALS FOR AMBULANCHA SERVICE
	ABILITY	DEMAND		
REGULATION TEAMS - COMPOSITION AND TRAINING	Lack of training aimed at regulating occurrences in riverside and coastal communities; absence of guidelines for the incorporation of professionals in the team with experience as interventionists in the ambulancha component	Need to collect accurate information about the occurrence, given different beaches with identical names, remote and difficult to access places of occurrence, absence of telephone and radio signal, and applicants without mastery of the Portuguese language	Vessel teams without sufficient information to find victims and without "pre-regulation" support for occurrences in places without the possibility of communication with the Regulation Center, opacity of the seriousness of the occurrence to SAMU 192	Training of regulation teams on topics such as: fluvial, maritime and island geography of the region in drought and flood regimes; profile of the communities served and coverage of the health care networks to them; main berthing places for ambulanchas; communication signal coverage; navigation distances and average response time to communities; scenarios for typical occurrences and pre-regulation; linguistic regionalisms
BOAT TEAMS - COMPOSITION AND TRAINING	Multiple arrangements in the composition of the teams between different regional coordinators of SAMU 192, with teams often having only 2 members; limitation in specific training	Need for three people to board a victim; complexification of care due to the nature of occurrences and long time to reach the health unit; need for at least two people for Patient handling and navigation	Dependence on the victim's companions to board the ambulance; need to pause the return trip (which in maritime regions can only be done in clashes) to perform medical procedures; need for nursing technician to stop monitoring the patient to assist in night navigation, or reduction of speed	Addition to the minimum BLS team of a health or seamanship professional, depending on availability for hiring in the region; implementation of intermediate teams, with nurses but no doctors, for regions with a shortage of doctors; bivalent training in seamanship and BLS procedures for all vessel team members
BIOSECURITY	Biosafety guidelines and measures not differentiated from those oriented to the terrestrial component of SAMU 192	Exposure of vessel crews to infection by infectious diseases increased compared to land crews, due to extended periods in contact with victims and companions	Increased risk of infection of boat crews, victims, and companions by infectious-contagious jaguars; large number of absences during the COVID-19 pandemic	Design of a curtain system around the stretchers of the vessels; equipping the vessel with PPE kits for teams, victims and companions; sanitizing benches at the bases; training of vessel teams in the use of PPE, good isolation practices in the expedition and disinfection of the vessel; training of regulation teams in the identification of suspected cases of COVID-19 and other infectious-contagious diseases and in the pre-regulation of pre-Boarding of the victim
INTERSECTORAL ACTIONS	Regional actions of SAMU 192 in management and training with little articulation with municipal and state public agencies such as Primary Health Care, Civil Defense, Federal Agriculture, Firefighters and Municipal Works	Absence of wharves in most of the communities served; inspections of vessels by inspection agencies; occurrences located within riverside and coastal communities; need for articulation with community health agents (CHAs) of the communities	Need to dock on beaches, rocky shores and ravines, often bow, making it difficult to board victims, especially when boarded; increased response time due to ambulancha inspections; difficulty in finding victims and transporting them to the coast in inland occurrences; difficulties in articulating with community health agents	Promotion of partnerships for the installation of floating piers in the communities aiming at greater safety, comfort and speed in the docking and boarding of victims; implementation of communication protocols between the Regulation Center and waterway inspection agencies in order to facilitate and speed up inspections in the ambulancha; encouragement of pacts with health units or community residents' associations to provide land vehicles to help with inland occurrences; Training of CHWs from the communities to support the care of the teams
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5. DISCUSSION

The use of the demand x capacity framework allowed us to identify points of misalignment between these two strands, showing where the system needs to be improved.

The process of acquisition of ambulanchas occurs without any support from the Ministry of Health, so the decentralization of the purchase process does not meet a minimum standardization of specifications for vessels that do not consider either local construction experiences or the supply of parts for maintenance.

As a result, the result is often impaired because vessels, when they suffer damage or need replacement of certain parts, are unable to carry out these repairs quickly, causing the service to stop.

Another crucial point, especially in the Alto Solimões and the São Francisco River, is the issue of the telephone signal, which presents enormous instability and many "blind spots" where the boat teams cannot achieve any type of communication.

In most of the locations visited, the absence of navigation equipment such as sonar, GPS and low-range radio on the vessels also appears as a central problem, which makes the work of the drivers difficult and increases the probability of accidents and hinders the process of rescuing the vessel in case of any damage along the way to carry out the services.

The lack of clarity in the financing of the system by each of the entities that make up the tripartite system, federal, state and municipal, negatively impacts the functioning of the system, as the smaller municipalities end up subject to the influence of the local political game, which sometimes end up interfering negatively with the functioning of the system.

Although there are manuals of standardized procedures for the care of SAMU 192 patients, the lack of standardization of the boat service by the Ministry of Health has led to a diversity in the models of boats and with very different structures that has impacted the operation of the service and the performance of the teams, as there are boats with side boarding, bow and stern, which in some cases add an increase in effort and present difficulties for the boarding of patients by the care teams, offering risks to the teams and to the patient.

The need to implement river bases was highlighted, where the boats can be preserved from theft and vandalism, and where the team can be quickly available to the services in comfort and safety. A partnership was suggested between related entities for the sharing of a common river base, such as SAMU 192, the Fire Department, Civil Defense, the Special Secretariat for Indigenous Health (when applicable) and others, in a study that should be carried out in the future.

Since the arrival of the COVID-19 pandemic in riverside and coastal communities in the country, the operation of ambulancha services has faced unprecedented challenges throughout the national territory. Among these are the sharp increase in the volume of care, the vulnerability of boat teams to infection by the virus – given the prolonged contact with patients and companions, which can reach several hours – and the complexification of the rescue of teams in case of incidents during the expedition. To respond to these challenges, the regional coordinators of SAMU 192 implemented - in accordance with local restrictions - measures such as the use of bubble stretchers, specialized procedures for disinfecting vessels, as recommended by ANVISA, and adequacy in the use of PPE by the vessel teams, as directed by the class councils.

In a complementary manner and in support of such actions, the research formulated specific guidelines to strengthen the service during periods of pandemic and outbreaks of other infectious-contagious diseases, covering elements of the layout of the vessel and the

decentralized waterway base, the training of vessel teams and regulation, and the provision of PPE for teams, victims and companions.

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