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Decision-making strategies used by emergency electricity distribution service operators

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Summary

The operation of an electrical distribution system in control rooms is a task that requires specialized cognitive skills to act in complex environments under dynamic and uncertain conditions. The study aims to analyze the decision-making of operators in the emergency service of an electrical energy distribution system control center, in order to identify components of expertise to generate training interventions. The strategy used to elicit knowledge from expert professionals was the Critical Decision Method (CDM), which makes it possible to understand how decisions are made in challenging and non-routine situations. Four operators were interviewed. The MDC results showed 14 decision points, in which 43% of decisions were intuitive, 43% rule-based and 14% analytical. The unpredictability associated with security risk threats and time pressure makes the activity complex, requiring agility in the decision-making process, which characterizes the naturalistic decision approach. In conclusion, it is observed that the MDC is a valid method to address decision-making strategies by expert professionals in order to develop instructional designs.

Keywords: Critical Decision Method. Decision making. Control Center.

Introduction

Control rooms are places where people carry out monitoring and supervision activities for complex systems. Operators are removed from the real environment and manage the system through displays, sensors and communication channels. Technological advances in electrical systems control rooms have made increasingly available more information with an excessive number of screens, maps and alarms, contributing to increased cognitive demands due to the greater complexity of the work (ALMEIDA; KAPPEL; GOMES, 2007; FRANCISCO; RODRIGUES, 2006). Aspects of the task involve dealing with system perturbations, which require a series of cognitive processes, such as perception, planning, decision making and action control. These are skills that operators need to acquire to become proficient in performing the function (SHEPHERD, 2004). In this sense, cognitive task analysis is a useful approach that can serve for the acquisition and modeling of specific knowledge used by operators at work (PATERNÓ, 2000).

The article presents results from the analysis of the cognitive task, focusing on the decision-making process of operators of an electrical energy distribution system control center. The task analyzed was emergency assistance, a process in which operators manage occurrences in real time with the aim of reestablishing the supply of electricity to consumers. Emergency occurrences are characterized by being unforeseen, unplanned, and can occur at any time or place, and require service recovery in the shortest possible time and in a safe manner (COELCE, 2012). Operators carry out work in the control room, using computer screens, communication systems and specific software, as well as coordinating teams of electricians in the field (GONÇALVES et al., 2014).

The study describes the use of the Critical Decision Method (KLEIN; CALDERWOOD; MACGREGOR, 1989) to examine how operators make decisions when critical situations occur in a real context. We sought to identify components of expertise to support the construction of training scenarios, favoring the development of skills by novice or less experienced operators.

The naturalistic decision approach

The field of study of naturalistic decision making (TDN) addresses decisions that are made in complex natural environments. In real contexts, decisions are not an end in themselves, they are a means to achieve a greater objective. Decisions are inserted into task cycles that consist of defining the problem, understanding which solution is most reasonable, taking action to achieve the objective and evaluating the effects of this action. The success of the decision will depend both on the characteristics of the task and on the knowledge and experience of the decision makers (ORASANU; CONNOLLY, 1992).

TDN implies an intuitive decision style, which differs from analytical decision strategies. The analytical process refers to analyzing the situation, generating several options, evaluating and comparing alternatives, and then choosing the course of action to follow, which requires more time (SIMPSON, 2001). The intuitive process involves low cognitive control, speed in data processing and reduced conscious perception of the process (HAMMOND et al., 1984). The intuitive approach is more appropriate in natural environments (SIMPSON, 2001; KLEIN, 1998).

A TDN model was developed by Klein, Calderwood, and Clinton-Cirocco (1986), called “first option identified decision making” (TDPOI). The model describes that when people need to make decisions, they quickly make associations to identify patterns they have learned. In general, decision makers look for the first functional option they can find, rather than having to create a variety of alternatives to make sure which is the best decision. They imagine carrying out the action through mental simulation to discover weaknesses and how to avoid them, without having to compare several options. These decision strategies appear to be more used than analytical strategies (KLEIN, 1998).

The naturalistic decision approach contributes to changing the conception of human decisions, incorporating advances in cognitive psychology. It broadens the view of the decision process by including previous stages of perception and recognition of situations, while focusing on the knowledge and experience of those who make the decision. It thus provides useful guidance for training in decision-making and cognitive skills (KLEIN, 2008).

Materials and methods

In the research, different methods were used to provide an understanding of the operators' work process, covering on-site observations, document analysis, hierarchical task analysis, SHERPA analysis (systematic approach to reducing and predicting human error) and the Critical Decision Method (MDC).

In this work, the results obtained through the use of MDC, which is based on the critical incident technique to evaluate decision making, will be described. The method was developed to help elicit knowledge about behaviors related to the TDPOI model, that is, decisions that are made based on the recognition of critical information and prior knowledge (KLEIN;

CALDERWOOD; MACGREGOR, 1989). Conducting the MDC interview goes through four stages: (1) identifying incidents, (2) checking the timeline, (3) deepening, and (4) "what if?" questions. At each stage, questions are asked to deepen the report of the incident (CRANDALL; KLEIN; HOFFMAN, 2006)

For the MDC study, four emergency service operators in the electricity distribution network were interviewed. The inclusion criteria were being in the service for at least three years and agreeing to participate in the research. Initially, participants were asked to identify incidents that occurred during the execution of the work that they considered challenging, requiring the use of their skills and knowledge. Then, the interviewer together with the participant chose the incident that had most strongly influenced the decision-making process. Afterwards, the interviewee repeated the report in detail, explaining the context of the situation, background, people involved and other related aspects. Using post-it notes, the interviewer organized the events described in a timeline, identifying decision points, that is, the moment in which there was a change in understanding of the situation or when an action was taken that affected the course of events. events. At the end, the timeline was reviewed and corrections could be made. The next step consisted of using the timeline to delve deeper in order to clarify questions about: objectives, signs, information obtained, decision making, options considered, procedures followed, experience, assessment of the situation, knowledge bases, time pressure and mental models. Afterwards, "what if" questions were asked, examining differences between experienced professionals and novices and points of vulnerability for failure. Finally, the interviews were transcribed and analyzed based on categories.

Results and discussion

The work of operators in emergency service

The task of emergency service operators is to manage unscheduled occurrences to restore the electricity supply. Operators receive reports of incidents and determine measures to be followed by field teams, which are made up of electricians. They check occurrences in the Driving Assistance System (SAC) sent by the Relationship Center (CR). The incident is handled according to the priority level criteria, with the highest priority level involving life-threatening situations. The next step consists of sending a field team to the location of the incident with the aim of carrying out the service of restoring power. Each operator is responsible for a region and coordinates 7 to 11 field teams. The teams are classified according to the type of service they perform, ranging from the simplest (e.g., services on a home extension) to the most specialized (e.g., fixing or replacing poles). Based on the type of incident, the operator defines the team that will be sent to the location. The information is passed on through a computerized system and transmitted online to the teams, who use a tablet or smartphone as a mobile platform. If necessary, the operator can communicate via cell phone or radio with electricians in the field. After completing the service, the incident is finalized in the system.

It is noteworthy that operators manage several occurrences at the same time, with continuous monitoring in a dynamic and uncertain environment. Operations are carried out under strong time pressure resulting both from the need to satisfy consumers and to maintain the safety of the people involved. This context is consistent with complex systems, which are characterized by situations that evolve indefinitely over time, uncertainty in information about the system, number of highly interconnected components and high risk with costs associated with the consequences of decisions taken (WOODS, 1998). Complexity imposes excessive demands on the execution of tasks, putting pressure on the operator (LIMA et al., 2015).

Analysis of MDC results

Four critical incidents were reported. Two incidents were related to a broken cable, one to an interruption in the power supply affecting a large region, and the other to a failure in the operating system. In total, 14 decision points were identified. To analyze decision-making strategies, the model by Flin, Youngson and Yule (2007) was used, which considers four methods: intuitive (based on pattern recognition); rules-based (application of operational procedures); comparison of options (rational or analytical choice); and creative (development of a new course of action). The analyzes showed that 43% of decisions were intuitive, 43% rule-based and 14% analytical. No creative strategy was used in the incidents mentioned, which is also not common in other fields, such as aviation and medical surgery, due to the high time pressure and risk environment (FLIN; YOUNGSON; YULE, 2007).
The emphasis on intuitive or rule-based decision making demonstrates that operators consider only one option at a time (FLIN; YOUNGSON; YULE, 2007), instead of analyzing multiple alternatives. Below are excerpts from the interviewees' statements regarding the decision-making method:

Decision making method	Operator statements
Intuitive	"This kind of situation where you have to make a quick decision" "Because we already live in this rhythm of speeding up and prioritizing things, it's common" "It's an extreme situation, it's not a common thing, but it happens, and you have to make a quick decision"
Rules-based	"And we are already so automated, that the procedure practically comes to our minds, with practice it becomes automatic"
Analytics	"What was decided was the following, we call the supervisor or whoever is on duty and report the situation to him (...) Then we call the supervisor so we can agree what is going to be done."

The analysis of the collected data was divided into three categories: information/signs; assessment of the situation and strategy for resolving the problem.

- Information/signs:

The main source of information to assess the criticality of an occurrence is the record from the CR. If there is no detailed information, doubts may arise about the accuracy of the record or even suspicions regarding the veracity of the seriousness of the occurrence. Failure to trust the information causes the operator to seek to capture more data, whether through the system or other sources, in order to be sure of the course of action to be adopted. This search for additional information, resulting from the uncertainty of information, requires the ability to search for data efficiently to clarify the state of the situation (KLEIN, 1998).
Other valid sources of information are sound signals and communications from the medium and high voltage Control Center, as well as data obtained from the system (e.g., times and location of teams, region of occurrences). In addition, field teams pass on information when they arrive at the incident location, communicating details of the situation to the operator. Teams, therefore, function as the main means of obtaining reliable information to assist in decision making. One of the interviewees explains: "for us to have this correct cable information, the most accurate thing is for the team to go to the location, there is no other way, the team has to go to the location, if not, there is no way for us to know if the cable It's broken or not."

- Assessment of the situation:

The interviewees' reports showed that previous experience was significant for defining the problem and making decisions. An operator explains: "many repeated occurrences add a little more knowledge, but the occurrence that you have never experienced is something new, which in your know-how will give you more experience". For example, one interviewee reported that a critical situation experienced by a teammate that resulted in the death of a passerby influenced the assessment and future projection of possible consequences of the incident. In this case, pattern recognition (KLEIN, 1998) or the existence of mental models – knowledge structures – help to determine relevant information and form expectations about future states (ENDSLEY; BOLTÉ; JONES, 2003).

Another operator described that he assessed the situation as critical because it was not something familiar: "because I felt that this service was going to be different (...) I felt sorry for the situation, because I had never dealt with a case in which the team had refused (to do the job)". A basic aspect of decision making is that experienced people can assess the situation, identifying it as familiar or typical in order to establish the appropriate course of action (KLEIN, 1998).

Time pressure and the criticality of situations also influenced the operators' assessment. In the two incidents of broken electrical cables, operators were concerned about making quick decisions to resolve the problem due to the high risk involved (e.g., shock, death from electrocution). One of the characteristics of naturalistic decisions is that they are taken under time pressure and in circumstances that involve high risk, that is, that involve serious losses in case of failure (ORASANU; CONNOLLY, 1993).

- Decision-making strategies:

The operator's main objective is to conduct the network restoration service, maintaining the safety of both customers and staff. The main strategies used by operators for decision making were:

- Search for information: to meet the need for more information about the occurrence, operators use the feature of calling the CR and/or calling the customer, which becomes an additional source to the data obtained by the system, especially when the information are imprecise or ambiguous.
- Anticipate problems: operators adopt strategies that allow them to anticipate possible problems, such as identifying imprecise or inaccurate occurrences, ensuring the transmission of detailed information to the people involved, taking preventive measures to support medium and high voltage operators.
- Share problems: faced with atypical situations, the operator shares the difficulties with superiors for joint decisions.
- Establish a relationship of trust with the teams: the operator seeks to develop more accurate knowledge of the field teams through good communication, which favors the reliability of information.
- Prioritize security: in situations that involve the physical security of the field team (e.g., risk of robbery), alternatives are examined to avoid the risk, such as requesting police custody, sending another team to provide support or ask the customer to accompany the team to the location.
- Provide agility to the service: in critical situations or those involving special customers, with the potential to cause greater losses, the operator relocates teams from other areas to enable short-term service.
- Establish cooperative relationships with other sectors: the operator both maintains a collaborative attitude with other sectors and seeks help to obtain new resources in order to facilitate problem solving.
- Avoid wasting resources: the operator assesses the need for resources and avoids sending more teams than necessary to the location of the incident.

As a factor of difficulty in decision-making, reduced autonomy of operators was observed to decide on certain courses of action, with demands for compliance with procedures and the need to consult superiors in situations of greater risk.
When the interviewees were asked what the likely behavior of a novice or less experienced person would be when faced with a situation similar to the one they experienced, they responded that the novice operator would tend to become more tense given the criticality of the situation and would have difficulty diagnosing the problem. and anticipate actions, would seek help and guidance from colleagues and supervisors and could even have conflicts in communication with field teams to make them follow their instructions. As one of the operators reported: “if this was a novice operator perhaps he would not have acted with the speed that the moment required”.

Conclusion

The results showed that operators manage a high number of incidents that occur in a dynamic and uncertain context. The unpredictability associated with security risk threats and time pressure makes the activity complex, requiring agility in the decision-making process, which characterizes the naturalistic decision approach. The analysis of MDC interviews revealed a set of strategies used by emergency service operators when faced with critical events that mainly combine intuitive and rule-based methods. The lack of evidence of creative strategies in the incidents analyzed suggests that the space for autonomy for decision-making is reduced due to procedures with little flexibility for creating new courses of action.
In this study, several knowledge and skills were identified to compose the training of novices or less experienced professionals, such as seeking information, anticipating and sharing problems, establishing efficient communication and cooperative relationships, managing service and safety objectives. Special attention must be paid to time pressure conditions when making decisions in unforeseen situations. Thus, the method proved to be valid for eliciting knowledge from experts, with a view to developing instructional designs. However, future studies are still needed to deepen the analysis of decision strategies in order to facilitate the process of learning complex skills.

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