RECRUITMENT, SELECTION AND TRAINING OF NEW WORKERS BASED ON RESILIENCE SKILLS: A STUDY WITH GRID ELECTRICIANS

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Abstract

In this paper, we discuss the role played by the recruitment, selection, and training (RST) in the use of resilience skills (RS) by electricians and control room operators who perform emergency maintenance activities in an electricity distribution company. This investigation was based on a field study which involved three main steps: (i) characterization of the requirements the company posed for the RST of new workers; (ii) identification of RS demanded by electricians and control room operators, as well as the work constraints these face in every day work; and (iii) crosschecking of the data in step (i) with the data of step (ii), which allowed evaluating if and how RS and work constraints were accounted in the RST of new workers. This comparison indicated that all RS were partially covered by the psychological tests, even though these had greater emphasis on personality traits, reasoning and memory. Furthermore, a training program which accounted for the last stage of the selection of new workers was changed in order to explicitly include work constraints and request the use of the RS identified in the data collection. As a result of this change, 10% of the 215 applicants studied were considered as inapt during this late stage of the RST process. This is in contrast with the 1% fail rate that was previously common in the company.

1 INTRODUCTION

Resilience skills (RS) are defined as skills of any type necessary to adjust performance, in order to maintain safe and efficient operations during both expected and unexpected situations [Saurin et al., 2014]. From the resilience engineering (RE) perspective, the unit of analysis for studying RS should be the joint cognitive system (JCS) formed by the interactions between the individual professional and his social and material environment. Therefore, data collection for the identification of RS should be concerned not only with the RS themselves, but also with the context in which they are deployed [Wachs et al., 2016].

In this work, the RS subject is studied in an electrical power distributor. The complexity of the work involved in power distribution is worth noting, with maintenance being carried out because of equipment failure and with a constant demand for speed in the restoration of the system to service the company's customers. This generates operations under high pressure for completion of the work in the shortest time possible, with risks of serious accidents and damage to equipment and personnel during its execution, and, above all, in an environment with constantly changing conditions.

Additionally, the energy distribution activity has a quite peculiar characteristic, since the priorities are dynamic during the execution of the work. For example, at a given moment the focus of the work may be the restoration of electricity to a school, but if the blackout on a hospital occurs, this priority will be changed and most efforts will be quickly redirected. Furthermore, companies of the electrical sector are subject to the

application of penalties by the federal government, and the system is often operating close to its physical limits, with its operation being increasingly subject to such phenomena as: the loss of synchronism, drops in frequency, tension collapse, cuts of generators and charges. The operation of an electrical power distributor is also strongly affected by climatic conditions, which can cause a large volume of problems to occur simultaneously. There are also cases where a delay in action by the distributor can cause fatalities. These kinds of cases occur, for example, in situations where powered lines are on the ground due to a broken wire, accessible to people in the community. This may result in accidents, especially to those who lack the knowledge and awareness regarding the dangers of electricity.

Because of these characteristics and also due to the adversities encountered during the activities of the electricians in the field and the control room operators (CRO), this is a field a knowledge that is quite aligned with the study of resilience skills. Technical training alone is not able to cover all situations encountered in the varied universe faced by the field teams.

The recruitment, selection and training (RST) of new workers is an important part of this context, for two reasons: (i) hiring workers who are unqualified for their jobs is likely to require unnecessary and reactive resilience from their coworkers; this may imply an additional workload, safety hazards and the excessive use of resources in order to get the job done; (ii) personal characteristics matter in the performance of high-risk JCS, even though they are not stressed by RE, which emphasizes the organizational context.

In this paper, we discuss the role played by RST in the use of RS by front-line workers who perform emergency maintenance activities in an electricity distribution company. Said workers involve electricians who work in the field (usually in pairs) and control room operators at the company´s headquarters. These workers must work in close collaboration and synchronization.

2 RESEARCH METHOD

The study was conducted in a public electric power distribution utility in Southern Brazil, which is active in 21 countries with approximately 25.000 employees. The power distributor under study operates in an area of 99,512 km2 and services nearly 1.270.332 customers distributed in 118 municipalities. The analysis occurred in an operation that has been going on for 18 years.

The field study involved three main steps: (i) characterization of the requirements the company imposed for recruiting, selecting, and training new workers; (ii) identification of the RS and work constraints demanded from electricians and control room operators; and (iii) crosschecking of the data in step (i) with the data of step (ii), which allowed evaluating if and how RS and work constraints were taken into account in the RST of new workers.

Sources of data involved: (a) about 50 hours of participant observations, which were carried out by the first author of this paper, who was the company´s training coordinator; (b) analysis of documents that described how the RST should be carried out; (c) twelve interviews using the Critical Decision Method (CDM)[Crandall et al., 2006] with five electricians, five control room operators, and two psychologists who worked at the company´s human resources department, which was directly involved in the RST of new workers; (d) data regarding the performance of workers who participated in the RST over a seven-month period, including 450 applicants for the electrician job and 80 applicants for the position of control room operator.

Interviews and notes from observation diaries were subjected to a content analysis, in which the RS and work constraints which triggered their use were identified based on the method proposed by Wachs et al. (2016). When the recordings and transcriptions of the generated audio files were concluded, they were all analyzed and the relevant excerpts of text were classified according to the resilience skills and work constraints.

Using this data, changes were proposed in the training process and in the filters applied during the qualification of the professionals being trained. This was facilitated by the fact the first author, as the manager responsible for the training of company's professionals, had the authority to change the studied process of RST of new workers.

3 RESULTS

3.1 Characterization of the Company Requirements for RST

It is important to understand the duties of electricians in the field and the control room operators (CRO), which should operate in sync, to assess the recruitment and selection process. The main activities of electricians consist in the mounting and installation of pylons and structures to support suspended lines and the operation of suspended networks of de-energized or energized low voltage distribution systems. On the other hand, the

CRO technicians manage the dispatch of service orders, the emergency dispatch and the coordination and control of the handling of the equipment of the distribution network.

The selection process of new professionals is managed by the Human Resources (HR) department, and their technical and education requirements are tested during the process. With respect to the psychological tests, the following skills are required:

- for electricians: leadership, negotiation, communication, customer focus, initiative, capacity for analysis and planning, decision making and interpersonal relationship skills.

- for the CRO technicians: confidence, interpersonal relationship skills, operational discipline, capacity for analysis and planning, emotional balance and management of work under pressure.

As shown in the research method, a group of 450 candidates who intended to participate in the electricians training course was assessed, in addition to 80 candidates for the technical CRO position (results shown in Table 1 and Table 2).

Table 1 *Result of the Electrician Admission Tests*

Participants	Failed Psychological Test	Failed Physical Test	Failed Driving Test	Failed Medical Assessment	Failed due to bad professional references	Deemed suitable by the end of the process
450	106	40	20	82	74	215

As can be seen, among the 450 professionals interested in becoming electricians who presented resumes to the distributor, only 47% were deemed suitable for the activity. It should be noted that some candidates were disqualified in more than one test. The approved candidates were referred to the qualification training, where another filter was applied, which, on average, removed approximately 10% of the aspiring candidates per class.

Table 2 *Results of the CRO technician admission tests*

Participants	Curriculum Evaluation	Failed Interview	Failed Psychological Test	Failed Medical Assessment	Professional References	Interview with department manager
80	65	4	1	1	0	2

The difference in the failure rate in psychological tests between the two activities (23.53% and 1.25%, for electricians and CRO, respectively), in addition to the differences in profile and the nature of the tests, can be explained by the education level. A significant portion of the public that pursues an electrician course completed their studies when they were already adults. In the period that they should have developed in school, they were deprived this opportunity, which, according to the psychologist responsible for recruitment, directly impacts their performance in one of the psychological tests with the highest failure rate: logical reasoning. The control room operators, on the other hand, were not only younger candidates, but they also had the prerequisite of a minimum level of technical education.

3.2 Identification of RS

The resilience skills of the electricians and CRO technicians are presented in Figure 1. The identified categories of RS are similar to those obtained by Wachs et al. [2016]. Figure 2 describes the work constraints cited by the respondents. The work constraints should be handled by the Company, whether through training or managerial actions, depending on the case, in order to avoid employees from having to use resilience skills to overcome them.

1 - Assuming leadership.
2 - Managing to keep attention focused on the task.
3 - Establishing priority actions.
4 - Identifying failures in procedure, in communication, in the system, in equipment, in the limits of the body/mind, and/or in other factors that hinder the work, in addition to respecting the procedure manual.
5 - Having a working method, doing planning, connecting information to search for the best way to accomplish a task.
6 - Managing conflict, helping/assisting colleagues, working on professional relationships, having the maturity to give and receive feedback.
7 - Dealing with teams or managers without the proper training or skills for the activity, in addition to anticipating the possibility of failure.
8 - Dealing with incidents, accidents and/or deaths with colleagues or people in the community.
9 - Keeping alert for the need to act in unexpected situations, including the lack of resources, in addition to always watching/checking if the procedures/tools are adequate.
10 - Having a perception of the activity's risks, in particular in moments of high demand, with a non-standard or run-down grid, in flooded, dark and/or hard to visualize places.
11 - Coping with pressure.

Figure 1. *Resilience skills*

Work Constraints
1 - Colleague who doesn't help, doesn't have the proper training for the job or has trouble with interpersonal relationships.
2- High work volume.
3 - Failures in the system and/or in communication.
4 - Work at night, in the rain, with the presence of animals or in flooded terrain.
5 - Use of new technology without grounding points.
6 - Working with old, run-down and/or non-standard networks.
7 - Working in places with difficult access.
8 - Working while having to request support regarding interpersonal relationship and not for processes and responsibilities.
9 - Working without all the required resources.
10 - Working under pressure and/or for several consecutive days with a high degree of stress.

Figure 2. *Work constraints*

3.3 Crosschecking of the data

The requirements in the psychological tests were crosschecked with the resilience skills identified (Figure 3), both for the electricians and for the control room operators. This comparison indicated that all 11 RS were at least partially covered by the psychological tests, even though these placed more emphasis on personality traits, reasoning and memory. It is worth noting that the lack of consideration of some RS in the RST process, could imply the emergence of some of the identified work constraints in the future. For instance, the RST evaluated how applicants performed in teamwork activities during the training course, while a lack of collaboration from coworkers was one of the work constraints identified in the data collection.

	RS1	RS2	RS3	RS4		RS5		RS6		RS7	RS8	RS9	RS10	RS11
Communication				Elect.										
Customer focus			Elect.											
Initiative						Elect.								
Leadership	Elect.													
Decision-making												Elect.		
Capacity for analysis and planning				Elect.	CRO	Elect.	CRO					CRO	CRO	
Interpersonal relations								Elect.	CRO					
Operational discipline		CRO												
Emotional balance										CRO	CRO			
Management of work under pressure														CRO
Safety												CRO	CRO	

Figure 3. *Crosschecking of the data: RS versus psychological tests requirements*

3.4 Changes in the training process

The training process of the electricians consists in a 362-hour training course, 192 of which theoretical and 170 practical. For the CRO technicians, the theoretical and practical training were 180 hours each, totaling 360. Both trainings have a high on-the-job portion.

One of the improvements proposed was the implementation of a training system that seeks to develop stress management skills for CRO technicians. This action seeks to improve the RS presented in item 4.1.2 regarding establishing priority actions (RS - 3) and coping with the pressure (RS - 11), since these skills can be trained and improved in a controlled environment with a simulator, before being experienced in a real-life situation.

Four suggestions were proposed for the training of electricians: inclusion of a nocturnal module, simulation of working-at-height activities before climbing the pylons, inclusion in the training center of simulations closer to those found in reality, and resilience skill assessments.

The inclusion of a nocturnal module is due to the fact that the maintenance activity from the distributor occurs 24 hours a day and electricians need to be prepared to work at any time and in all weather conditions. Therefore, the candidates would use the technical skills in another reality, where visibility is reduced and, as such, other difficulties are added, such as the need to use artificial lighting. It should be noted that rains and storms may eventually occur during the night module, as was the case experienced by one group of candidates followed by the researchers. The creation of this module, therefore, is one of the actions implemented by the distributor's training department in alignment with the resilience skill result, in particular in moments of high demand with a non-standard or run-down network in flooded, dark and/or with difficult to visualize places (RS - 10); as well as with the work constraint regarding the carrying out of night work, in the rain, with the presence of animals or in flooded terrains (Work Constraint- 4).

The simulation of activities at heights before climbing poles was proposed because of the fear of heights reported by some candidates for the electrician position. In order to assist in the development of this technical skill and facilitate activities at higher levels, the beginners are tested and monitored in a work simulation on the ground, but simulating other work conditions on the highest parts of the pylons. This way, electricians could get a feel of the safety equipment, gain confidence, and acquire the technical skills required to perform the task. In light of the above, this change in training is aligned with the resilience skill regarding the identification of the limits of the body/mind, and/or other factors that hinder the work (RS - 4), improves the training to avoid having to deal with a team without the proper training or skills for the activity (RS - 7) and also with a colleague who does not have the proper training for the job (Work Constraint - 1).

The redesign of the training center with simulations closer to those found in reality meets the demand that scenarios should reflect the challenges encountered in practice, in addition to the information received during the interviews that "when you are in a training, the network is completely clean there. Then, you arrive in the field, there are telephone lines, there is public lighting, there is a (cluster) of extensions on the pylon." For this reason, lighting fixtures were installed that are widely used in public lighting and cables that simulate telephony lines, hanging below the low-voltage grid, just as extensions were added to the pylons of the

training center. This new configuration makes it difficult to carry out the tasks. As such, the practical activities offered at the Training Center were closer to the conditions experienced by electricians in their places of work. This action seeks to improve the RS regarding the identification of factors that complicate the work (RS - 4), just as the work constraint of working in places of difficult access (Work Constraint - 7).

The resilience skill assessments in the training had a direct impact on the fail rate of the electrician training course of the electrical power distributor under study. Prior to this new form of management, fail rates were rare (less than 1%). Currently, the fail rate is approximately 10% per class.

The coordinator of the department, along with the training analyst and instructors, has begun holding a class council at the end of each training class, discussing and checking the comments of each instructor who participated in the training of the students. The technical evaluation assesses whether the candidate electrician has acquired the necessary dexterity required to handle the equipment. However, the big difference deployed is the monitoring/evaluation of other items, such as: teamwork, initiative/engagement/interest, interpersonal relations, communication, discipline/compliance with standards and rules, attention and focus on the activity, agility and productivity, punctuality and attendance, attitude and personal presentation.

4 CONCLUSIONS

This work has discussed the evaluation method in the selection process of the electricity distributor under study, presenting the tests and requirements for the functions analyzed, in addition to further exploring the resilience skills necessary to carry out the activities of electricians and control room technicians.

A convergence was observed between the developed resilience skills and the variables observed in the psychological tests conducted by the company, contributing to a better selection of the candidates. In addition, changes occurred in the training process of the company where this study was carried out. Changes that sought to improve the resilience skills of the professionals trained by the Corporate Education department. As could be seen in the course of this study, other suggestions for changes in the development training were also generated, which are being analyzed and could potentially be implemented.

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