SAFETY PERFORMANCE MEASUREMENT SYSTEMS BASED ON RESILIENCE ENGINEERING

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1 BACKGROUND

Traditional approaches to measure safety performance are based on statistical analysis of retrospective or lagging indicators and based on the assumption that safety can be increased by guaranteeing the reliability of individual system components (human as well as machine), and that if components or layers of defence do not fail, then accidents will not occur (Leveson, 2011). Construction projects are regarded as complex socio-technical systems due to the dynamic interactions between people and technology in an organizational structure. In this context, the growing technology, multiple players and interdependences, uncertainty in processes and goals as well as limitations in time, resources and information made people need to adjust what they do to the actual situation. In recent years, emphasis has shifted to system approaches driving the focus of safety to interactions between human, technology and environment (Dekker et al., 2009). Resilience Engineering is in line with this approach, being associated with the organization's ability to learn and adapt by creating safety in an environment of failures and losses while compensating decisions and multiple objectives (Hollnagel et al., 2006; Wreathall, 2006). Resilience Engineering is aligned with the Lean perspective, as it look for evidence on how people at work fill the gaps in plans to create safety in a context of increasing production demands that needs reliable workflows.

2 RESEARCH AIM

This paper presents preliminary results of a systematic literature review on principles to design a safety performance measurement system based on the Resilience Engineering paradigm. Discussions about how resilience engineering principles fits with lean thinking are also presented.

3 RESEARCH METHOD

The research question that guided this systematic literature review was: What principles to design a Safety Performance Measurement System are based on the Resilience Engineering paradigm? Among 6 databases, and after search refinement, 27 papers were finally selected

4 RESEARCH FINDINGS

- Different areas of expertise were found, such as: chemical and petrochemical industry (28%), aviation and air transport (25%), nuclear power and electricity distributor (21%), railways and road transport (12%), construction projects (8%), manufacturing industry and health care (6%).

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- Five principles of resilience engineering have a broad consensus across the domains as contributors to improve safety performance, such as: management commitment, awareness, anticipation, continuous learning and flexibility. A set of requirements to design a Safety Performance Measurement System based on Resilience engineering were proposed.

- The principles of management commitment in a systemic approach and awareness are aligned to the lean principle which aims the whole system optimization though a broad thinking rather than local optimizations. The company must to be aware of the state of the safety defences and system's boundaries. The commitment and awareness in all dimensions of the organization can contribute to assess the trade-off between safety and production as well as to identify issues and problems related to human performance to take appropriate decisions to eliminate or limit them. One key factor to assess the trade-off between safety and production could be thought risk management concept by proactively managing and understanding the various types of risks.

- Because awareness allows the anticipation of constraints and threats to cope with the unexpected, commit to the look ahead process can contribute to establish more reliable safety projects and levelling resources, anticipate hazards, recognize abnormal conditions and progress deviations as well as helps to develop leadership skills to reinforce pertinent attitudes and behaviours to complete the work.

- Procedures must to be an accurate reflection of working safely in the company, recognizing the positive and negative variability that arises in daily operations. People's adjustments normally ensure the safe and effective functioning of the system but result in performance variability. This variability can propagate through the system and sometimes result in unexpected and unwanted outcomes. A lean production tool that helps to reduce the negative variability in the work flow and improves safety and learning culture is the standardized work, by capturing the accumulated learning from workers best's safety practices, not only from incidents and accidents but also from normal work, to improve upon safety standards and procedures.

- Accumulated learning allows addressing uncertainties flexibly and behaves as a redundancy of the system in having different ways of performing a function. Another lean production tool that contributes to flexibility is autonomation, which implies encouraging the teams to make important decisions and use the worker’s perception and inputs for evaluating the aspects of safety.

- Those principles are interrelated and reinforce the need to design and use measurement in continuous improvement cycle as the lean thinking advocates. In order to reduce performance losses against disruptions and uncertainty, the integration of lean thinking and resilience perspective into a management system seem to be promising, since both pursue similar continuous improvement initiatives.