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Abstract—Analytical methods in engineering and economics have been proposing that investments in safety lead to improvements in performance. However, no research has proposed a management approach that studies the organizational elements that conceive safety management as a source of strategical performance to a company. In this study, we aim to shed light into a possible theoretical path that could bridge this issue in the construction industry. We present a framework explaining how Knowledge Management can leverage both worlds under the condition of having a psychological safe environment. After, we draw final considerations, limitations, and indications to further studies.

Keywords—Dynamic Capabilities, Resilience Systems, Psychological Safety, Knowledge Management, Construction Sector

I. INTRODUCTION (HEADING 1)

Although analytical methods have already tested the relationship between safety and performance, there is still an organizational belief that poses safety as contradictory to production goals; the trade-off between prevention and performance [1], [2]. The debate is such across 30 years of literature [2]–[5], that some researchers have found analytically that investments in safety do not imply performance losses [6]–[8], while others argue that complying with safety regulations significantly *decrease* the odds of a company to survive longer [9]. However, case studies have shown that it is possible to combine both worlds empirically [10].

In performance measurement literature, this debate is even more scarce [11] since no clear management approach has been proposed so far. Theories and models have approached quality, safety, and environment dimensions together, [12]–[14], but the complex relationship between production, in terms of cost, time, and safety are still unclear: safety management literature assess its impacts on safety goals, and operations management literature on production goals; no complementary approach is proposed explaining what elements it should comprise and how they inter-relate [5], [10], [11].

Nevertheless, literature has progressed showing that two alternatives are possible to improve safety in organizations: (i) increase both regulation and market pressure – which ought to be much more expressive to motivate organizations since “treating

compliance as a cost, and trying to comply, is more expensive than not complying and having accidents” [9]; or (ii) we conceive safety as a source of competitive advantage, considering that worker is part of the unique capabilities of a company [15].

Understanding the company as a for-profit organization, since it still needs to pay salaries, and especially to run safety operations, we argue is that as long as managers and directors fail to conceive safety, as a source of performance to company’s strategy it will be seen as a trade-off to production goals, being a ‘sidecar’ to operations management [16] that proposes extra tasks [1], [17] to a worker.

Current literature close to this subject argues that cultural aspects of the organization [10], [18] are key determinants on exploring this relationship. In general, a misalignment between a company’s espousal policies (i.e., what is said) and the enacted practices (i.e., what is done) makes the workforce understand production goals as a priority since those are the ones rewarded and supported [18]. A reflex of this is the performance measurements employed that also foster this behavior [11], [19], [20].

Therefore, in this paper we aim to shed light on possible theoretical paths to place safety as a strategic component inside organizations, in line with [16], [21] suggestion of further studies. We rely on industrial engineering and organizational sociology literature to push this debate towards strategic management and microeconomics. As we explain in this paper, we argue that knowledge management is a key component in because it seems to be a common lever of safety and performance.

We get deeper into the case of the construction sector because, because of many *in-loco* observations, companies’ headquarters are far from site reality – it implies, therefore, in multiple knowledge management issues: information asymmetry, quality, and speed of information, and sharing barriers for instance.

In the next section, we bring our theoretical foundations from Dynamic Capabilities, Organizational Agility, Psychological Safety and Resilience Engineering literature. Next, we present how these concepts interrelate in our context, and after we draw final considerations for this study.

II. THEORETICAL BACKGROUND

A. *Dynamic Capabilities: Creating Organizational Agility from Organizational Routines and Knowledge Management cycles*

Capabilities are created when organizational routines are stacked, forming an strategical asset [22]. Having a capability, the organization can exploit this knowledge offering it to the market without needing to modify – it is an ordinary capacity of the company: they employ current knowledge i.e.: knowledge exploitation [23].

Due to external pressures, the company may be impelled to adapt its internal process developing new knowledge to defend its competitiveness in the market. When companies have the process of improvement routines clear and structured, it can adapt easily to those pressures, meaning a company has Dynamic Capabilities (DCs) – in other words: when the organization goes beyond its current knowledge boundaries, adapting its current routines it creates new organizational knowledge – i.e., knowledge exploration [23] (e.g., implementation of a new procedure obtained by an improvement cycle).

Therefore, we can define the DCs as the organizational routines that adapt their current operational routines (sic.); in other words, it is the systematic set of activities that allows an organization to adapt its routines to create competitive advantage [23]. The more an organization can adapt, the more DC it has. This is why, e.g., having extra and non-used assets can contribute to DC, in line with Edith Penrose contributions [24].

Since DCs are seen as an “integrative approach to understanding newer sources of competitive advantage” [25, p. 510], in this paper, we propose that safety activities can contribute to this end. We consider that safety occurrences or problems workers face during the building process trigger DCs routines that may enhance the current method of knowledge exploitation.

If we look at an organization across a lifetime, as time passes by, the more safety occurrences and difficulties it will eventually have; therefore, the more a company has opportunities to improve its current production process, rather than only safety protocols beyond necessary. With DC literature, we can state that these events are an opportunity to seize the odds by exploring accumulated experience to create DCs. This is consonant with the path-dependence approach underlying the DC theory [25].

We argue that safety activities can benefit from this approach when they are to foster learning and knowledge exploration. Therefore, it transforms workforce activity from pushing buttons into problem-solvers, creating human capital cost advantages for the company [15].

More than building human capital, which is already a source of competitive advantage from resource-based view approach [15], the competitive advantage also comes from the ability of fast adapting to the situations; it requires agile knowledge cycles inside the organization. The faster an organization can employ those mechanisms, the more a company can exploit knowledge created, contributing to organizational agility [26] creating a competitive advantage. This is particularly problematic in construction companies because site and headquarters are often distant, as literature in this field shows [21].

Since we are proposing that safety occurrences can lead to creation of DC via organizational routines improvement, we sustain that a psychological safety environment can boost this process because it fosters innovation capabilities [27], knowledge creation [28], and DCs [29].

B. *Boosting Dynamic Capabilities: The need for Psychological Safety in the work environment*

Exploring knowledge and creating new solutions asks for a learning behavior in work. [30] suggests that team members must believe they are in a space where they will not be punished for taking interpersonal risks during learning behavior.

Learning behavior is characterized by seeking feedback, discussing errors, and experimentation [30]. In a psychological safety environment, members have “a sense of confidence that the team will not embarrass, reject or punish someone for speaking up”, which “stems from mutual respect and trust among team members” [30].

Despite countersense, safety studies research have reported that uncertainty creates open space for personnel to speak up and discuss issues [31]. In other words, when softening rules and increasing flexibility, workers gain autonomy to give ideas and to participate, eliminating the sense of control that would once hamper workers from speak up, as reported in the multiple case study in [10]. It also elevates workforce status by developing human capital, which is key to competitive advantage in a resource-based view approach [15].

Plus, this flexibility was key when bridging production goals and safety trade-offs in construction sites [1] because managers ease internal rules and relies on knowledge networks with their peers to commit both goals. In addition, this flexibility allows systems to reduce the gap between work imagined and work done [2].

The ease of internal rules, to some extent, is reported to be beneficial in safety management literature since the contrary, having too many rules may make workers take shortcuts to comply with production pressure and therefore put their safety at risk [10]. Plus, management literature has found that increased tight couplings in a system increase the odds of creating new accidents [32].

Psychological safety measurements have also been proposed as a leading indicator in safety management literature by increasing work engagement and motivation [33]. This approach proposes practical means to guide safety inside organizations towards worker well-being as a condition to work. In our opinion, it approximates prevention and performance logics as [16] propose and we endorse, towards a joint management system that yields safety and performance outcomes [10].

Even though rules and procedures may hamper the process, we argue that key functions from safety literature are still necessary to organize the creation of Dynamic Capabilities from safety activities: resilience system concepts.

C. *Organizing Dynamic Capabilities in Safety Management: Resilience Engineering*

Resilience Engineering (RE) is understood to be paradigmatic in safety management literature due to its ability to deal

with conflicting goals [34]. In safety management in the building sector, this literature has achieved prominent adoption [21] by encompassing lean construction features [35].

Rather than monitoring failures of safety mechanisms, RE focus on events that go right during production since they are more, and hence easier to monitor; “the purpose of an investigation is to understand how things usually go right as a basis for explaining how things occasionally go wrong” [36]. Therefore, we argue that the role of safety in an organization approaches some form of “knowledge exploration of success”, as a baseline to find solutions that comply with safety and production goals.

RE proposes four functions to safety systems that allow them to adapt before safety occurrences: “to respond to events, to monitor ongoing developments, to anticipate future threats and opportunities, and to learn from past failures and successes alike” [37]. In this research, we organize those functions to both: exploit current knowledge to attain production goals and explore and new solutions to enhance production and safety goals.

Despite its potential, [38] claims there is a need to develop management strategies, tools, and indicators that concretely allow a broader integration into management systems. Advances in RE have shown possible paths for researchers to develop tools and organizational mechanisms that achieve conflicting goals of production and safety [39], [40], despite not having yet formed a joint management system showing how they can contribute to organizational competitive advantage.

III. CREATING DYNAMIC CAPABILITIES FROM SAFETY ACTIVITIES

As seen from the Dynamic Capabilities (DCs) literature, we divide our framework into two sections: the Ordinary Capabilities (OCs) – where workers benefit from what they know (the green region in Fig. 1); and the DCs (the blue region in Fig. 1) where workers increase the benefits of exploiting what they already know.

First, the OCs, is the region where organization exploit their current knowledge while seeking production goals. We synthesize in two resilience systems constructs: to monitor activity’s current state and to respond according to what we already know; it is some sort of “automatic pilot” in which workers only execute what it is needed to accomplish production goals.

Second, the DC, is the region where organizations explore knowledge and develop improvements, enhancing the results obtained by the OC. We have another two resilience constructs: learning, which asks the worker explore knowledge discovering methods of doing what they do; and anticipate which knowledge explored are institutionalized and widely shared among workers, which asks for knowledge codification mechanisms.

We argue that while companies exploit their current knowledge and meet production goals, all the workers (including workforce) need an environment of psychological safety to discuss and talk about their work, share mistakes, difficulties, near misses, embrace imperfections, etc. We sustain that having failures, is not bad leading to production losses. Indeed, it humanizes the process allowing them to create trust between each

other, eventually increasing performance in the DC region because workers are in an environment open to innovation putting aside fears and the behavior of self-protection of status quo [41].

Leadership behavior is key in this process, since s/he may foster a bottom-up movement, increasing worker autonomy and valuing collective experience. Meanwhile, having too many procedures, and strict rules, especially safety ones, may hamper the process, as mentioned in [10], where reducing control and paperwork opened a space to discuss the issues and collectively find solutions, into a more participative approach.

When opening this discussion space, companies are both increasing psychological safety at work, but also creating a DC since knowledge articulation [23], [42], [43] takes place because they are asked to analyze, evaluate and create solutions according to their experience [44]. Therefore, we enter blue region of Fig. 1 characterized by improvement routines.

In this region, first, workers learn by discussing their difficulties and may eventually find solutions to their problems. In the construction industry, this is problematic because solutions tend to stay on that site, within the team members that have proposed it. Knowledge does not go upstream to designers and engineers, nor to other organizational levels such as the headquarters managers or directors; even worse: when a company has multiple construction sites, workers do not have a space to share knowledge that would help their colleagues in a different site. Plus, this is particular to this economic sector, which has higher accidentology rates.

If an organization has the means to codify this knowledge developed to further diffusion (knowledge diffusion), we argue that it would succeed in making prevention because the knowledge acquired would anticipate difficulties that other workers could have. Especially, if this knowledge goes upstream to engineers and designer team, they would be better informed about terrain reality which reduce the distance between site and office, widely reported in construction sector literature [21].

In this framework, we also argue that an organization’s performance would be better defined if concepts were rooted in organizational agility. It means that a more performant organization would have the mechanism described more structured allowing them to quickly adapt to workers difficulties and share this knowledge throughout the organization.

Therefore, an organization would be capable to convert the value of safety into organizational performance, consequently increasing company’s overall attractiveness. We also defend that it would increase attractiveness even for the workers, since it becomes a better environment to work by increasing safety. The quicker an organization adapts to a given problem, the more time it will have to exploit this exploit knowledge in Ordinary Capabilities with higher competitive.

In this framework, we raise the hypothesis that problems the workforce faces during the building process are a source of learning that can increase prevention and performance. We propose that by managing the knowledge developed during the problem-solving across multiple sites, companies create Dynamic Capabilities that allow them to quickly adapt to different situations, reducing and anticipating safety occurrences.

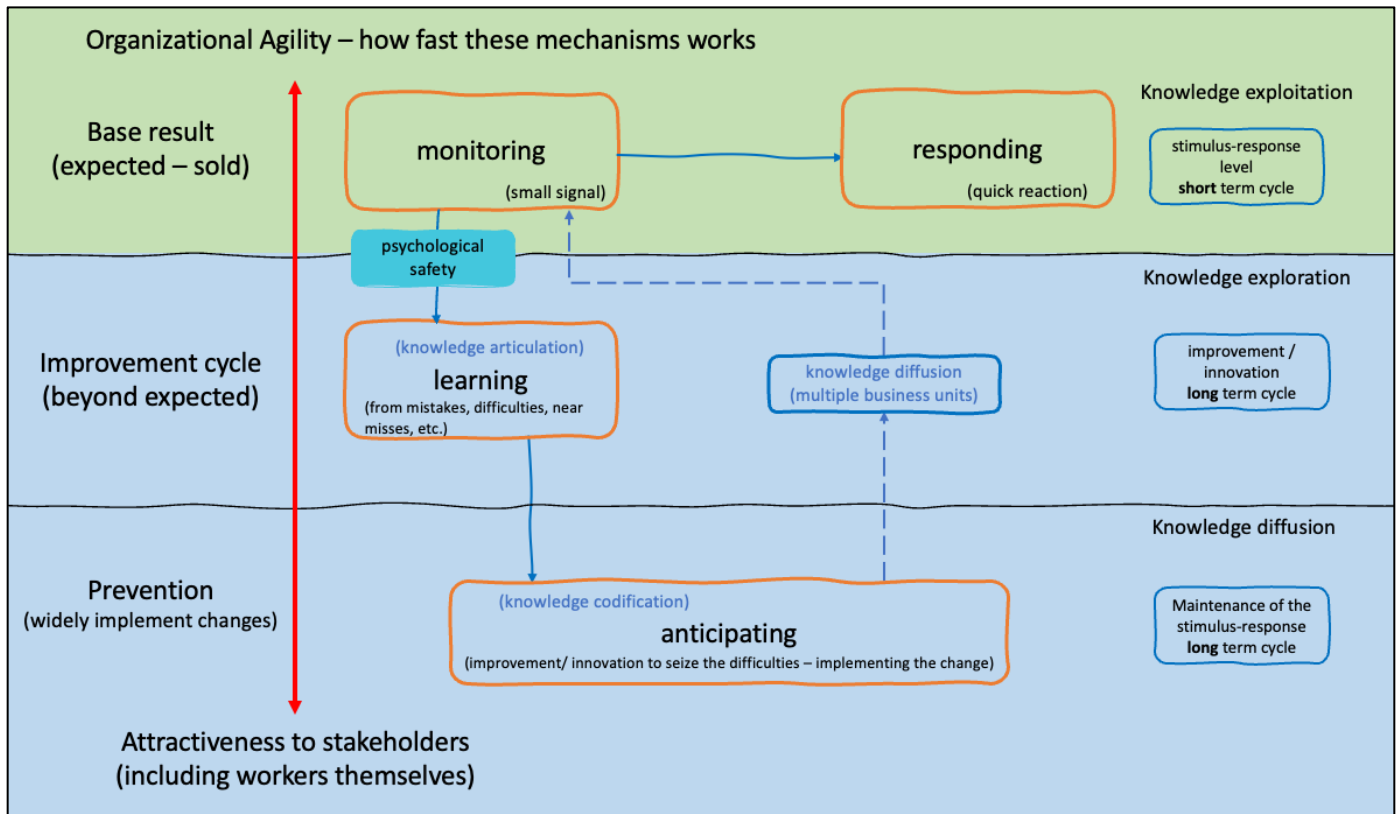


Fig. 1. Knowledge management leveraging safety and production goals

The framework is also consistent with [10] that says the joint management system of safety and production goals should: “Part of the formal processes encompasses continuous monitoring and measurement to enable continuous improvement” the resilience constructs ensure the monitoring and measurement. The creation of DCs respond to continuous improvement, and we push more further with more concepts of RE.

The accountability [10] in which everyone is responsible for ensuring safety is also part of it when we understand that to create the psychological safety environment, plus, its results may benefit the entire organization.

IV. FINAL CONSIDERATIONS

In this paper we explored a possible theoretical path that shows in which conditions safety could become a strategic component in organizations. Mainly, we have proposed that managing safety in organizations may give workers autonomy, giving room to discuss solutions before workers difficulties openly. The leaders have a key role in this process since they need to ensure an environment that allows interpersonal risk-taking with no fear of speaking up or to be punished.

Our reflections raise the possibility that safety may work by establishing a structured knowledge management mechanism across multiple construction sites. Therefore, this department can create possible cognitive (psychological safety) and organizational (resilience engineering) capabilities [45] able to sustain a strategical strength for safety activities.

Since this framework was conceived specifically for the construction sector, it may limit the possible applications. Further

research could test this framework and explore the knowledge function power to improve safety and performance: the common lever.

Finally, in the same way organizations suffers from balancing innovation and production routines [23], they also have difficulties on managing safety and production routines. This resemblance is curious since, in this paper, we propose that safety occurrences can be a source of knowledge exploration to create Dynamic Capabilities. Further studies could explore this resemblance.

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