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Development of Resilient Safety Culture Model Using Qualitative Data Analysis

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Abstract

Resilient engineering is a new area of research in safety engineering. Resilience is required in modern, dynamic organizational environments to more comprehensively address safety issues. The resilient safety culture of an organization can be attributed to behavioral, psychological and managerial capabilities as found in literature. To explore the concept of resilient safety culture in the extant literature, Leximancer (an automated text mining tool) was used to analyze 117 articles on safety culture including papers which dominate the resilient safety culture domain to a) assess the existence of several constructs and b) how they are conceptualized. There were two methodologies involved, one looking through focused approach and other using holistic approach. The analysis revealed that there were four major themes: resilience, managerial, psychological and behavioral. These themes were discussed in relation to the current conception of safety culture in the literature and how the integration of resilience can further enhance an organization's safety culture. This paper thus looks at the main themes dominant in the literature and validates the literature review which was done to develop the resilient safety culture model.

Keywords

Data mining, resilient safety culture, themes, concepts, literature review

1. Introduction

Resilient safety culture is a new concept which has been proposed in order to address the weaknesses of safety culture. It is a safety culture with resilience, aims to learn, and seek out continuous improvements and cost effectiveness measures [1]. Resilience Engineering (RE) is added in the safety culture to look at safety in a different way and is sometimes referred to as safety-II way. This safety-II way was proposed since the current safety-I had drawbacks as the fatalities have not been fully reduced and the researchers were looking at the dynamic aspect to figure out if this methodology can be of assistance. This methodology is not an alternative to safety-I but is in addition to safety-1 concepts. RE looks at learning as an important way to take care of dynamic challenges thus safety-I and safety-II both are incorporated in the RE. The leading and lagging indicators both give additional information to the model to stay abreast in the changing environmental scenarios.

This study understands the various predominant themes prevelant in the literatuture which develops the resilient safety culture model and thus validates the model using the automated text mining tool, Leximancer. The following sections will discuss resilience engineering and how it is incorporated into an organisational safety culture. This is followed by a discussion of the methodology and how leximancer was employed using thematic and conceptualise analysis to uncover themes and concepts.

In terms of qualitative analysis, Leximancer was used in this study. There have been multiple softwares available in the market which can be used for data mining. Nvivo and Leximancer are the two main which stands out. NVivo has been the leading software but Leximancer has grown in popularity [2]. The main difference between these two softwares is that Leximancer provides a form of automated analysis based on properties of texts, NVivo requires manual handling of data which is not very beneficial in large qualitative data analysis and is subject to greater levels

of subjectivity in coding and analysing texts. Leximancer uses bayesian statistics to analyze texts and visually display the information to form concept maps and network clouds [2]. Leximancer has notable advantages such as quantify concepts, split and then analyze documents and generate its own dictionary. It also has the characteristic to identify word frequencies and relationships between concepts in terms of under-root foundation then displays the information in interactive visualized map form [3].

Previous studies have used Leximancer in various areas studied how to solve grievenaces in terms of procedures, roles of individuals and outcome in line with policy through Leximancer [3]. Leximancer helped look underlying themes and concepts that may be missed or overlooked by other analysis. Harwood investigated the potential of Leximancer to support the Grounded theory (GT) analyst in assesing the completeness of his study. It was found that Leximancer output showed smilarities to the main themes emerging from the GT analysis. It was concluded that Leximancer can provide a useful, effcient and impartial crosscheck of saturation in the open coding stages of the GT study. Tseng et al. used Leximancer to identify nine major textual themes and their relationships among these themes [4]. Further the paper looks at the various topics which define the dominant themes which are used to develop the resilient safety culture model and how the papers in the literature were selected.

1.1 Safety

Safety is defined as the absence of accidents where accident is an event which lead to unacceptable loss [5]. Safety is a system property and not component level property. In the past, the product designs were manageable as the components interactions were understood properly but now it is getting hard due to complexity in the system. This complexity has introduced new challenges. Since, there is no full control over the socio-technical system, complexity is not taken into consideration when designing the safety systems [6]. Previously, most systems employed conventional risk management techniques to deal with risks which were based on knowledge of previous experiences, failure reporting and risk assessments by computing historic data. But today, these are traced to organizational factors, functional performance variability and unexpected outcomes [1].

There has been an evolution from past theories in safety management which contributed to the knowledge. Each stage was not left behind but was built upon which was already there. There have been five eras of safety management. First is the technological era, second is the behavioral and human factors, third is the socio-technical era, fourth is the cultural and fifth and latest is the resilience engineering era [7]. There are various research papers which emphasize the causal link between risk and variability as a starting point of resilience. Primary risk areas is personal risks, risks due to errors committed , risks due to insidious accumulation of latent conditions within the maintenance, managerial or organizational spheres, risk due to third parties [8]. Why resilience is used in the safety theory is discussed in the following topic.

1.2. Organizational resilience

Resilience in the system is what is required to bounce back from any strain in the system [9]. Resilience is sometimes called resilience engineering or RE. Resilience engineering is recognized as other alternative to traditional approaches in safety management. One of the definitions of resilience engineering is "*intrinsic ability of a system to adapt its function before or after the mishaps so it can continue to work under both expected and unexpected conditions"* [10]. The challenge for health and safety is to draw up prevention strategies which adequately address complex, dynamic and unstable systems [11]. The idea behind resilience engineering is that an organization must continually manage risks and create an anticipating, monitoring, responding and learning culture. Pillay et al. identified three dimensions of organizational resilience: cognitive, behavioral and contextual. Figure 1 shows the structure of organizational resilience.

Fig. 1. Organizational resilience structure

Cognitive or psychological capabilities notice and interprets uncertain situations, analyses and formulate responses. Organizations with cognitive capabilities encourage ingenuity and develop new skills. Behavioral capabilities move the organization forward that means it enables a firm to learn about the situation and fully utilize its resources. Firm having choices of different actions it can take and easily adopt to market shifts in unexpected situations. Contextual or managerial capabilities provide the setting for integrating cognitive and behavioral capabilities. It consists of connections and resources. This organizational resilience influences an organizational response to environmental change. It encourages the firm to develop varied repertoire of routines for responding to uncertainty and complexity in the system. It also encourages the firm to think about its environment such that it can improve its ability to determine the content and duration of change [12]. Let's understand what safety culture is and its subcultures to better understand why resilience engineering is important and why resilient safety culture is used and modelled.

1.3 Safety culture and sub-cultures

Safety culture is branched out of organizational culture [13]. Organizational culture is considered to be "top-management business". A term used as observed in behavioral regularities when people interact, formal philosophy, rules of the game, organizational climate, embedded skills, habits of thinking paradigms [14]. Many studies have been done on safety culture, but it has been seen that safety culture is not fully understood. Safety culture is divided into many sub-cultures as seen in figure 2. It shows the safety culture with other cultures in inter and intra-relationships [8]. This can be due to focusing only on "just culture" and disregarding resilience aspect. The main drawback is the dynamic aspect of the culture is not taken into consideration interaction between people, technology and administration [1].

Safety management, safety climate and safety culture are terms which are used interchangeably but they are all different. Safety climate is dependent on safety culture [14]. Safety management is documented and formalized system of controlling against risk, but the actual safety management system cannot reflect actual practice. That is where the term safety culture is used. It is the safety culture that influences the deployment of safety management resources, procedures which represent the actual work environment.

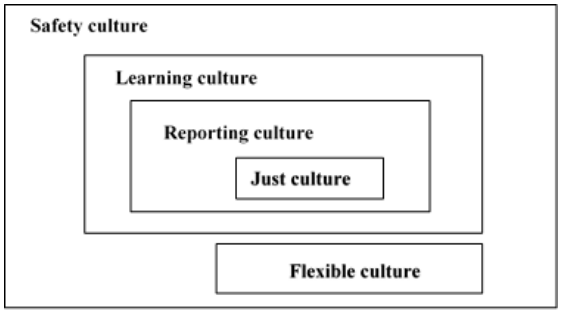

Fig. 2. Safety culture and its relationship with other culture types [8]

Learning culture is the degree to which an organization responds to problems with denial versus modification [10]. It involves organizational learning, organizational memory, learning from accidents and disturbances, observations, investigations, risk analysis and research [15]. Reporting culture is a subset of learning culture since learning is limited without good reporting. Reporting culture is cultivating an atmosphere where employees have confidence to report safety-related issues without fear of blame. Reporting culture brings about a just culture, which is motivation for reporting, user-friendly forms of reporting, good training, feedback from reports, and regular follow-up by management [15]. Just culture is an atmosphere of trust that workers are encouraged to report essential safety concerns and issues but also gross negligence, willful violations, and destructive acts which are not tolerated. Flexible culture involves shifting from bureaucratic mode to a mode where knowledge, skills and abilities counts which leads the task in challenging situations and shifting back again when the challenges are gone [16].

Safety culture is also defined as having three aspects: psychological aspect, which is about safety climate and how people feel, behavioral aspect which is what people feel and situational aspect talks about safety management system and what organization has as a structure [16]. The situational aspect deals with the structure of the organization, its policies, procedures, management systems. The behavioral aspect is measured through peer observations, self-

reporting and outcome measures. The psychological aspect is critical and is measured by safety climate questionnaires to understand the employees' perception of safety. Some authors infer that psychological/cognitive capabilities come under just culture, behavioral capabilities come under reporting culture, managerial/ contextual/ situational capabilities come under flexible and learning cultures [8], [17]. The main drawback in safety culture is the dynamic aspect of the culture is not taken into consideration in the interactions between people, technology and administration [1]. That is why there is need for a resilient safety culture model.

Fig. 3. Safety culture structure as perceived by many authors

Understanding figure 2 and figure 3, it has been explained by some authors that psychological/ cognitive capabilities come under just culture, behavioral capabilities come under reporting culture, managerial/ contextual/ situational capabilities come under flexible and learning culture [8], [17].
The safety, safety culture and organizational resilience are the three main domains under which the resilient safety culture model is located. This is the basis for the literature review for this study. Further the Leximancer is used to pinpoint the themes and concepts which help in generating the resilient safety culture model.

2. Research Methodology

Leximancer allows research to conduct automated thematic and conceptual analysis of text based data, in this case, journal articles. The texts are partitioned into user-defined coding segments and then using baysian statistics. Leximancer analyzes the occurreance and co-occurrence of word pairs within the coding segments to uncover not only the concepts and themes within a piece of text (or texts) but to also find the connections between them [3]. Leximancer builds concept families aound words which it then uses to code or classify each sentence or two sentences block with the presence of multiple concepts. Leximancer has several advantages over traditional coding methods namely that it is automated, reducing the likelihood of human bias, and can analyse large masses of data [3]. With 117 papers being used in this study, Leximancer was a logical choice. Whilst this study is using Leximancer to triangulate and verify the established model, it has been used in contexts such as the improvisation in safety critical situations using Leximancer by Trotter [18], and Colquhoun et al. studying the link between indigenous culture and wellbeing [19].
Figure 4 shows the flow chart how Leximancer creates automatic map of the documents. Text preprocessing is the first phase of the processing. This phase converts raw documents into a useful format for processing. In the automatic seed extraction, the important concepts are automatically identified from the text. In the concept editing phase , the users have the option of deleting automatically identified concepts that are not of interest, adding extra concepts or merging concepts. Concepts in Leximancer are collection of words that travel together throughout the text. For example,"rifle" may have other terms such as "ammunition" or "bullet". The learning phase identifies such clusters of words that surround the main term. Once the concept definitions have been learnt, each block of text is tagged with the names of the concepts that it contains. This process is similar to manual coding. The last phase of processing is "mapping" in which the conceptual map that displays the relationship between variables is constructed [20].

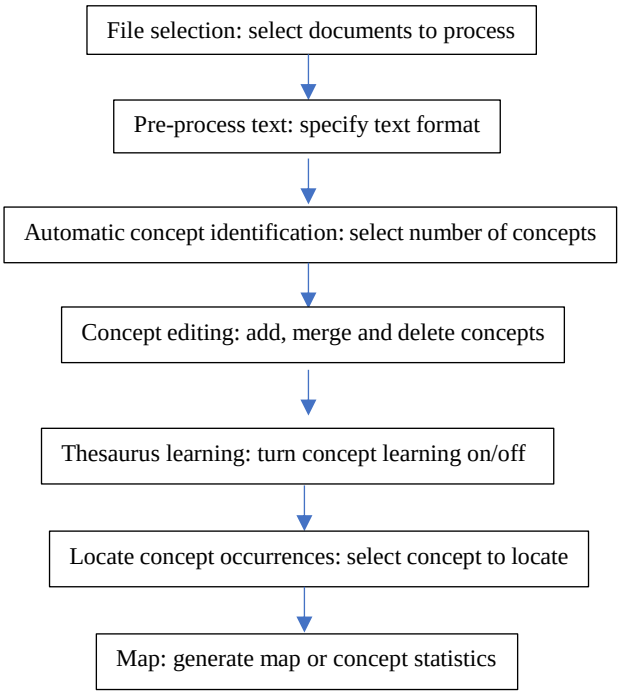

Fig. 4. Phases of processing in Leximancer [20]

In this study, the goal of using Leximancer is to generate themes and concepts which help in building the resilient safety culture model. We find journal articles which relate to safety culture (SC), resilience (R), psychological capability(P), behavioural capability (B) and managerial capability (M). Six electronic databases (CINAHL, Google Scholar, PsycINFO, PubMed, Scopus, and Social Science Journals) were searched using "resilience engineering" and "safety culture" as the keyword—i.e., TITLE-ABS-KEY ("resilience engineering," or "safety culture"), to identify articles published or in press from January 1976 to December 2019. The search was limited to full-text articles and conference proceedings published in English. "Grey literature" was also searched by reviewing reference lists to identify any articles that may have been missed. The search of six databases and grey literature generated 3748 articles, from which 3631 duplicates were removed, leaving 117 articles for title and abstract screening. These 117 articles were used for holistic study. A further 78 were screened out at this stage, resulting in 75 articles for full-text review. An additional 58 were deemed not eligible at this stage due to repetition, resulting in 17 studies for the final review and synthesis. These 17 articles were used for the focused approach. The study collected journal articles which relate to safety culture (SC), resilience (R), psychological capability(P), behavioural capability (B) and managerial capability (M). The appendix gives the whole list of these papers. The authors segergated the search to two types-focussed and holistic approach , one was the 17 focussed papers which they felt would extract enough information which they were looking for and the other was the total set of all the papers which had the 117 papers included along with other relevant papers. The 117 papers had broad list of papers which touched on the B, M, SC and P topics

2.1 Method

The settings for the 17 focused papers were as follows. In the text processing options, the authors choose one sentence per block, selected break at paragraph, selected merge word variants. In concept seeds identification, the authors selected automatically identify concepts. Automatic concept identification is the phase of processing in which seed words are identified as the potential starting points of concepts. In concept learning, selected learn concepts thesauras using source documents. In classification settings, selected behaviour, management, pshychological and resilience as required concepts. Rest remaining settings were default settings.

The settings for the 117 papers project was as follows. In the text processing settings, sentences per block was one, merge word variants were selected along with break at paragraph. In concept seeds identification, selected automatically identify concepts. In concept learning, selected the learn concept thesaurus using source documents. Required concepts in classification settings were behaviour, management, psychological and resilience.

Both the settings, focussed and holistic choose social maps in the concept mapping out of the social and topical maps. Social maps has more circular symmetry and empahisze the simmilarity between the conceptual context and the words appear. This type of map is best when entities tend to be related to fewer other entities. The topical map is more spread out which empasize the co-occurence between items. It is best for discriminant analysis. The topical map is more stable for highly connected entities such as topics. Topical clustering algorithm is more stable but will discover fewer indirect relationships. The cluster map should be considered as indicative and should be used for generating hypothesis for confirmation in the text data [20].

These settings were generated to focus on four themes only which is resilience, behavioural, managerial and psychological and how these four themes interact with each other and what concepts it generates using the focused and holistic approach. The goal of Leximancer was to identify which set of papers to follow and which themes were generated using both these approaches and also once the set of papers were identified from the two approaches, the resilient safety culture model was developed using those papers.

3. Results

3.1 Focussed approach

Top four themes using the focussed as well as holistic approach are resilience, psychological, behavioural and managerial as configured for Leximancer to generate. The concept maps generated themes other than these four themes, then the inter-relationship between these themes cannot be understood. Figure 5 shows the amount of hits of these themes get using the 17 papers. The amount of hits are less as compared to holistic approach since the number of papers were less comparativily as seen in figure 8. Maximum hits were for resilience with 686 hits followed by management, behaviour and psychological. Figure 6 shows the top emergent concepts with "resilience" and "capacity" are the most relevant. It shows that the resilience tops and subsequently behaviour, management and psychological are subsets.

Fig. 5. Top level hits for 17 focussed papares (Leximancer)

Word-Like	Count	Relevance
resilience	473	100%
capacity	374	79%
management	320	68%
behavior	133	28%
organizational	120	25%
firms	96	20%
strategic	85	18%
alliances	81	17%
product	76	16%
innovativeness	70	15%
creating	62	13%
resource	61	13%
performance	60	13%
organizations	59	12%
learning	49	10%
actions	48	10%

Fig. 6. Top ten words with relevance for the 17 focussed papers (Leximancer)

Figure 7 shows the themes and concepts using 17 focussed papers choosen. The top concepts come under "resilience" theme. It should be noted that behavior incorporates large amount of space in the map. The behavioural capability does play a very important part in the RSC model. It is human resource development attribute which the organization need to focus since it is very complex capability and it gets influenced by the psychological and managerial capability together.

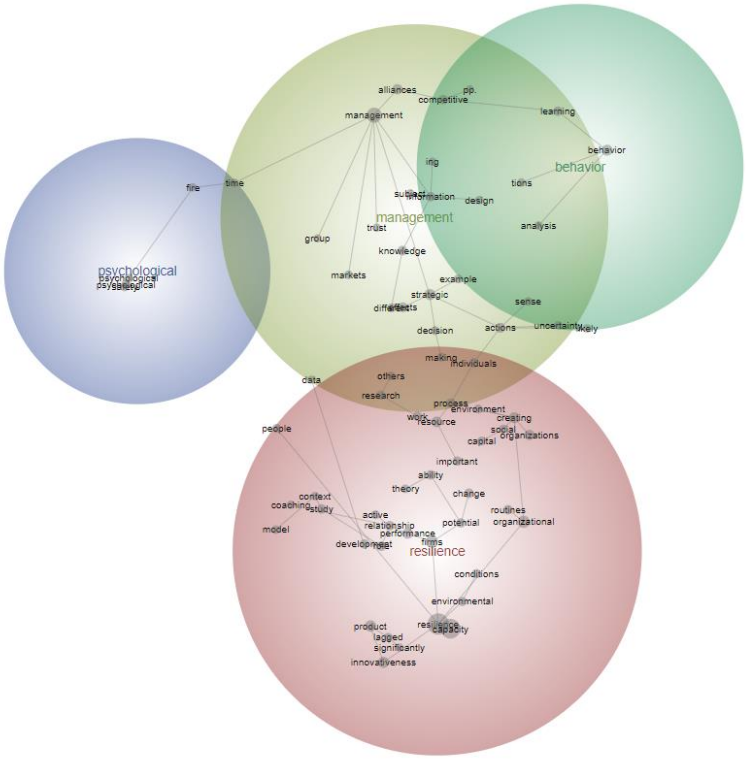

Fig. 7. Leximancer created themes using 17 focussed papers

3.2 Holistic approach

Figure 8 shows the top four themes including resilience, managerial, behavioral and psychological. Management with highest hits of 2828, resilience is second with total hits of 2611, third is behavior with hits of 1121 and psychological with 192 hits. Holistic approach is further chosen for our study for the results since it gives bigger hits on relevant themes and has more data to work with. It also shows better results to generate the resilient safety culture model. The themes in the Leximancer concept map are heat mapped that means the hot colors which are red, and orange denote the most important themes then comes the cool colored blue and green which shows less important themes.

Figure 9 shows the top ten most prevalent concepts including "management", "resilience", and "behavior" with first, second and third. Concepts come under themes. Management which is top in the list of concepts which shows that this concept is most prevalent. The relevance is just a percentage frequency of text segments which are coded with that concept, relative to the frequency of the most frequent concept in the list. The most frequent concept will be 100% always. This does not mean that all the text segments contain that concept.

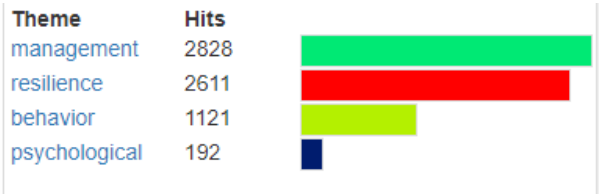

Fig. 8. Top level theme hits for 117 papares (Leximancer)

management	2828	100%	
resilience	2611	92%	
behavior	1121	40%	
system	582	21%	
risk	336	12%	
crisis	317	11%	
capacity	308	11%	
work	291	10%	
process	275	10%	
development	273	10%	
used	268	09%	
factors	236	08%	
change	231	08%	
study	222	08%	

Fig. 9. Top ten words with relevance for the 117 papers (Leximancer)

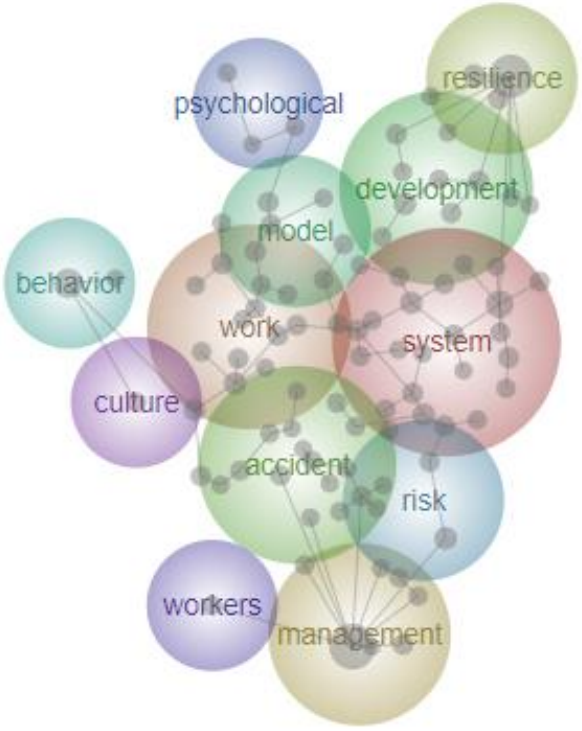

Fig. 10. Leximancer created lower order themes using 117 papers (holistic approach)

Figure 10 and 11 shows holistic approach based themes and concepts. This shows more information and more saturation using large database. The themes are constrained to just four in figure 11 using higher order themes (theme size) but it shows more concepts and interconectivity. The resilience has the highest theme followed by managerial capability then behavioral and then psychological capability. It should be noted that as discussed further in the discussion section, psychological capability is the least focussed theme in the literature survey which should not be the case since the psychological capability is the foremost capability which the management or organization need to focus on before going to behavioral and managerial. Lot of papers on managerial capability shows high priorities given in the industry in this area and also in the related studies as well. Leximancer can easily see where the focus is while using the literature survey.

A leximancer theme is a group or cluster of concepts that have some commonality or connectness. The size of the theme has no bearing as to its prevelance or importance, the circles are merely the boundaries. Looking at the managerial capability theme, we find that “management”, “crises”, “risk”, “problems”, “workers”, “policy”,

"information","procedures" are various concepts which are prevelant to this theme. This is the theme which the literature talks about in the system in place where the HRM works and controls.

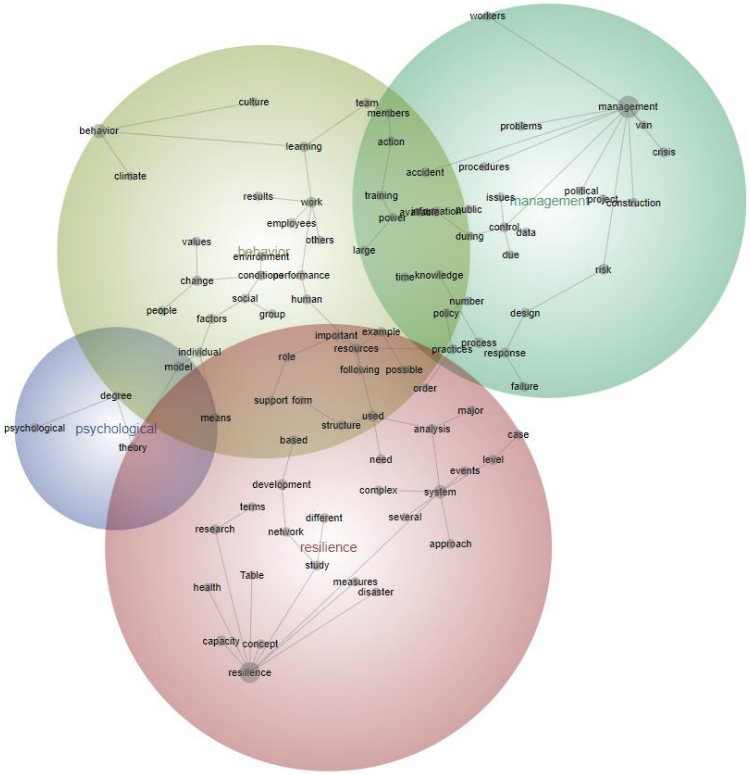

Fig. 11. Leximancer created higher order themes using 117 papers (holistic approach)

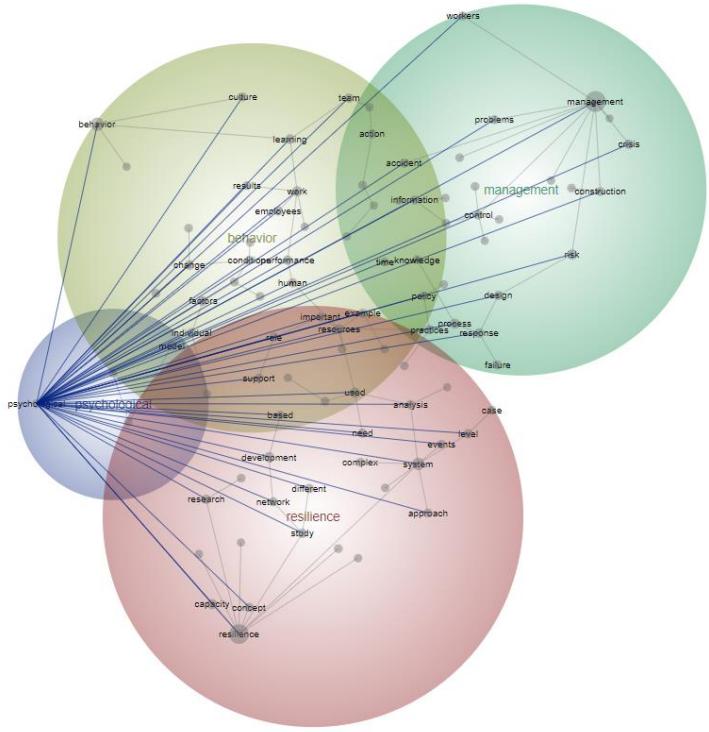

Fig. 12. Psychological concept interconnectedness

Figure 12 shows the Psychological concept interconnectedness with the other concepts in other themes. Similarly, other concepts can easily be seen how they are connected in the concept map. Appendix 1 shows the various references which were used to generate these concepts and themes for comparison with the RSC model. This table shows which papers focuses on which area and how all the areas are covered. A comprehensive literature review was done to generate the Leximancer results along with the RSC model.

4.0 Discussion and Conclusions

4.1 Resilient safety culture model

Figure 13 is the model generated seeing how resilience, psychological (cognitive), behavioral and managerial (contextual) capabilities are interlinked. As seen from the figure 11, the resilience is present in all the themes and thus the management, behavior and psychological thus form the sub construct to our model. It shows how the total holistic view of the whole scenario where the resilience engineering plays its part. The uncertainty influenced on the system is taken care by resilience characteristics of the system which enhances the system performance as given in literature. Seeing figure 11, the resilience relates to the psychological, behavioral and managerial themes and "system" and "performance" are the concepts in concept map.

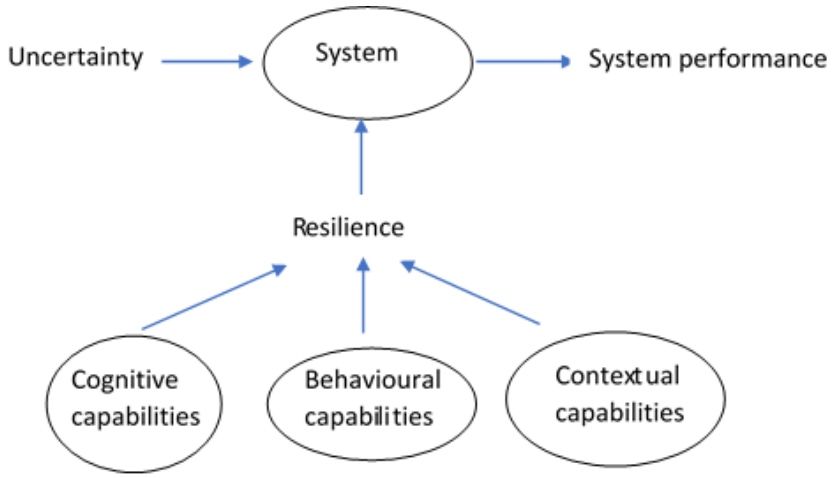

Fig. 13. Resilient safety culture model

The psychological/cognitive capabilities of an organization enable an organization to notice shifts, interpret unfamiliar situations, analyze options and figure out how to respond. It relates to sustaining pressures in a company environment and is a personality trait. Behavioral capabilities comprise of established behaviors and routines that enable an organization to learn more about the situation, implement new routines and fully use its resources. Managerial / contextual capabilities is combination of interpersonal connections, resource stocks and supply lines that provide a foundation of quick actions [21].

Following sections will look in to psychological, behavioral and managerial capabilities in more details as found in the literature to understand the concept and thus explain the resilient safety culture model.

4.1.1 Psychological capabilities

Psychological/cognitive capabilities of organizational resilience is based on constructive sense making and conceptual orientation [12], [22]. Organizations can foster a positive, constructive conceptual orientation through a strong sense of purpose, core value, a genuine vision and a deliberate use of language [23], [24]. Strong core values coupled with sense of purpose and identity encourage an organization to frame conditions in ways that enable problem solving and action rather than in ways that lead to either threat rigidity or dysfunctional escalation of commitment [25], [26].

Constructive sense making enables firms and employees to interpret and provide meaning to unprecedented events. Collective sense making relies on the language of organization to construct meaning, describe situations and imply

both understanding and emotion. It requires an attitude that balances the contradictory forces of confidence and expertise against skepticism, caution and search for new information. Each situation is unique and contains features that may be subtle but that can be powerful in shaping consequences, relations and actions [19]-[21]. The mindset that enables a firm to move forward is one that consists of expertise, opportunism, creativity and decisiveness despite uncertainty. Cognitive foundations require a strong knowledge on reality and desire to question fundamental assumptions. The ability to conceptualize solutions which are novel and appropriate is desired [21].

4.1.2 Behavioral capabilities

Behavioral capabilities are based on behavior which helps get rid of any problems they face with their own ability and resources. Learned resourcefulness, ingenuity and bricolage are all the characteristics which are needed to cope with various challenges [22], [25]. It can be developed using practiced resources fullness and counterintuitive agility along with useful habits and behavioral preparedness [12]. The ability to follow a dramatically different course of action from what is the norm are the behavioral elements of organizational resilience. Behavioral resilience also relies on development of practical habits which are useful which provide first response to an unexpected threat. Organization which develop values that lead to a habit of investigation as compared to assumption, routines of collaboration rather than antagonism and traditions of flexibility rather than rigidity. Behavioral preparedness helps bridge gap between divergent forces of learned resourcefulness and counterintuitive agility and convergent forces of useful habits. It also means organization learns from situations that emerge and unlearns obsolete information. Behavioral preparedness enables an organization to quickly spot an opportunity which others might miss. These organizations translate thoughts into actions [30], [31].

Comparing figure 11 and 7, we find that as we move from the focused approach to holistic approach, the themes tend to merge together closely showing that the themes are more closely related which is needed to generate the original model. The concepts tend to increase since the amount of papers are 117 as compared to the focused approach which generate lot less concepts in the themes. Previous case studies done by authors has found resilience levels reduce predominately because of reduction in behavioral capability. This is related to human resource management of organizations [32] since the psychological and behavioral both come under the HRM category. We can see from figure11 as well that resilience comprises of all the three themes and reduction in any theme can reduce the resilience levels of the organization.

4.1.3 Managerial capabilities

Managerial/contextual capabilities of organizational resilience requires relationships within and outside an organization to facilitate effective responses to environmental complexities. It contains psychological safety, deep social capital, diffuse power and accountability and broad resource networks [12], [22]. Psychological safety is the degree to which people perceive their work is conducive to taking interpersonal risks. When people perceive psychological safety, they are more willing to take these risks. A climate of psychological safety needs to be established for organizational resilience [33]. Deep social capital evolves from respectful interactions within the organizational community. Interactions which are rooted in trust, honesty and self-respect. These interactions build informal intimacy and creates collaborative sense making. It facilitates growth in intellectual capital. Also, it enhances resource exchange. It also eases cross functional collaboration between different kinds of people in an organization. It enhances deep bonds beyond immediate transactions and creates long term partnerships. Finally, it creates network of support and resources [23]-[25].

Diffused power and accountability are another factor associated with creation of managerial resilience. Resilient organizations are not managed by hierarchical structures but by self-organization which create holographic structures where each part is a small replica of the whole organization. Resilient organizations share decision making widely. Each replica has discretion and responsibility for attaining best organizational interests [37], [38]. Broad resource network is the main element in the managerial capabilities of resilient organizations. Resilient individuals have an ability to forge relationships with others likewise resilient firms share relationships with supplier and strategic alliances for sharing resources. Resources gained through the network sharing promotes an assortment of interpretations for alternative applications of these resources. This leads to innovation leading to cultivation of constructive sense making [21], [39].

4.2 Conclusions

In conclusion, a resilient safety culture model was developed. Leximancer showed themes and concepts prevalent in the resilient safety culture model and thus helps in development of the model and provides enough information to understand the relationship between the three capabilities and how much focus currently the literature is focusing on

which capabilities. This study is limited to the amount of data available in the literature and thus the Leximancer tool has its constraints due to the constraint in the input data.

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Appendix

Classification of literature based on resilience (R), safety culture (SC), psychological (P), behavioral (B), managerial (M)

#	Reference	R	P	M	B	SC
1	Weick [36]	✓				
2	Thomas et al. [28]		✓	✓		
3	Coutu [25]	✓	✓	✓		

#	Reference	R	P	M	B	SC
4	Freeman et al. [24]	✓				
5	Lengnick-Hall et al. [12]	✓	✓	✓	✓	
6	Lengnick-Hall et al. [21]	✓				
7	Sheremata [40]		✓	✓		
8	Chen et al. [41]			✓		✓
9	Eisenhardt et al. [42]			✓		
10	Miller et al. [31]			✓		
11	Edmondson [33]		✓			
12	Ireland et al. [35]			✓		
13	Mallak [37]	✓	✓	✓	✓	✓
14	Judge et al. [39]			✓		
15	Nahapiet et al. [43]			✓		
16	Akgun et al. [22]	✓	✓	✓	✓	
17	Trinh et al. [44]	✓	✓	✓	✓	✓
18	Cole et al. [45]					✓
19	Shirali et al. [46]	✓				✓
20	Qureshi [47]	✓				✓
21	Kim et al. [48]					✓
22	Wachter et al. [49]			✓		✓
23	Daft et al. [50]			✓		✓
24	You [47]	✓	✓	✓	✓	✓
25	Lengnick-Hall et al. [12]	✓	✓	✓	✓	✓
26	Akgun et al. [22]	✓	✓	✓	✓	✓
27	Kashwani et al. [51]					✓
28	Azeez et al. [52]	✓				✓
29	Leveson [5]	✓				✓
30	Shiali et al. [6]	✓				✓
31	Sardoh [53]	✓	✓	✓	✓	✓
32	Lingard et al. [54]			✓	✓	✓
33	DeJoy [55]			✓	✓	✓
34	Boin [56]	✓		✓		✓
35	Boin et al. [57]	✓	✓	✓	✓	✓
36	Choudhry et al. [14]	✓	✓	✓	✓	✓
37	Costella et al. [58]	✓	✓	✓	✓	✓
38	Cox et al. [59]	✓	✓	✓	✓	✓
39	Dalziell et al. [60]	✓		✓		✓
40	Carvalho [61]	✓		✓		✓
41	Fang et al. [62]	✓	✓	✓	✓	✓
42	Suraji et al. [63]	✓		✓		✓
43	Pettit et al. [64]	✓		✓		✓
44	Hollnagel [65]	✓			✓	

#	Reference	R	P	M	B	SC
45	Cooper et al. [66]	✓	✓	✓	✓	✓
46	Muniz et al. [67]	✓		✓		✓
47	Fletcher et al. [68]	✓	✓			✓
48	Flin [69]	✓	✓			✓
49	Zhou [70]					✓
50	Woods [71]	✓				✓
51	Fruhen et al. [72]		✓	✓	✓	✓
52	Guldenmund [73]		✓	✓	✓	✓
53	Guldenmund [74]		✓	✓	✓	✓
54	Haavik et al. [75]	✓				✓
55	Hornell et al. [76]	✓		✓	✓	✓
56	Hopkins [77]	✓			✓	✓
57	Park et al. [78]	✓		✓		✓
58	Trinh et al. [13]	✓	✓	✓	✓	✓
59	Ulrich [79]				✓	✓
60	Hosseinian et al. [80]				✓	✓
61	Maloney et al. [81]		✓	✓	✓	✓
62	Reason [8]			✓		✓
63	Flin et al. [82]			✓	✓	✓
64	Guldemund [83]		✓	✓		✓
65	Mohamed [84]			✓		✓
66	Sorra [85]			✓		✓
67	Steen [86]	✓	✓	✓	✓	✓
68	Koornneef [87]			✓		✓
69	Ouyang et al. [88]			✓		✓
70	Beuzekom et al. [89]			✓		✓
71	Kozuh et al. [90]			✓	✓	✓
72	Lee et al. [91]	✓	✓	✓	✓	✓
73	Shirali et al. [1]	✓		✓		✓
74	Rae et al. [92]			✓	✓	✓
75	Oxstrand et al. [93]	✓				✓
76	Yazdani et al. [94]	✓				
77	Wiig [95]	✓	✓	✓	✓	✓
78	Akselsson et al. [16]	✓				✓
79	Bhamra et al. [96]	✓				✓
80	Mohamed [97]	✓		✓		✓
81	Hollnagel [98]	✓	✓	✓	✓	✓
82	Zellars et al. [99]	✓	✓	✓	✓	✓
83	Reason et al. [100]					✓
84	Richter et al. [101]					✓
85	Rochlin [102]					✓

#	Reference	R	P	M	B	SC
86	Rubio-Romero et al. [103]	✓		✓		✓
87	Wiegmann et al. [104]					✓
88	Pillay et al. [7]	✓		✓		✓
89	Wiegmann et al. [104]					✓
90	Cox et al. [105]					✓
91	Sorensen [106]					✓
92	Vinodkumar et al. [107]			✓	✓	✓
93	Wilson Jr et al. [108]			✓		✓
94	Liu et al. [109]			✓		✓
95	Geller [110]			✓		✓
96	Scott et al. [111]					✓
97	Smith et al. [112]			✓		✓
98	Bandura [113]			✓	✓	✓
99	Annarelli et al. [114]	✓				✓
100	Klockner [115]	✓				✓
101	Sutcliffe [26]	✓				✓
102	Mitropoulos et al. [116]	✓	✓	✓	✓	✓
103	Williamson et al. [117]		✓	✓	✓	✓
104	Choudhry et al. [14]	✓	✓	✓	✓	✓
105	Williams [118]			✓		
106	Pecillo [119]	✓	✓	✓	✓	✓
107	Clark [120]	✓		✓		✓
108	Cooper [17]	✓	✓	✓	✓	✓
109	Trinh et al. [121]	✓	✓	✓	✓	✓
110	Wood et al. [122]	✓	✓	✓	✓	✓
111	Chen et al. [123]	✓	✓	✓		✓
112	Rabbani et al. [124]	✓		✓		✓
113	Grote [125]	✓		✓		✓
114	Calabro et al. [126]	✓		✓		✓
115	Smith et al. [127]	✓		✓		✓
116	Newaz et al. [128]	✓	✓		✓	✓
117	Zhou et al. [129]	✓	✓	✓	✓	✓