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Enhancing Organizational Safety At Work Through The Application Of The FRAM Method: An Exploratory Study Of Joint Health And Safety Committees In Algeria

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ABSTRACT
Health and Safety Committees (HSC) play a crucial role in preventing accidents in the workplace and improving working conditions and well-being. The presence of these committees should considerably reduce occupational risks in companies. However, the number of accidents at work and occupational illnesses is still on the increase, despite the existence of these committees, whose functions have not been thoroughly evaluated.
This study examines the functional variability of the HSCs, more specifically the Algerian Joint Health and Safety Committee (CPHS), using the Functional Resonance Analysis Method (FRAM). The aim is to identify CPHS functions, the interactions, the variability and the functional resonance, as well as the underlying causes of the variability of these functions. This will make it possible to draw up a prevention policy and a national action plan for effective implementation of these committees in Algerian companies, enhancing the well-being and safety of workers. This study is the first to apply the FRAM method to the emergence of CPHSs, offering a new perspective for other countries to assess the functions of their HSCs, despite the limitations associated with the qualitative nature of the FRAM method.

Keywords: Work, Health, Safety, JHSC, Functions, FRAM.

Paper type: Research paper.

1. Introduction

Constant changes in the workplace expose workers to many challenges (Brown et al., 2020). Hence the focus is on improving regulation and worker representation on Occupational Health and Safety (OHS) issues (Kim & Cho, 2016; Nichol & al., 2020).
In this context, the establishment of the Health and Safety Committee (HSC), known by different names in different countries (The Joint Health and Safety Committee (JHST) in Algeria, the Combined Health and Safety Committee (CMSS) in Canada and the Health, Safety and Working Conditions Committee (CHSCT) in France), represents an important initiative for worker representation on OHS issues.
At international level, labor legislation mandates the establishment of health and safety committees in companies. These committees are crucial in implementing OHS policies and overseeing preventive measures. They are provided with the necessary resources to fulfill their responsibilities. The existence of these committees contributes to the overall performance of companies, as highlighted by Ollé-Espluga et al. (2015), Yiu et al. (2018), Aburumman et al. (2019), and Gosen et Mielly (2021).
According to Nichol et al (2020), HSCs have improved OHS performance, promoted positive safety behavior and improved the quality of operations in companies. Indeed, Addison and Teixeira, (2019) and Tompa et al., (2016) state that HSCs promote employer and employee involvement in OHS management and help to manage conflicts between OHS actors within a company. According to Bouville (2016) issues is associated with increased employee well-being. Kim and Cho (2016) confirmed the relationship between HSC functioning and occupational accident prevention.

Given their vital role in the company's overall performance, Addison and Teixeira (2019) noted that the emergence and effective operation of the HSCs can face challenges. Ghahramani et al., (2019) suggest that the challenges could be attributed to non-adherence to laws, internal dysfunctions, an insufficient lack of management engagement, and a shortage of qualified and skilled personnel.
In this regard, Bouville (2016) described these difficulties as the problem of the emergence of HSCs in companies. Nichol et al (2020) and Ghahramani et al (2019) state that this problem concerns all countries. According to the authors (Crollard et al., 2013; Tompa et al., 2016; Gosen & Mielly, 2021), exploratory studies frame this problem by highlighting the absence of leadership, resources, training, necessary authority, commitment from all stakeholders, and a lack of a continuous improvement process.
The research conducted on the Joint Health and Safety Committees (JHSCs) in the Algerian setting is highly sparse. The limited number of existing JHSCs raises significant inquiries regarding the optimal integration of their functions within a particular socio-professional setting (Bousfot et al., 2022).
Although there is interest in exploratory studies on the emergence of HSCs in companies, conducting more rigorous functional analyses is necessary to diagnose the problem entirely. This study aims to thoroughly investigate the complex issue of the emergence of HSCs by analyzing their international dynamics and examining their emergence and performance in Algerian companies. The objective is to comprehend the difficulties associated with the performance variability of JCHSs' in Algeria.
More precisely, this study aims to identify the root causes of performance variability in JHSCs using the FRAM (Functional Resonance Analysis Method). The choice of FRAM is justified by its in-depth analysis of the interactions and unexpected consequences of a socio-technical system such as JHSCs, and its ability to detect complex functional resonances and their impacts within JHSCs. Furthermore, numerous deployments of the FRAM method have garnered positive results (Grabbe et al., 2020; Patriarca et al., 2020; Sujan et al., 2022).

2. Literature review on the FRAM method

Initiated by Hollnagel in the 2000s and described in 2004, FRAM is a qualitative method for the functional analysis of complex systems, modeling functions and their variability (Hollnagel, 2004; Anvarifar et al., 2017). According to Benyettou and Megnounif (2022), FRAM is one of many methods developed over the last 30 years, such as Functional Block Diagrams (FDB), Structured Analysis and Design Technique (SADT), and the Functional Tree (FT).
FRAM differs in its ability to model not only the normal functioning of a system, but also its potential malfunctions by representing performance variability and its resonance (Grabbe et al., 2020; Sujan et al., 2022). It is based on a resilient systems approach focusing on service continuity despite disruptions (Patriarca et al., 2020). For these reasons, FRAM appears relevant for analyzing the variability of JHSC attributions within their socio-technical system.
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In this context, Sujan et al. (2022) confirm that FRAM focuses on understanding interactions and emerging phenomena in complex systems. FRAM can (Grabbe et al., 2020; Salehi et al., 2022): identify and describe functions, characterize their variability, interpret possible variability couplings, and suggest ways of managing unexpected variability. In addition, FRAM is interested in the occurrence of safe and unsafe interactions affecting functional performance variability (Kaya et al., 2019; Kim & Yoon, 2021). Moreover, according to (Anvarifar et al., (2017) and Lee et al., (2018) FRAM is relatively new compared to other functional analysis methods and has attracted the attention of many researchers from different countries and application areas.
A literature search on FRAM applications revealed that (Smith et al., 2017; Patriarca et al., 2020; Salehi et al., 2020; McCormack et al., 2023):

- FRAM has been widely used worldwide through various documents (conferences, articles, thesis , dissertations, and technical reports). Its use is very high in Europe (59.6%, more than 200 documents), low in Asia (18.2%) and Oceania (12.1%), and very rare in Africa (0.5%, only two documents);
- The main areas of application are aviation (24.87%), health (13.99%), industry (12.44%), maritime (8.88%), rail (6.47%), construction (5.18%), oil and gas (4.66%), Information technology and nuclear (3.63%), as well as emergency management, road safety, urban planning and mining (1.55%).
- FRAM offers a better approach for identifying and resolving human and organizational functions. Several comparative studies have been carried out, confirming that FRAM offers a better approach for identifying and resolving human and organizational risk factors in complex socio-technical systems.

Despite this massive extension in the use of FRAM, it should be noted that, according to the literature research conducted, FRAM has not identified the study of HSC/JHSC. This is also the reason for selecting the Algerian JHSCs as a case study for the application of the FRAM method.

3. Methodology

According to Hollnagel (2017), the FRAM method is based on four principles (equivalence of successes and failures, approximate adjustments, emergence and functional resonance) that divide a complex socio-technical system into 'functions' representing the means required to achieve an objective.
These functions can be classified as (i) human, describing individual or group actions to accomplish a specific task, (ii) organizational; describing what an organization does; or (iii) technical, describing what a technical system does, either by itself or with the help of an intelligent system, or a socio-technical system involving human intervention for its operation. The FRAM method is implemented in four stages, which are detailed below.

3.1- *Identification and description of FRAM functions*

This stage is decisive for the constructing FRAM and identifying he root causes of variability (Patriaca et al., 2020). In FRAM, each function is characterized by six (06) aspects, the first of which is the objective (Output: O). The other aspects vary according to the function.
Thus, the "Input (I)" aspect groups together the preliminary elements or tasks required to start the function, the "Preconditions (P)" aspect refers to the conditions to be met in order to perform the function, the "Time (T)" aspect relates to the time required to perform the function, the "Controls (C)" aspect refers to the means deployed to control the function, and finally the "Resources (R)" aspect refers to the technical, human, organizational and budgetary means required to perform the function.
This stage also involves identifying the nature of the function (human, organizational or technical). According to Hollnagel (2017) and Kaya et al., (2021), data on the functions and their aspects are generally collected through interviews with the stakeholders, the experts developing the work procedures, focus groups, documents describing the system, workshops, and questionnaires.

3.2- *Functional variability characterization*

This step aims to understand how functions are interconnected and how this can lead to unexpected results in terms of performance variability (Kwasiborska et al., 2023). The analysis focuses on the variability of the output of the functions, taking into account internal and external variability and upstream-downstream couplings. According to Hollnagel (2017) internal variability is inherent to the function itself, while other functions cause external variability.
For external variability, Hollnagel (2004) identified 11 Common Performance Conditions (CPCs), such as availability of resources, adequacy of training and experience, communication, etc. In addition, Hollnagel (2017) proposes two cases to describe the effect of upstream variability on downstream variability: a simple case considering two phenotypes (time and precision) and a complex case taking into account several phenotypes (speed, distance, sequence, object, force, duration, direction and time).

3.3- *Functional resonance research*

This step links between the functions to fully understand the resonance (propagation) of the actual potential variability during operation (Figure 1).

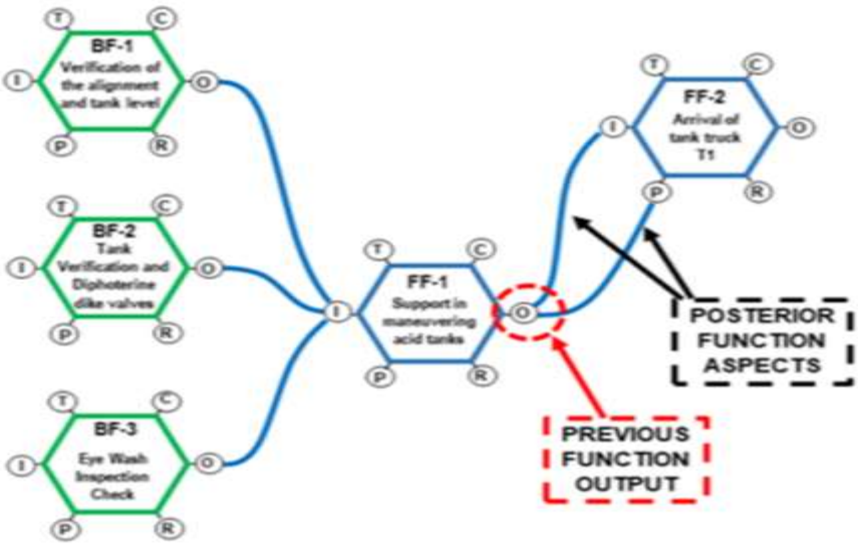

Figure 1: Coupling of two FRAM functions (Hollnagel, 2017).

3.4- *Identifying barriers against performance variability*

This stage aims to formulate recommendations based on the qualitative information collected previously. These recommendations define an action plan to conclude using of the FRAM method. This plan provides a framework for the changes to be made to the system, eliminating faults and malfunctions, and incorporating adaptations to optimize operability and guarantee improvements in the production, safety, and resilience of the system or organization (Hollnagel, 2017; Salehi et al., 2022).

4. Application of FRAM to analyze variability in the functions of Algerian JHSC

4.1- Identification and characterization of JHSC functions

This research on the identification and characterization of JHSC functions uses a variety of data collection tools, including observation, document analysis and questionnaires. Data collection on the functioning of JHSC took place from January to July 2021.

The observations, totaling 50 hours, were carried out in at different times of the day and week. The aim was to identify and characterize the functions of the JHSC within the companies that established one. For the latter, the observations included monitoring activities such as meetings, inspections, data collection and analysis, accident investigations, employee training, regulatory compliance, and participation in developing OHS policies. For companies without JHSC, observations focused on monitoring JHSC installation procedures, including regulatory violations.

The documents used were based on Algerian regulations. Particularly Executive Decree 05-09 of January 2005. They also included the minutes of the installation of the JHSC and the minutes of the meetings of these committees.

In addition, a questionnaire based on an earlier study by Bosfot et al. (2022) was distributed to stakeholders such as JHSC members, occupational doctors, and safety officers in the selected companies.

For this purpose, a sample of 20 companies out of the total number included in the study by Bosfot et al (2022) was used to identify ten functions (Table 1); each is described by its aspects (Table 2). The selected functions are presented in a FRAM network (Figure 2).

JHSC functions	*Description*
F_1 = National OHS bodies	Formal frame of reference for strategic and operational orientations in OHS.
F_2 = Company implication	leadership's/top management's firm and tenacious commitment to implement Algerian regulations and provid all the necessary means.
F_3 = Installation of JHSCs	Election of JHSCs members (company JHSC and unit JHSC).
F_4 = JHSC meeting	The committee members meet to discuss their duties: Formulating the action plan and the committees' internal rules
F_5 = Inspection of workplaces	Implementing laws and regulations and providing daily advice on hazards.
F_6 = Regulatory compliance	Application des lois et règlements en matière d'hygiène, de sécurité et d'environnement
F_7 = Data collection and analysis	Collect information from various sources (accident investigation, inspection, etc.) in order to obtain a complete and accurate picture of OHS.
F_8 = Accident investigation	Participating and getting involved in accident investigation.
F_9 = Training and information	Contributing to the information and training of workers, staff and fire and rescue service teams.
F_{10} = Promot OHS in companies	Efforts to improve OHS and the well-being of employees at work

Table 1. JHSC functions and corresponding responsibilities.

Fonctions	*Input (I)*	*Output (O)*	*Precondition (P)*	*Resource (R)*	*Control (C)*	*Time(T)*
F_1 = National	- Statistics on	Regulations in force	OHS Conventions	OHS stakeholders	Control	Immediate actions

OHS bodies	Occupational injuries and diseases - Regulatory constraints of the context (WHO, ILO)	(Executive Decree No. 05-09)			bodies	
F_2 = Company implication	Regulations in force (Executive Decree No. 05-09)	- Leadership commitment - Employees involvement	- Legal obligation - Maturity in the SC	- Qualified human resources - Documentary resources		
F_3 = Installation of JHSCs	Regulations in force (Executive Decree No. 05-09)	Qualified members of JHSCs	Leadership commitment	- Employers, - Employees, - Worker's representatives		
F_4 = JHSC meeting	Legal obligation	- Minutes - Activity reports - Company OHS policy	- Qualified members of JHSCs - Leadership commitment - Employees involvement	- OHS stakeholders - Data analysis report - Statistics on Occupational Accidents - Inspection report		During the JHSC mandate
F_5 = Inspection of workplaces		Inspection report		- Acteurs SST - Equipements techniques		
F_6 = Regulatory compliance	Regulations in force (Executive Decree No. 05-09)	Legal obligation		- Documentary resources - Leadership commitment		
F_7 = Data collection and analysis	Legal obligation	Data analysis report		- OHS stakeholders - Data analysis report - Statistics on Occupational injuries - Inspection report		
F_8 = Accident investigation		-Statistics on Occupational injuries and diseases Causality of occupational injuries and diseases				Immediately after an accident
F_9 = Training and information		- Staff trained and made aware of occupational risks - First aid and rescue team	- JHSC member training - Leadership commitment	- Qualified members of JHSCs - OHS stakeholders and experts		During the JHSC mandate
F_{10} = Promot	Company OHS	Sustaining OHS		Internal OHS stakeholders	Performan	

OHS in companies	policy	performance			ce indica tors SST	

Table 2. Descriptions of JHSC functions by aspects.

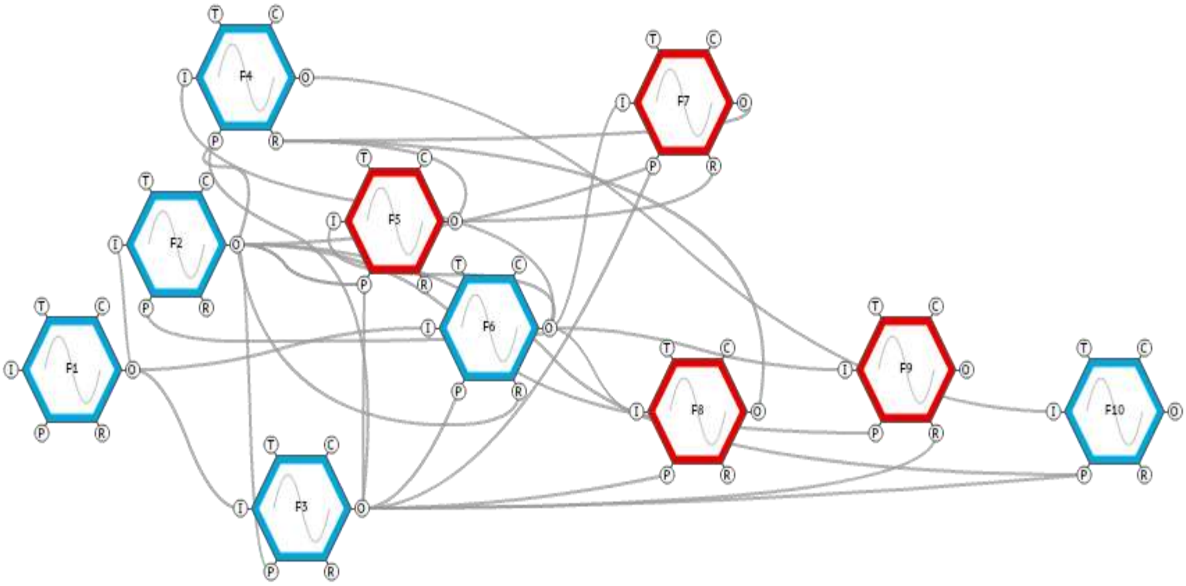

Figure 2. FRAM network representing JHSC functions

4.2- Characterization of the JHSC function variability

This characterization consists of a qualitative description of the variability of the identified functions by the criteria "Time -T-" and "Precision - P-" (Table 3).

Note that a survey of experts using the Delphi method collected the data concerning the qualitative assessment of the two criteria selected for each function. In this study, the experts were members of the JHSC, occupational doctors, and HSE managers. They were asked to evaluate and assess the following specific criteria: the category of the function (human, technical, or organizational), the source of the variability (internal/external), the function's output variability as a function of time, and the precision.

We carried out the Delphi assessment process in several iterations. The experts received a questionnaire containing the criteria to be assessed and instructions on scoring them for each JHSC function. This iterative process continues until a consensus is reached on the importance of the criteria for each JHSC function.

Fonction	***Category***	***Source of variability***	***V=f(T)***	***V=f(P)***	***Consequences***
F1	Organisational	External/Internal	Too late	Précise	Low frequency, high amplitude
F2		External/Internal		Imprécise	
F3		Interne			
F4					
F5	Human				
F6	Organisational				
F7	Human		On time		High frequency, high amplitude
F8		External/Internal			
F9			Too late		
F10	Organisational	External/Internal			Low frequency, high amplitude

Table 3. Data from the survey of JHSC functions

Note that in Table 3 the output of each function verifies performance variability as soon as one of the selected attributes shows variability.

5. Results discussion

The FRAM method enabled a detailed functional analysis by decomposing the JHSC socio-technical system into ten interconnected functions (see Figure 2). The first observation is that these functions are only human and organizational, implying the fragility of the studied system (Hollnagel, 2017; Gao et al., 2019). The identified functions are, therefore, susceptible to greater, more significant variability, being influenced by human and organizational factors.

The first merit of FRAM is to identify all JHSC functions exhaustively given their multiple aspects (inputs, outputs, conditions, resources, control, and time). The other merit is that, by using experts, FRAM makes it possible to characterize the variability of JHSCs functions (Table 3) according to two criteria: precision and output time. The results show variability in the performance of almost all the organizational functions of the JHSCs.

Thus, for the function relating to government bodies, function F1, "national OHS bodies" shows remarkable variability for "T" and "P". The reasons for this may be linked to the considerable time required to make use of agreements, minutes and statistics in order to draw up clear national regulations that are easy to implement. The study by Ghahramani and Salminen (2019) confirms this finding. According to (Haslam et al., 2016; Zwetsloot et al., 2020) adopting an OHS policy based on proactive rather than reactive indicators could help.

Concerning the management functions:

- Function F2, "Involvement of companies", characterized by a variability of "T" and "P", indicating a lack of commitment on the part of management and a lack of involvement on the part of OHS actors, as well as difficulties in implementing the regulations. Stone et al. (2020) confirm this finding. According to Farouk (2017) and Heddar et al. (2021), management involvement is recognised as an effective lever for influencing employee behavior.
- Function F3, 'Installation of the CPHS,' marked by internal variability, includes delays in the election of qualified members or the appointment of unqualified members by management. The aim is to limit the impact of the JHSC in the event of divergences on OHS issues. These problems are related to the remarkable variability of F2, as identified by Curcuruto and Griffin (2023).

Concerning the JHSC functions:

- Function F4, " JHSC meeting," shows a very high variability of "T" and "P," which translates into difficulties in organizing meetings, defining and monitoring objectives, and inefficient functioning of meetings. Bousfot et al. (2022) stress the importance of meetings as the ideal forum for discussing OHS-related problems. The variability of F4 is due to the variability of F3 and F2.
- Function F5, "Inspection of workplaces," has a significant variability of "T," indicating a delay in planning and carrying out inspections due to the variability of F2 and non-compliance with regulations. The significant variability of the "P" criterion refers to a lack of technical means of measurement and the significant variability of F3 and F6, as confirmed by Dugué and Petit (2018).
- Functions F7, "Data collection and analysis" and F8 "Accident investigation are characterized by considerable variability of "P." The investigation and data collection procedure is carried out on time due to the intervention of external actors to the company, such as the National social Security Fund and the Labor Inspection Office. However, the output quality is imprecise due to the significant variability of F3 and the reliability of the data, as revealed by Comberti et al. (2018) and Stemn et al. (2021).
- Function F9 "Training and information", characterized by marked variability in the "P and T" criteria expressing a deficiency in communication and information means and procedures, a lack of a training program, a lack of human and budgetary resources dedicated to training, as well as employee resistance to training. Furthermore, the network in Figure 2 shows that the dysfunctions in F9 are linked to the variabilities in F2, F3 and F6. Several studies corroborate these conclusions. According to Curcuruto & Griffin (2023), programs promoting open communication on OHS effectively supports employee involvement in appropriate OHS actions. Similarly, Kwasiborska et al. (2023) emphasize periodic training to organize raise awareness of the actions carried out during activities, which contributes to improving OHS.

For management and JHSC functions:

- Function F6 "Regulatory Compliance" shows marked variability in "T" and "P", highlighting difficulties in regulatory compliance, due to the notable variability in F2. This finding is corroborated by previous studies, particularly in developing countries (Soyaa et al., 2019; Simukonda et al., 2020).
- Function F10 "Promote OHS" shows significant variations for "T" and "P", reflecting difficulties in the creation, implementation and sustainability of the OHS policy in Algerian companies. The variability of F10 is associated with an increase in occupational accidents and diseases, as well as with poor development of the safety culture within these companies (Fourar et al., 2021).

As shown by the results of the FRAM application on Algerian JHSCs, the FRAM method has demonstrated its relevance for understanding the functioning, highlighting dysfunctions and critical interconnections at the level of the complex socio-technical system selected in this study. This method provides essential elements of understanding to overcome negative performance variability and strengthen the overall resilience of the JHSC.

6. Conclusions

This paper analyses the functioning of a particular complex socio-technical system of “organizational system” using the FRAM method. In this study, the JHSCs in Algerian companies are listed. As with technical systems, FRAM confirmed its relevance for studying and modeling the interconnected functions of JHSCs.
The identification and detailed description of JHSC functions, characterized by their aspects, made it possible to establish a FRAM network highlighting the interconnections between these functions. The FRAM network demonstrates how a given function's performance variability can propagate and impact other functions through a resonance effect.
The observed variability exposes dysfunctions at various levels, including promulgating and implementing of OHS legislation, management commitment, JHSC operation, inspection, and promotion of OHS in Algerian companies. The application of FRAM to JHSCs has shown that the FRAM network makes it possible to understand how these variability’s can propagate and support each other within the JHSC organizational system.
The distinction in variability confirms the primary significant interest analyzing the couplings between functions to understand the root causes of this variability. The FRAM approach demonstrates that variability is caused by emergent phenomena resonating within the functional network. The study of couplings is, therefore, essential for identifying the root causes of variability and guiding the corrective actions to be implemented to optimize the operation of JHSCs and strengthen their resilience.
Despite the many advantages of the FRAM method, its use remains challenging, especially for complex systems with numerous interconnected functions. The construction of FRAM models requires detailed data to identify the functions, their aspects, the characterization of their variability, and their couplings. Furthermore, the use of experts can introduce a degree of subjectivity in this process. The FRAM method is mainly qualitative, so the analysis of the FRAM network and the interpretation of the results, particularly the identification of critical functional couplings, can be complex and requires other quantitative methods for quantitative risk prediction. Despite these limitations, FRAM remains a powerful and flexible method for the safety analysis of complex socio-technical systems when applied appropriately.

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