

Toward a Qualitative Assessment Model of the Process Vulnerability : Case of Project Management in the Automotive Industries.

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Abstract: In the industrial context, especially in a project risk management system, the main concern of project managers and the company's general management is to identify vulnerable processes that generate disruptions to the progress of a project. This article is based on previous research on our qualitative model named "H.I.K", which deals with the three operating factors (Human, Information, Knowledge). Thus, the latter are fundamental elements to evaluate for any development of a new project likely to be contaminated by weakness links to different processes in a project management system, as the case of international companies in Morocco. The major question that arises is then, how to protect our managerial system from major risks related to the lack of evaluation or ignorance of the factors of the HIK model ? For this, the evaluation of these factors is an obligation that must be imposed by the management of the company and can be ensured by delimiting so-called vulnerable or risky processes. We consider, as the first phase of our approach, a qualitative methodology to highlight a qualitative assessment of the elementary and global factors of our concept. Then, in the second phase, we present our quantitative model which will end with an implementation of our tool for assessing the vulnerability of a process through experimental studies in a Moroccan automotive industrial environment.

Keywords : Concept (HIK), Processes, Project management, Qualitative, Quantitative, Vulnerability.

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I. Introduction

In the industrial context, particularly on development of new projects, the direction of engineering management is always thought to be taking into account of many sources of risk that may be influenced on the final result of the project. The risk project management methods are developed from the company to another according to their needs, but do not allow the control of the project in its globality. In addition, every challenge of the company aims to reduce the weak and intrinsic links of their management system in the pre-project phase that can disrupt the way of the project in particular and the goal of the management team in general.

In this article, we propose a conceptual approach to the qualitative modeling of the vulnerability of a process in the project management system within the company. Our research mobilizes work on the proposal of a vulnerability modeling tool through a quantitative evaluation model by introducing the vulnerability index and its factors [1]. From several models of vulnerability mentioned by authors of different domains, the concept of vulnerability remains fundamental to the core of the process-based on risk assessment methods in a project [2] and that we regard as a step prior to the evaluation of elementary and global factors influencing on the purpose of each project.

The objective then is to propose a qualitative conceptual model of the vulnerability of a process through a method of qualitative evaluation of the elementary and global factors studied. This assessment is considered an inseparable part of risk management in a project management system in the company. This first phase is considered as a first step before starting the second phase which will be dedicated to the parametrization of the factors of our model towards a quantitative intelligent tool of the vulnerability of a process using experimental studies in the automotive industrial context in Morocco. In this article we propose an evaluation model taking into account the fundamental elementary and global factors identified in a published article [1]. Our concern will be to : (i) To propose a qualitative approach which helps the decision of evaluation of the fundamental factors studied; (ii) identify the factors that are appropriate to our model and which are the most influenced on a given process; (iii) Validate the qualitative model thereafter.

II. Contexte and Interest

The concept of vulnerability modeling has been defined by several authors from different domains, as it was defined in [3] that the objective of the modeling is not to give a quantitative estimate of the event but it was necessary to have reliable data on vulnerability, in our case we start with a qualitative conceptual analysis using parametrization of the global and elementary factors of our concept as was cited in the [7] on the application to the parameterization of the vulnerability. In [4] We can initiate our study by identifying combinations of the most sensitive or vulnerable factors within our project management system.

This methodology presents a part of our interest in the qualitative study of our proposed concept of the vulnerability of a process in a project management system in the industrial context. For this, the performance of a project management system requires a parameterizable assessment of the factors that can influence the project progress and by evaluating the weak links of our system during the pre-project processes in advance.

III. Problematic of research

In the industrial context on the management system project, the notion of risk remains an unidentifiable aspect before having the undesirable results on the purpose of the project, in particular that means of the management process of the new projects in which the company must ensure the good image and impression with the customer. That said, the culture of management risk project is ignored in the managerial population level in the industrial context in Morocco [5].

Our research problem is oriented towards the qualitative assessment of factors related to a given process in a project management system in terms of its vulnerability. The identification of these factors has been clarified in previous research [1], which provides a better understanding of the weak links that carry risks that could disrupt the purpose of a process. As a first step, the quantitative analysis of our model using the definition of the vulnerability index as indicated in [1] will remain a complicated step to evaluate it, for this we propose a definite preliminary step in this article, we will take a critical approach to the vulnerability of a process, in order to separate the studied factors from our model, so as to take into account the qualitative effect of exposure to major weakness on the state of a process. This section will present a method of vulnerability analysis in two aspects, including the qualitative assessment of elementary factors and the global factors of our H.I.K model [1].

The study of these factors contributes to the qualitative evaluation of our concept, which has the theoretical objective of identifying the most vulnerable combinations that constitute three factors studied and concretely revealing through the experiments the weakness of a process and identifying the malfunction of our system. Our general research problem can then be stated as follows : **How can we parameterize the elementary and global factors of a process, in order to qualitatively assess vulnerability in the framework of project risk management in the industrial context ?** In order to provide the answers to our general research problem, we must first determine how to qualitatively evaluate the elementary and global factors of vulnerability and then define the factors that are most vulnerable from our proposed model (HIK). in this article ?. The second research sub-question: What level of analysis should be used to determine the basic vulnerabilities that interact to define the combinations that are more sensitive and vulnerable in our qualitative model ?

IV. Approach and research methodology

In this article, we focused on a method of qualitative assessment of vulnerability, based on our model (H.I.K) as a reference concept of our study. On which it can be divided into two types of analysis, namely : qualitative and quantitative (Figure 1).

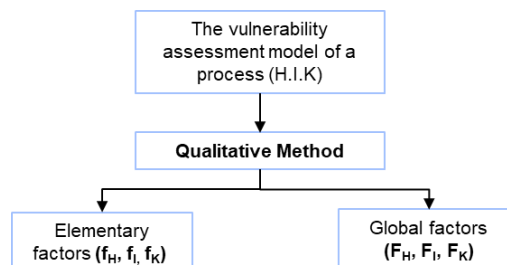


Fig.1: Qualitative methodology conceptual of the model « H.I.K »

Modeling of the qualitative vulnerability of global factors of our model is based on 13 elementary factors [1], which are summarized in the figure 2. Each parameter will be valued qualitatively at the end of its vulnerability by an elementary indication "v" and global by "p".

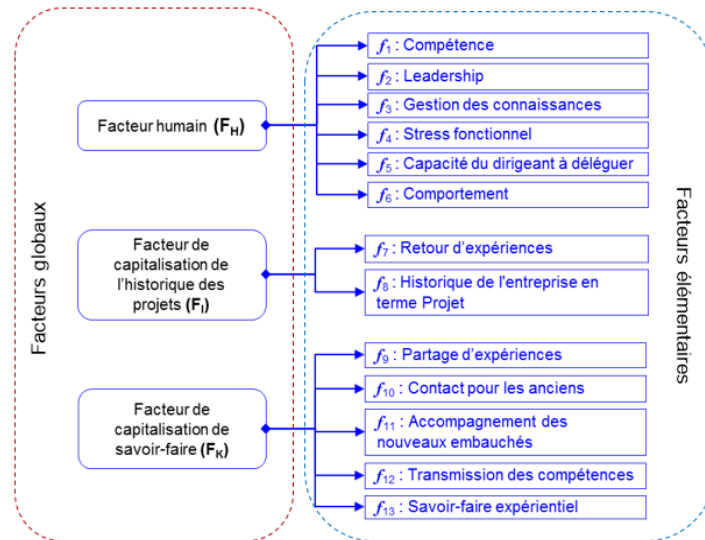


Fig. 2 : List of elementary factors analysis and global of the model « H.I.K »

The rating principle chosen corresponds to the sensitivity criteria as a function of the evaluated valuation of each factor studied in terms of its qualitative vulnerability. This methodology is an analysis that must be adapted to the objectives and research question in the assessment of our model at the end of its vulnerability. In the light of this new concept, our research, whose aim is to provide an analytical framework to have a level of vulnerability, based on the qualitative analysis of the global and elementary factors and involve the implementation of a qualitative method of collecting data by integrating sensitivity analysis by identifying the vulnerability index "Iv" of the process [1].

V. Reference model : Qualitative Analysis of Model H.I.K

5.1. Qualitative analysis of the elementary factors (fH, fI, fK)

As a first step, we start by analyzing the elementary factors of our model. For this, the qualitative analysis of the elementary factors is a necessary and intrinsic data as a first phase and a data collection and analysis technique using the concept of our study (Figure 3).

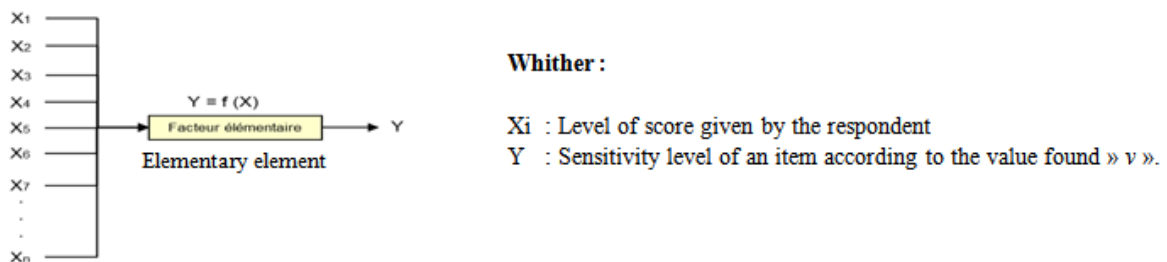


Fig. 3 : Conceptual study of a elementary factor of the concept « H.I.K »

Taking in account the inputs Xi being an assessment of each respondent to have a single output Y of an element being an evaluation result in terms of its sensitivity. In this case, it's a question of working with an ordinal scale of 1 to 5 levels proposed in "Table 1" with an initial score level that changes to a sensitivity scale of an element (f_e) after calculating the variance of each element.

Table no 1 : The example of the assessment scale used for the elementary factors

Score	Score level	Variance scale of an element	Sensitivity scale of an element
1	Less impact	0 ≤ v < 1	Less sensitive
2	Low impact	1 ≤ v < 2	Low sensitive
3	impacted	2 ≤ v < 3	Sensitive
4	More impact	3 ≤ v < 4	More sensitive
5	Extremely impacting	4 ≤ v < 5	Extremely sensitive

First of all, we can calculate the value of the variance "v" according to the chosen population of our sampling based on the theoretical saturation principle and allowing to identify the sensitivity of the element by using the following equation :

$$v(X) = \frac{\sum_{i=1}^N (X_i - \bar{X})^2}{N}$$

Legend :

X_i : Resulting score level by the respondent (from 1 to 5).

\bar{X} : Average score of the investigated X.

N : Total number of the defined population.

This research is particularly appropriate when the elementary factors observed are difficult to measure or to find, our goal is to give these factors of values and reliable criteria for validation which contributes to the evaluation of our model.

5.1.1 Indirect sampling techniques used

The techniques that we are going to list are generally used to detect and identify theoretically and qualitatively the basic elements sensitive and vulnerable. However, a number of authors had tried to use these techniques for a quantitative study of populations. But this time, what are work only will be targeted to a qualitative approach of our model. All the analyses of the data necessary to answer our problematic are based on results obtained from our conceptual research work on the model of vulnerability that could be defined as global and elementary factors (f, F) [1].

In this context, we prepare a sample by population area with a category by department concerned and which are direct stakeholders in the process chosen in the project management system. However, we follow an exemplary harvest chart for all the information involved in the chosen process (Table 2). In order to provide the maximum of information, we diversify the data sources as much as possible until the theoretical saturation [6].

Table no 2 : Exemplary table of general information on the respondents by service.

Position	Type (M/W)	Seniority (Years)	Activity sectors	Department
Responsible 1	W	8	Automotive	Engineering
Responsible 2	M	3	Automotive	Quality
Responsible 3	M	10	Automotive	Maintenance

According to Thiétart in 2014¹, say that "the size of the sample is actually to estimate the minimum size required for the results with a satisfactory confidence". The selection of our sample is made from the selection of a single process according to its reasonable criticality and judged by the management team in a project management system. On the other hand, we can't study all the processes at the same time, seen the complexity of sequence of the process found within the company.

5.1.2 Techniques of data collection

In the context of qualitative research, we propose to distinctness between several modes of data collection, namely: individual interview, group interview, participating or non-participating observation and collection of documents. In this context, we will choose a method most appropriate to the field of activity of the chosen company, that is why we will start our study from individual interviews semi-directive, using the following (Table 3).

Table no 3 : Tableau exemplaire de collecte de données par enquête.

Processes	investigat ed	Global factor (H.I.K)	Elementary factor related by the model	Department	Example	1	2	3	4	5
Process 1	RES. 1	Human	Competence	Engineering	To be defined			X		
Process 2	RES. 2	Information	Return of experience	Quality	To be defined				X	
Process 3	RES. 3	Knowledge	Sharing of experience	Maintenance	To be defined			X		

5.2. Qualitative Analysis of the global factors (F_H, F_I, F_K) :

In the conceptual framework, we prefer our qualitative analysis using the identification of possible combinations at the level of the global factors that give the degree of each parameter and its impact on the process studied according to the difference function of a process to another and the size of the project in an industrial context.

From the first qualitative analysis of the elementary factors, we can conclude the size of impact "p" found, it is necessary to assess the situation of each global parameter in the most objective way possible. It should be, for this purpose, rate the possible combination, taking in account the nature of the process studied :

¹ Thiétart, R. A. (2014). Méthodes de recherche en management. Paris, Dunod.

Table no 4 : Rating scale that can be used for the global factors

Degrees of impact	Signification	Scale average of elementary elements	Classification of global factor scale / investigated
H_{Mi}	Less impacting	$0 \leq p < 1$	Less sensitive
I_{Pi}	Low impact	$1 \leq p < 2$	Low sensitive
K_{Ti}	Very impacting	$2 \leq p < 3$	Very sensitive

$$p = \frac{\sum v_f}{N}$$

Legends :

p : The average of the variance of a global setting;

v_f : Basic variance of an item;

N : Total number of elements.

The possible combinations can be found to qualitatively assess the process (Figure 4):

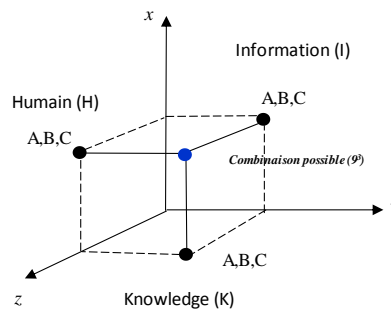


Fig. 4 : The growth of the global factors in the model « H.I.K »

5.2.1 Presentation of theoretical model HIK

The intersection of these data that allow to obtain a listing that aids and classify the priorities to be implemented in the framework to find the conditional interaction between the factors being considered. Based on this analysis we can find different assumptions (Figure 5, 6 & 7) that allow to find the qualitative weak links in our model, with which we can measure them by experiences that it will be the goal of our following article.

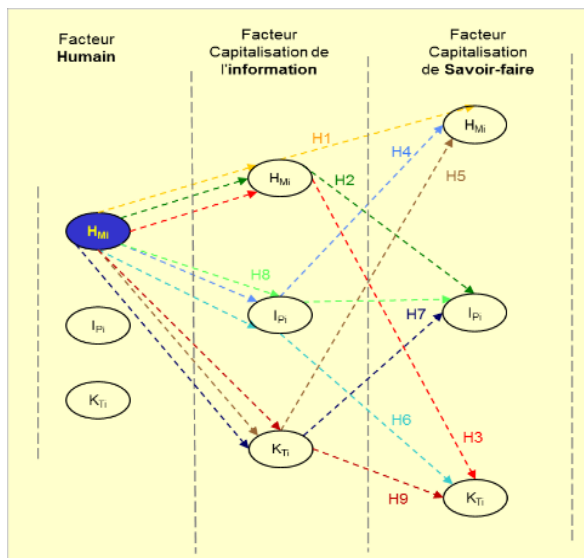


Fig. 5: The possible combinations related by the human factor of the model « H.I.K »

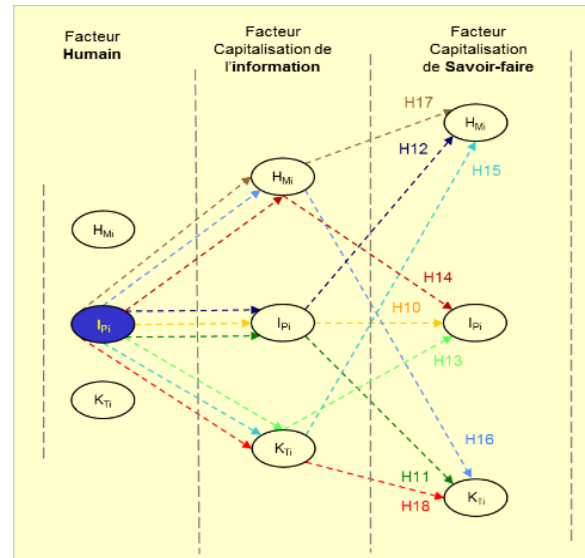


Fig. 6: The possible combinations related by the information capitalization factor of the model « H.I.K »

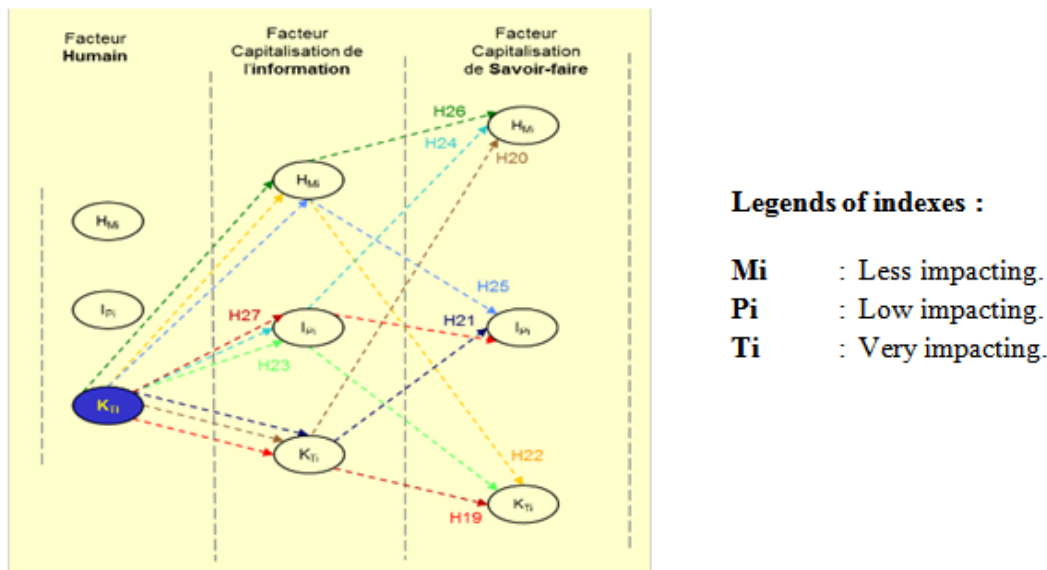


Fig. 7: The possible combinations related by the Knowledge capitalization factor of the model « H.I.K »

5.2.2 The theoretical assumptions of research according to the H.I.K model

The principal of theoretical reflections are necessary to understand the interaction between the parameters of our model and its qualitative valuation. The goal is to identify the possible combinations that are links between three factors that transform theoretical and qualitative assumptions by the state of each factor, highlighting the following levels: (little impact, Medium impacting and very impacting), in order to find the qualitative vulnerability of our most suitable for our theoretical model (H.I.K) of global factors. The following figures show the different assumptions of research from our model, so this analysis to identify all possible combinations, the starting assumptions lies in the fact that the working conditions are the main qualitative factor.

In fact, we hope through this qualitative analysis affirm the importance of an assessment by combination by valuing the degree of vulnerability questioning us about the place of variables in our model, in order to identify if there is specific relationships between the variables in our model in the automotive industrial context in the Morocco. This approach will help us to understand the cultural contexts of the surveyed players. The ultimate goal of this analysis is to refine our conceptual model. Subsequently, the results of this phase will provide the basis for a quantitative empirical study. Our theoretical model aims to understand the path by which the project management system contributes to the performance and maturity of the studied process to risk management project. Thing that can bring a clarification on the roles of the different actors of the company operating in this sector, in order to create synergies, whose goal is to have a better understanding of the key processes related to project management systems to the company. The ambition of our research based on these assumptions is to position our qualitative concept in the system of project management as a lever for good predictive risk management within companies of the automotive industry Moroccan.

- The assumptions proposed for relating to the human factor combinations :

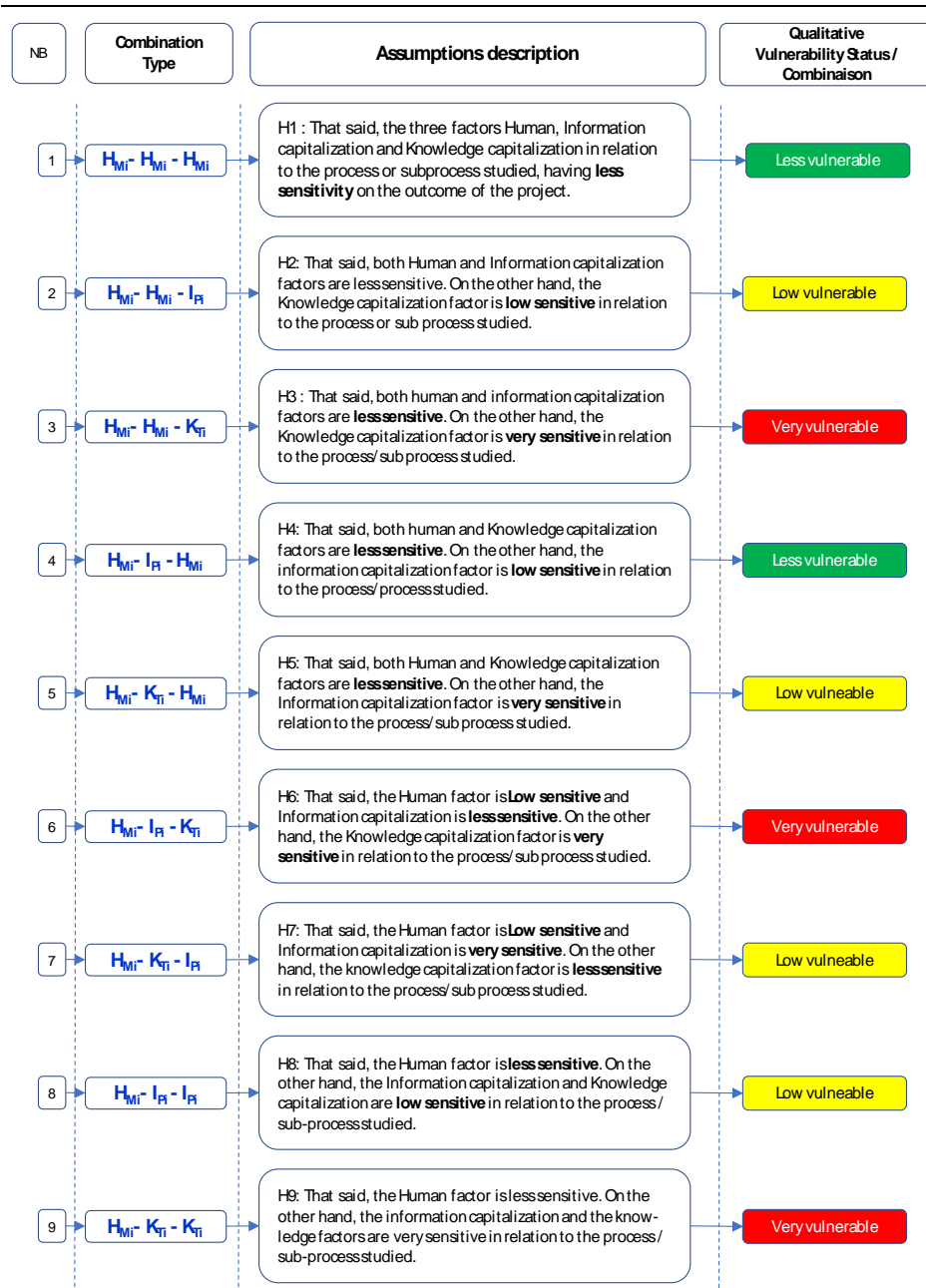


Fig. 8 : First group « G1 » of the assumptions proposed with their degrees of qualitative vulnerability

Synthesis 1 :

Based on the first phase of combination analysis relating to the human factor and according to the different results obtained theoretically in terms of its valuation of vulnerability. We find that this loop constitutes **22.2%** of combinations are less vulnerable, **44.5%** of combinations are low vulnerable and **11%** of combinations are very vulnerable, which says that the human factor theoretically has low vulnerability for any process in a project management system within the company. the human factor plays a very important role in the lead of a project and its steering towards the results desired by the company's management, but from the analysis that has been done it seems that this factor does not have a vulnerable impact on the result of a process because it can have the human factor as much as a pilot of a project but without having the establishment of Know-how and Information relating to our projects.

- The assumptions proposed for relating to the capitalization of Information factor combinations:



Fig. 9 : Second group "G2" of the hypotheses proposed with their degrees of qualitative vulnerability

Synthesis 2:

During the second phase of analysis of the studied combinations related to the factor of information capitalization according to the different results obtained theoretically in terms of its valuation of vulnerability. We note that this analysis showed that 22,2% of the combinations are less vulnerable, 33,3% of the combinations are low vulnerable and **44,5%** of the combinations are very vulnerable. That said, the capitalization of information factor presents a vulnerability little impact on a process given in a project within the company management system. This factor plays a very important role in the sustainability of the information or the capitalization of the history of a project to learn from other future projects, based on the analysis we did it seems that this factor has a vulnerable impact on the result a process because the ignorance of a tool of the establishment or lack of information it may generate delays in actions or the implementation of a project in time given and agreed with the customer.

- The assumptions proposed for the related combinations to the factor Knowledge (Know-how):

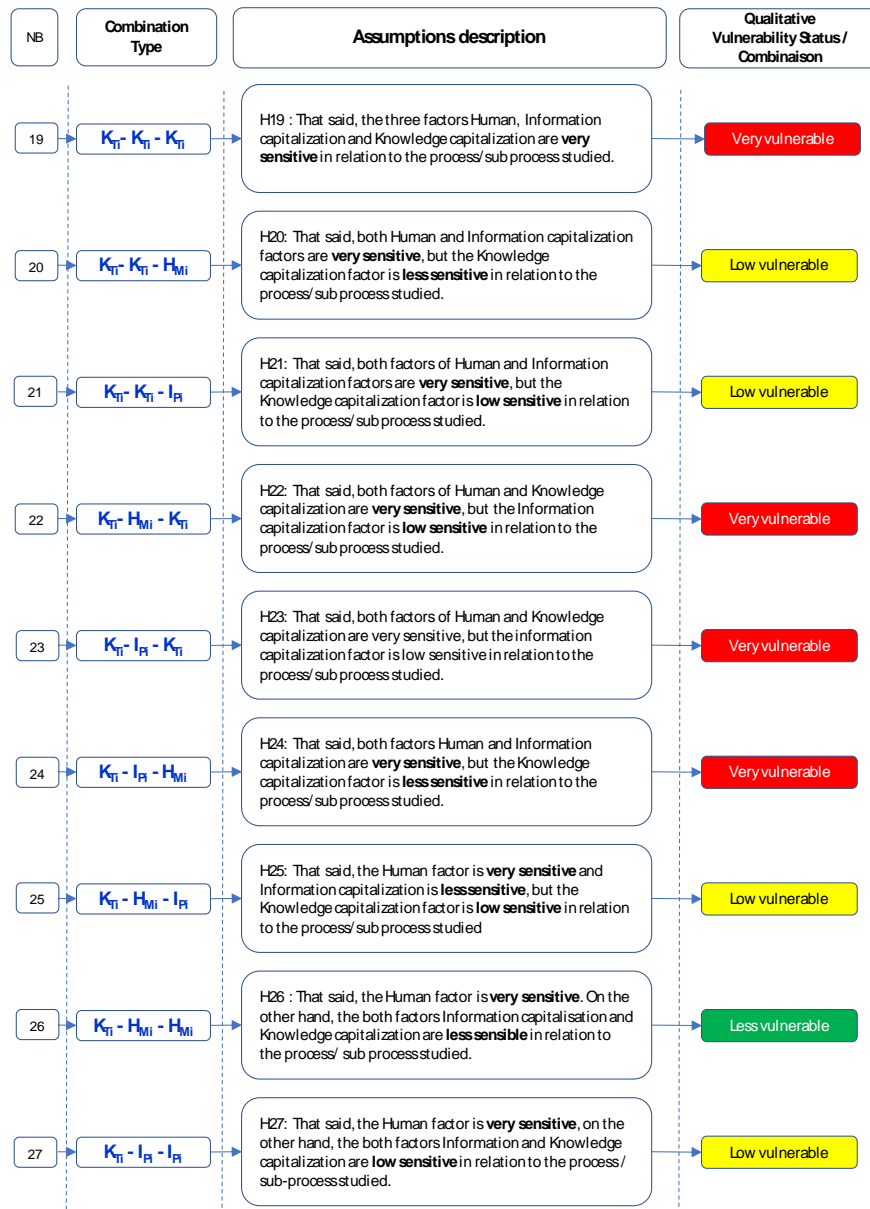


Fig. 10 : Third group "G3" of the assumptions proposed with their degrees of qualitative vulnerability.

Synthesis 3 :

In the final phase of analysis about the combinations of the know-how capitalization factor and according to the different results theoretically obtained in terms of its vulnerability valuation. We find that this analysis is given to 11% of combinations are less vulnerable, **44.5%** of combinations are little vulnerable and **44.5%** of combinations are very vulnerable, it said that the capitalization factor of know-how theoretically has a very significant vulnerability that impacts on a given process in an industrial environment. This factor plays a very important role in the sustainability of a project using the means and capitalization techniques within a project management system and which allows us to retain the knowledge and skills acquired and accumulated. strategically by an experienced population. It is also a question of integrating know-how into industrial processes or business processes.

Based on the analysis, it appears that this factor has a vulnerable impact on the outcome of a process because ignorance of a know-how tool can lead to disruptions in the purpose of a project that is based 80% of experienced employees represents a mature and capable team for the success of a project.

• **Summary and explanation :**

Table no 5 : Explanations on the results of the assumptions proposed

N°	Types of Combinations Studied	Studied factors of our HIK Model	Explanations and discussions on the results of the combinations found
1	$H_{Mi} - H_{Mi} - H_{Mi}$	Human	In this set of G1 combinations relating to the Human Factor, it is found that the latter plays a very important role in a given process during the development of a new project and its assessment of its vulnerability. On the other hand, in this first phase we find that the capitalization of know-how and information are more qualitatively vulnerable and sensitive in relation to the Human factor.
2	$H_{Mi} - H_{Mi} - I_{Pi}$		
3	$H_{Mi} - H_{Mi} - K_{Ti}$		
4	$H_{Mi} - I_{Pi} - H_{Mi}$		
5	$H_{Mi} - K_{Ti} - H_{Mi}$		
6	$H_{Mi} - I_{Pi} - K_{Ti}$		
7	$H_{Mi} - K_{Ti} - I_{Pi}$		
8	$H_{Mi} - I_{Pi} - I_{Pi}$		
9	$H_{Mi} - K_{Ti} - K_{Ti}$		
10	$I_{Pi} - I_{Pi} - I_{Pi}$	Information Capitalization	In this set of G2 combinations relating to the information capitalization factor, we find that the know-how capitalization factor is most sensitive at the end of its vulnerability qualities of a given process or process. That said, ignorance of know-how factor will have a negative impact on the outcome of a project.
11	$I_{Pi} - I_{Pi} - K_{Ti}$		
12	$I_{Pi} - I_{Pi} - H_{Mi}$		
13	$I_{Pi} - K_{Ti} - I_{Pi}$		
14	$I_{Pi} - H_{Mi} - I_{Pi}$		
15	$I_{Pi} - K_{Ti} - H_{Mi}$		
16	$I_{Pi} - H_{Mi} - K_{Ti}$		
17	$I_{Pi} - H_{Mi} - H_{Mi}$		
18	$I_{Pi} - K_{Ti} - K_{Ti}$		
19	$K_{Ti} - K_{Ti} - K_{Ti}$	Knowledge (Know-How) Capitalization	In this set of G3 combinations related to the Know-how capitalization factor, we find that this factor is the most important factor that needs to be considered in assessing the vulnerability of a process. That said, this factor has a radical impact on the outcome of a project.
20	$K_{Ti} - K_{Ti} - H_{Mi}$		
21	$K_{Ti} - K_{Ti} - I_{Pi}$		
22	$K_{Ti} - H_{Mi} - K_{Ti}$		
23	$K_{Ti} - I_{Pi} - K_{Ti}$		
24	$K_{Ti} - I_{Pi} - H_{Mi}$		
25	$K_{Ti} - H_{Mi} - I_{Pi}$		
26	$K_{Ti} - H_{Mi} - H_{Mi}$		
27	$K_{Ti} - I_{Pi} - I_{Pi}$		

VI. Analysis and discussion

The contribution of our research lies in a new concept proposed in this article, which allows to assess the vulnerability overall and qualitative factors Basic (f) (F) of our 'H.I.K' model for processes and/or under process as part of the management of projects in an industrial setting. Or, considering it as a first step in evaluation of the proposed model to allows us to begin the second phase quantitative into that we can quantify our model to aid an empirical study that evaluates the index of vulnerability "Iv" and which is a tool for decision support to managers of projects in industry and which will also guide the direction of management of the company to an effective management plan.

L'objectif ultime de cette analyse est d'affiner notre modèle conceptuel. Notre modèle théorique vise à comprendre le chemin par lequel la vulnérabilité qualitative d'un processus dans un système de management de projet contribue à la performance et la maturité des processus en terme de sa faiblesse dans le contexte industriel. Chose qui peut apporter une clarification des rôles des différents acteurs de l'entreprise opérant dans ce secteur, afin de créer des synergies, dont l'objectif est d'avoir une meilleure connaissance des processus clés liés aux systèmes de management risque projet. L'ambition de notre recherche est de placer ce modèle comme levier de la bonne gestion de projet à risquer ou vulnérable. Dans ce cadre, nous avons considéré le concept trouvé en fonction de l'évaluation qualitative des facteurs globaux et élémentaires et qui fait partie de notre modèle de la vulnérabilité d'un processus dans le contexte industriel.

The results of the analysis, that we found **89%** of the combinations showed the factor of capitalization of know-how (**Knowledge capitalization**) is the most impacting compared to the factors of the studied model, this is that the qualitative influence of this factor on the purpose of a process can affect the outcome of a project. In addition, **78%** of the combinations showed that the capitalization of information plays a very important role on the sustainability of a project and keeping the flow of information and project history.

After these analyses, we noted that the human factor is moderately impacting approximately **11%** on such project, there may be a change of employees within a project, but without having the necessary jurisdiction for information on detailed history a project that are diverged towards the goal of a project.

VII. Conclusion

This article was based on the proposal of a new concept of our model "H.I.K" in the industrial context, the latter is subdivided into two qualitative and quantitative concepts as part of project risk management, in order to assess the vulnerability of a process with the help of a theoretical and conceptual study that allow to find combinations are at least different according to their degrees of vulnerability and sensitivity. Speaking on

the global factors (human, capitalization of information and know-how (Knowledge)), so it seems necessary to break up this model in three combinations related to these factors being considered for assessing vulnerability qualitative of a process. This assessment took place from a strong hypothesis proposed that we can trace the fragile and sensitive bindings for a given process. The types of the corresponding assumptions that led to the development of a quality conceptual model.

In any case found in this study, the degree of qualitative vulnerability would be more impactful when you could have three factors are vulnerable in a process, which will cause disruption to the progress of a project activity level in an industrial setting.

This methodology to provide solutions to this problem in a qualitative concept. Found combinations are functions which are to guide and organize a project manager to control the weak links of a system is the process in a value chain. The assessment of these combinations according to the proposed model is not an end in itself and the vulnerability of the process is an omnipresent permanent issue in each direction of the company activities and including, which should permeate more and more management function and the goal of the company.

This model has an excellent decision-making tool at the preliminary stage of the expertise in the hands of the management of the company in the direction of development of new projects.

Acknowledgments

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