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Risk Mitigation and Monitoring Challenges in Software Organizations: A Morphological Analysis

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Abstract— **Context:** The present body of research on risk mitigation focuses mostly on sparse and dispersed research using various approaches during project development.
Objectives: This paper's goals are to conceptualize and construct a morphological analysis (MA) framework, examine the literature that has already been published on these risks and how to mitigate them in software development, and identify research gaps that suggest areas for further study.
Methods: Based on a survey of 102 works, we provide an MA framework. The MA framework, which is composed of five dimensions and 17 variants, identifies 33 distinct research gaps as the maximum number of potential areas for future study. The implications for future research are covered in the paper's conclusion. Risk reduction during the project development process is extremely beneficial for project managers at an organization in delivering high-quality goods on time and within budget.
Results: Based on a review of the literature, it was discovered that the development of software projects used a very low percentage of official risk mitigation and elimination methods. Research also revealed the significance of people-related risks in the risk mitigation process for the benefit of the organization. Some key research demonstrated experimentation, case studies, and empirical approaches for evaluation. Future work may include examining project managers' perceptions and knowledge of risk management. Managers of software development teams require greater risk-mitigation strategies.
Conclusion: Scholars and researchers need to put more effort into developing quantitative and intelligent risk models. It is crucial to identify major risks so that they won't compromise the project's future success. In our future work, we can employ more models that are helpful for combining quantitative and intelligent risk models using various AI strategies to reduce hazards.

Keywords- Risk Mitigation Monitoring and Management, Morphological Analysis, Risk Factors

I. INTRODUCTION

Mitigation and elimination will raise project success rates, give accurate time estimates, and boost the caliber of the final result. A risk avoidance plan tries to entirely eliminate risk rather than only aiming to diminish its effect on the firm. An organization can reduce risk, for example, by delaying a project. Another strategy for reducing risks is called risk reduction since it decreases the likelihood that they will occur or the intensity of their effects. Managers of risks and business executives should adopt agile project management techniques to meet the organizations' goals for risk reduction. The many different types of risk can be managed by a firm using a range of risk mitigation strategies, such as risk avoidance and risk reduction. Future work may include a study of project managers' perceptions and knowledge of risk management. Lack of study on risk management strategies for micro and small businesses Studies on risk analysis and management are currently being conducted in both traditional and different ways. The literature research led to the conclusion that new risk-mitigation technologies, like genetic algorithms, Bayesian statistics, etc., are required in software projects in order to test the efficacy of novel techniques and approaches. Managers of software development teams need to implement more risk-mitigation techniques. Researchers and academics must put in more effort to develop clever quantitative risk models. By fusing quantitative and intelligent risk models, we can merge more models in our future work to lower risks.

The Risk Management Plan, a document that specifies the risk management practices to be applied throughout the Project, is what the Plan Risk Management process aims to generate (PMBOK Guide). A corporation with a high appetite for risk will have a high level of risk tolerance since it wants to make big profits, as opposed to a company with a low appetite for risk, which may aim for lower but safer profitability. Risk

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appetite defines the percentages that will be allocated to likelihood and impact in the analysis matrix depending on the threshold that has been established by stakeholders by setting the acceptable risk threshold for a project.

The first process in the knowledge area is Plan Risk Management since it defines the guidelines that must be followed for carrying out all other risk management procedures in the Project. For any project to achieve organizational commitment and the individual commitment of every Project Team member, these guidelines must be in place within the parameters of the policies, procedures, and cultures of the participating organizations. The minimal basic aspects that must be clarified and documented for proper management as well as to ensure effective communication among all engaged stakeholders are project risk management rules, processes, procedures, templates, limits, roles, and responsibilities.

If the risk is below that threshold, the organization will take it. Over that risk threshold, the organization will not tolerate any risk. (PMBOK Guide) / Project Management Institute. Since there are so many outside variables to take into account, risk cannot be avoided in business. The predicted outcomes and your risk tolerance will influence how you manage hazards. It may be useful for you to comprehend the potential hazards if you work in management for an organization. Particularly cutting-edge IT initiatives and software projects are constantly subject to significant levels of risk. The improper criteria or specifications of a software project are one of the biggest obstacles that must be overcome when working on a creative software development project. However, since no prior data can be used or consulted in that regard, managing this in creative initiatives might be challenging. In order to accurately ascertain the needs of clients and end users, one must exercise extreme caution [59].

Risk management strategies are critical as they contribute to the success of the projects in many ways:

• Project managers and workers can concentrate on the factors that are most important and have the biggest effects on the project because risks are prioritized and ranked.

• By reducing overall project risk, risk mitigation measures hasten project completion.

• Because projects are finished faster, they are less expensive. Additionally, taking steps to avoid risks may further lower project costs.

• Projects that employ risk reduction techniques follow more foreseeable completion timetables and encounter fewer surprises.

• Risk identification enables all staff to document their view of potential problems and provide suggestions on how to prevent or lessen the severity of such issues.

• Risk mitigation aids in attaining company objectives and maximizing shareholder value. • It offers an audit record of the risk-handling effort in a project.

II. THEORETICAL BACKGROUND AND RESEARCH GAP

High-level risks must be recognized, understood, and managed since they vary in nature, severity, and consequences [37]. The process of identifying and estimating system risks can be accomplished by a variety of techniques—regression analysis, expert systems, and stochastic models; Influence Diagrams, Monte Carlo Simulation, PERT, Sensitivity Analysis, Multiple Criteria Decision Making (MCDM), Fuzzy Sets Approach (FSA), Neural Networks, Decision Tree and Fault Tree Analysis, Risk Checklist, Risk Map, Cause-And-Effect Diagram, Delphi Technique, and Combination of Decision Tree and AHP.

According to the reviewed literature's tendencies, identifying risk factors seems to be a common theme in studies. However, it seems to us that the author’s main aim is to establish the dynamics of the software development environment so that further research on this topic might be produced. The lack of research on this subject in some journals that focus on research on micro and small firms is another sign that further research is required. Another rationale for performing more research on micro and small firms is that none of the studies assessed directly mentioned them; rather, the majority of the studies' subjects were important governmental or private sector enterprises or initiatives. The ability to recognize and categorize risks in an incubated company may represent a breakthrough in their management procedures, enabling new research that may assist the managers of these companies in determining which operations require more attention in terms of potential risks and what choices to be made in the event of an emergency [60].

One of the major issues that must be handled expertly and effectively is risk management. Implementing preventative measures is crucial to reducing the likelihood of risk occurrences and their effects on achieving effective project management. Risk management is one of the nine knowledge areas used in software project management, and it is very important. Various risk management models and concepts are covered in this essay. A framework or model is selected for managing risks in a project as a tool for effective risk management. Included are the fundamental procedures for risk identification, risk assessment, risk reduction, and risk monitoring and control. The goal of project risk management is to minimize potential negative risks as much as possible while maximizing potential positive risks.

Risks are evaluated, and prioritized, and a strategy is developed that outlines containment measures that will lower

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the risk's likelihood of happening and/or lessen its effects if it does. The plan also specifies the associated triggers (indications that the risk is developing into a problem) and emergency actions that will be put in place if the risk becomes a problem. The plan's containment component is subsequently put into practice, and steps are taken. The tracking stage entails keeping an eye on both the status of identified hazards and the outcomes of risk reduction efforts. When a problem first appears, a trigger signals its commencement, and the accompanying contingency preparations are put into action. The inclusion of recently discovered risks or the elimination of existing risks is another possible outcome of tracking [11]. A trigger should be present for every risk that has a backup strategy. The earliest sign that a danger will materialize is called a trigger, which is a future time or occurrence. We want to set the trigger as early as possible to give ourselves plenty of time to implement risk mitigation strategies. Additionally, the further in advance we can set the trigger, the more information we will have at our disposal to help us make the best decision. The time and money spent on creating the project documentation is one of the issues with traditional methods. Project management standards may be combined in future studies, according to studies in the fields of risk management and Agile Scrum methodology. such as PMBOK, P2M, OPM3, PRINCE2, etc., and Agile techniques like Scrum, DSDM, XP, and ASD that place a stronger emphasis on project management procedures to construct hybrid models to assess and minimize the risks connected with software projects.

Such a large future study is possible if academics can build a systematic picture of the entire conceptual domain of risk reduction in project development. In order to use morphological analysis (MA), a qualitative approach, to break down this complicated phenomenon into its component pieces, we intersected the elements reflecting the literature on risk reduction in the project development process. This allowed us to make suggestions for further research. There are several other approaches to literature reviews, but this one is the most common. MA combines numerous other treatments' most significant benefits, including:

a) Using a conceptual framework to represent the literature;
b) Highlighting temporal developments in the study and existing as well as potential linkages across works;
c) Proposing novel options for extension.

One of the key benefits of MA is that, prior to any prioritization for more study attention, research gaps may be graphically recognized using the Variants' Intersection Matrix (VIM). The fact that MA is a modular conceptual representation technique also allows for progressive enhancements and/or additions from other researchers, resulting in a continually expanding body of knowledge that reflects the most recent results in the literature within a tabular framework. The remainder of the essay is structured as follows. This introduction is followed by an explanation of the theoretical framework and a description of the methodology used to conduct the systematic review of the literature. Following that, we give a descriptive analysis of the publications that were chosen for the review before moving on to morphological analysis. The VIM resulting from the MA is then presented. The discussions, contributions, and implications are then presented [96].

As a result of research on various processes (such as Risk mitigation monitoring management) and risk events related to risk mitigation in project development in an organization growing in silos, there are gaps in the literature and a lack of understanding of the risk mitigation process as it occurs in real-world scenarios. Therefore, we use MA to organize the body of knowledge on risk mitigation monitoring and management. To do this, we identify the various structural components of the project development process in an organization and pinpoint potential areas for further research into their intersections (i.e., by generating various possible configurations of the intersections).

III. METHODOLOGY

An overview of primary research that uses repeatable processes is included in the systematic literature review (SLR) which is a type of MA. Additionally, there are other varieties of SLR, including bibliometric reviews, meta-analyses, structured reviews, theory-based reviews, and framework-based reviews (Tabular representations that organize the informative content from the articles make up structured reviews. Typically, such reviews are laid out in a number of tables. A framework is used to create a framework-based review. Unlike the narrative form of review, which includes more descriptive write-ups and fewer tables, the bibliometric review does not provide an in-depth analysis of the methodology or constructs. A substantial corpus of literature in the subject area is necessary for a meta-analysis. In an MA, the body of existing literature is arranged into conceptual dimensions, subdimensions, and variants [98][97] which collectively represent the conceptual space of the subject at hand. Another benefit is the Morphological Framework's modular design, which allows for future additions of new dimensions, sub-dimensions, and variants.

A. Systematic Review Protocol

The following search phrases were used to conduct the search: [Risk management or mitigation of risk] AND [Software development life cycle or IT projects or enterprises]. AND [frameworks or models] In the abstract field of the Emerald, Taylor & Francis, Springer, IEEE Xplore, Mendeley, Science Direct, Wiley, and Sage databases, along with [HR risk management framework] AND [risk factors].

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Utilizing Mendeley desktop software, duplicate results were removed, leaving 394 articles. 198 papers were kept after the removal of articles that do not pertain to risk mitigation and proceedings that do not pertain to peer-reviewed publications. For a more thorough search result, contend that an organic search should be added to a mechanical search of journal articles. As a result, a natural search inside these 198 publications was done to find more cited papers. There were now 204 papers altogether (Fig. 1) after this rose to 6 papers.

The documents were then thoroughly read after being downloaded. We specifically looked for the following: (1) Does the paper explore, propose, or test a framework or concept(s) linked to risk mitigation in IT organizations and enterprises as its main point of focus? (2) Does the article at least partially address the process of risk reduction, for example, by creating implications or contributions for risk mitigation in IT companies and businesses? Papers that didn't fit the above two requirements were discarded. In the end, we had 102 papers on the enterprise risk reduction process and IT organizations, which were used to create the MA framework. A Microsoft Excel database was constructed to classify these 102 papers and look at the trends in the corpus of knowledge. The body of knowledge was conceptually organized using MA, a "systems thinking" technique, in terms of its constituent dimensions and their related variants, in order to identify research needs.

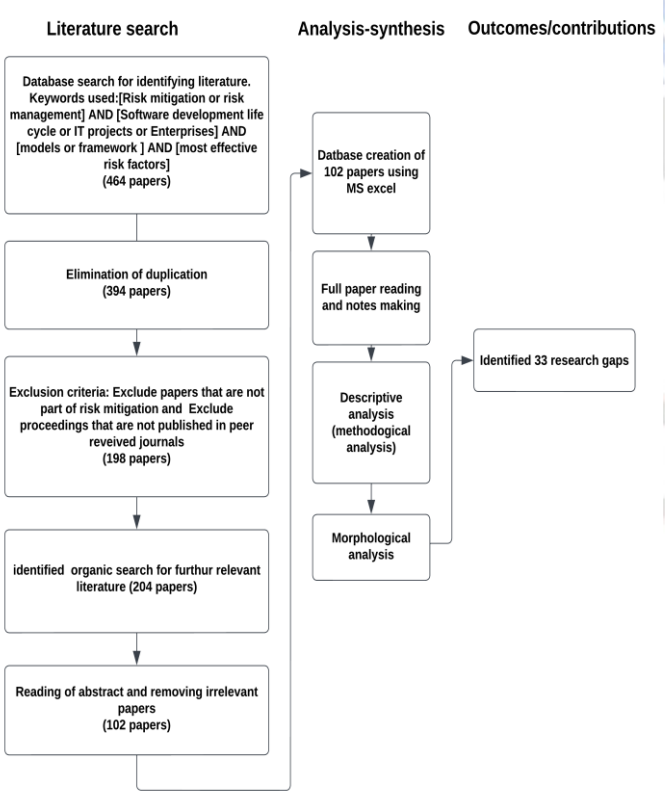

Figure 1 Summary of the methodology used in the paper

B. Morphological analysis overview

The social sciences typically employ the well-structured, qualitative MA technique "for systematically structuring and analyzing the total set of relationships contained in multi-dimensional, non-quantifiable problem complexes"[100]. Some advantages of MA were mentioned at the start. Right now, the MA process is being described. The issue complex or system must be grouped into several dimensions, subdimensions, and variants in order to be considered in MA. Then, the whole set of potential combinations of variants can be analyzed by cross-matching (or intersecting), which can help discover the gaps. The MA technique and SLRs have both been blended by a number of management academics. One study by Xin et al. (2010) employed MA to help practitioners and policymakers spot emerging technical opportunities. Knowledge transmission in organizations was the subject of a literature study conducted [96-99] using MA. [97] used MA to organize the literature on Lean Six Sigma (LSS), [98] used MA to include sustainability in construction projects.

The MA framework is used to identify potential areas for subsequent research. It can be used by researchers to identify dimensions, variations, or combinations that haven't been sufficiently covered in the literature. Based on their earlier experience defining dimensions, sub-dimensions, their components, and adjustments therefrom as well as their knowledge of the literature, two of the authors debated and developed the MA framework. The basic draught MA structure underwent three versions before being finished. It was double-checked and then thoroughly evaluated by the remaining authors. The MA framework (shown in section 4) contains 5 broad dimensions, 7 sub-dimensions, and 17 variants as a result. In order to create a VIM, the variances of these dimensions were crossed. By severing the links between the variations of the same dimension, internal pairing—the following phase in the analysis-synthesis process—was subsequently terminated. As a result, the new VIM was created, connecting every dimensional variant in the MA by cross-references (as shown at the end of section 4). It is critical to note that no references to direction or causality were made throughout this matching approach; instead, the mutual coherence of the paired variations was examined. 33 research gaps were ultimately identified as a result.

C. Descriptive analysis

Our MA framework was created using 102 publications in total, as was previously mentioned. The methodological analysis is described in Table 1 in general terms. Out of 102 papers, 55 (54%) were theoretical or conceptual in character, followed by 24 (23%), 10 (10%), 8 (8%), and 5% from survey-based research and five (5%), respectively, from case study research and empirical studies.

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TABLE 1 PAPERS METHODOLOGICAL CLASSIFICATION

Research Method	No. of papers	% papers	Sample papers
Theoretical (Review)	55	54	Elzamly, Abdelrafe & Hussin, Burairah. (2014) Khdour, Thair. (2014)
SLR	5	5	Masso Daza, Jhon & Pino, Francisco. (2020) Menezes Júnior, Júlio & Gusmao, Cristine & Moura, Hermano. (2019)
Case study research	10	10	Dey, Prasanta & Kinch, Jason & Ogunlana, Stephen. (2007) Alshehab, Abdullah & Alfozan, Thalaya & Gadelrab, Hesham. (2021)
Empirical study	8	8	Irfandhi, Kornelius. (2016) Addison, Tom & Vallabh, Seema. (2002)
Survey based research	24	23	Felderer, Michael & Auer, Florian & Bergsmann, Johannes. (2017) Baccarini, David & Salm, Geoff. (2004)
Total	102		

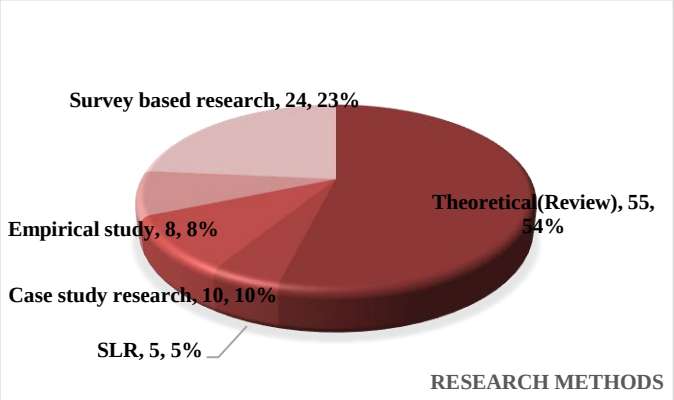

Figure 2. Methodological classification of papers

IV. MORPHOLOGICAL ANALYSIS

In the context of risk mitigation during the project development process, the justification for choosing various MA framework dimensions and their modifications is discussed in this section. The five dimensions and seventeen variants found here are shown in Fig. 3. The thorough MA framework is shown in Table 2.

A. Dimension 1: Risk framework and models

This dimension deals with risk frameworks or models used in different organization domains. In the context of the application of analysis and design of risk mitigation systems, scholars have emphasized the significance of the application domain. The related variants are listed in Table 2 and Fig 3 respectively.

B. Dimension 2: Industry context risk reduction

According to Table 2, which summarises our literature review, the relevant research on RMMM in project development was constrained to a small number of industry contexts.

C. Dimension 3: Risk modes/factors

Different modes of risk occur during the development process in an organization. Scholars have emphasized few risks that are highly ranked to mitigate for smooth running of the process of organizations. The related variants are listed in Table 2 and Fig 3 respectively.

D. Dimension 4: Risk mitigation monitoring and management techniques

The literature research led to the conclusion that further risk-mitigation technologies, such as genetic algorithms, Bayesian statistics, etc., should be used in actual software projects in order to test the efficacy of novel techniques and approaches. Managers of software development teams need to implement more risk-mitigation techniques. Researchers and academics must put in more effort to develop clever quantitative risk models. By fusing quantitative and intelligent risk models, we can merge more models in our future work to lower risks. Discussed in Table 2.

E. Dimension 5: Research methodologies

There are number of research methodologies used for analyzing and validating the concept of risk reduction to find out better and efficient systems. Through the number of reviews, case studies, empirical studies, and surveys, the importance of risk frameworks of highly ranked risks has been found through morphological analysis. As a result, plenty of gaps are also analyzed for future research in this area. The corresponding classifications are shown in Table 1.

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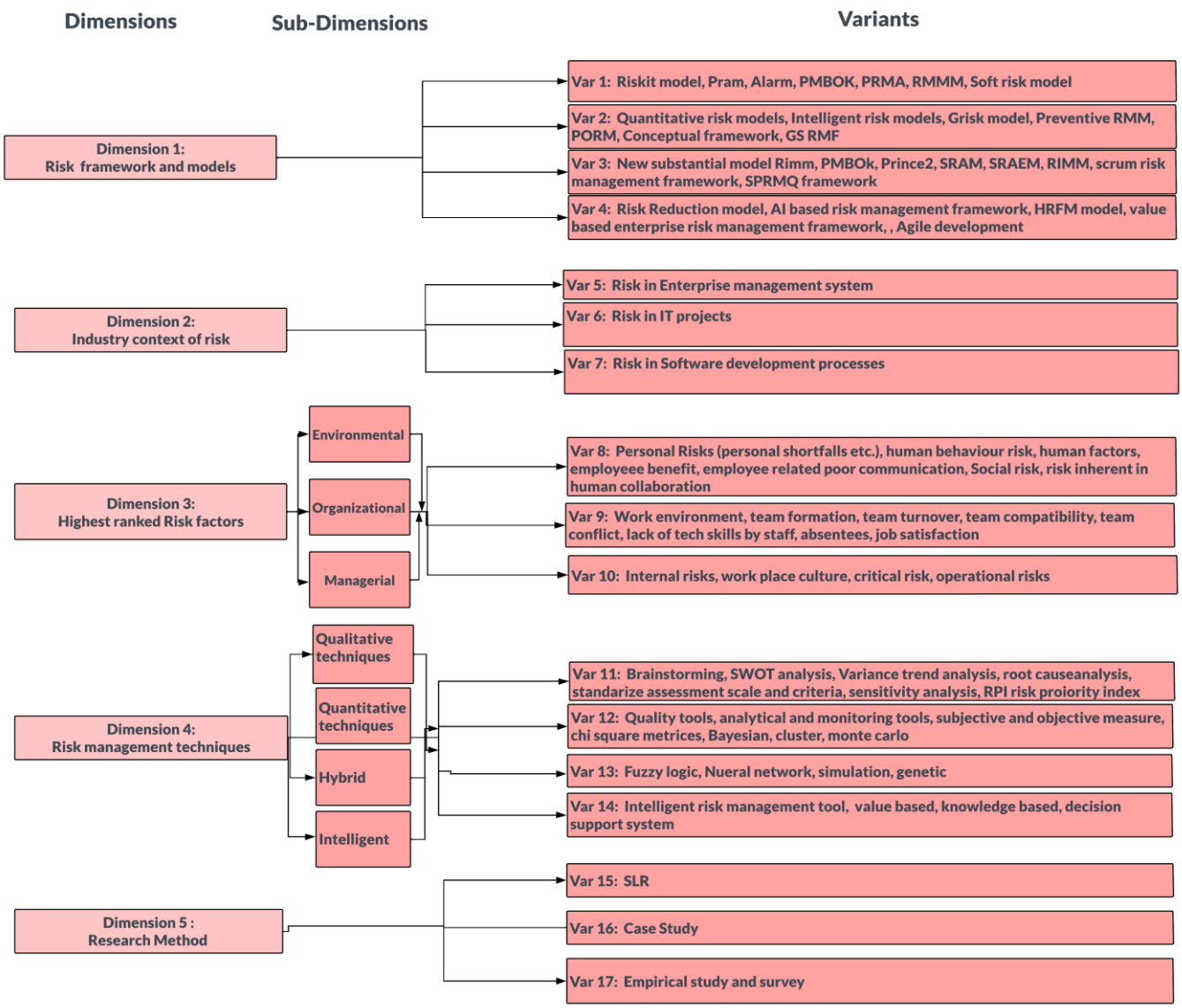

Figure 3. MA framework for risk mitigation monitoring and management

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TABLE 2 MA FRAMEWORK OF RISK MITIGATION MONITORING AND MANAGEMENT

Dimension 1 Risk framework and models	Riskit model, Pram, Alarm, PMBOK, PRMA, RMMM, Soft risk model	Quantitative risk models, Intelligent risk models, Grisk model, Preventive RMM, PORM, Conceptual framework, GS RMF	New substantial model Rimm, PMBOk, Prince2, SRAM, SRAEM, RIMAM, scrum risk management framework, SPRMQ framework	Risk Reduction model, AI-based risk management framework, HRFM model, value-based enterprise risk management framework, Agile development
	• A process-based approach to risk management that is founded on theoretical principles and supports risk management activities. • The lack of logical strength and inclination towards the genericity of repository-based risk management solutions. It lessens their efficiency in software development initiatives because each project is different. • Knowledge base tools are dependent on particular technologies or development techniques despite having the potential to make deductions. As a result, they are less independent of the technology and systems around them. (***Dhlamini, J., Nhamu, I., & Kaihepa, A., 2009).*** • Multilateral notions linked with these principles include effectiveness and efficiency. (***Chawan, Pramila & Patil, Jijnasa & Naik, Radhika., 2013)*** • These models are unable to accurately pinpoint internal threats. Therefore, those models need to be reevaluated and rebuilt. Due to these flaws, it appears that there are two options • One is to use the tools that have been built to meet our needs. These methods can guarantee that internal dangers are being identified. Creating new models is another strategy. Another significant role is maturity. ***Haghnevis, Moeed & Sajedi, H. (2006).***	• The capacity to learn, or the capacity to gain knowledge and then apply that knowledge to change conduct, is a prerequisite for intelligence (natural or artificial) that covers weaknesses between techniques, risk management approach, and phases of software projects studied. • The majority of papers focused on traditional risk-identification procedures, but in our opinion, project managers should apply a variety of methodologies throughout the lifecycle of software projects in accordance with risk methodology practice. (***Elzamly, Abdelrafe & Hussin, Burairah. , 2014).*** • The suggested PORM system also includes a superior risk factor evaluation that uses machine learning with less iteration. (***Firdose, Salma & Rao, Manjunatha Rao., 2018).*** • A thorough model that evaluates and properly explains the organizational principle is still lacking. • In the field of software development project risk management, there isn't a comprehensive, well-founded, distinct, and applicable system that can point project managers to successful management approaches for managing the relationships among software project risk, risk identification methods, project characteristics, project risk management team, residual performance risk, project quality, and project performance (***Sarigiannidis, Lazaros & Chatzoglou, Prodromos., 2011)***	• Due to the high implementation costs, Scrum is not appropriate for small projects. A scrum coach may be required to teach the team members how to use Scrum throughout its deployment in an organization. ***Henri, Evans. (2020).*** • When working on software projects, there is no ideal process. The ability to manage risk in software depends on the human element. ***Bazaz, Yogini & Gupta, Shashank & PrakashRishi, Om & Sharma, Lalitsen. (2012).*** • Nowadays, many businesses prioritize agile software development above conventional software methodologies. This needs to be improved, and other methodologies should use it as an example. • As more research is done, it may be possible to specify which factors are crucial and which are less crucial by taking into account the tools mentioned above, internal risks, the identification phase, and its importance, as well as the use of a thorough risk register in various projects and countries. • Project management standards may be combined in future studies, according to studies in the fields of risk management and Agile Scrum methodology. such as PMBOK, P2M, OPM3, PRINCE2, and Agile techniques such as Scrum, DSDM, XP, and ASD that put a larger emphasis on project management processes in order to construct hybrid models to assess and mitigate the risks connected with software projects. ***Mousaei, Mahdi & Javdani Gandomani, Taghi. (2018).***	• Effective risk mitigation is based on early detection of potential foreseeable issues. Senior management and functional business managers must apply the least expensive strategy and implement the best controls to reduce mission risk to a manageable level with the least possible negative impact on the organization's resources and mission. ***ROJA BANU. M. S. 2013.*** • The main source of project risks is personnel risk, which also has an impact on the total productivity of software products. • In order to keep the momentum going in SRE risk management, a continuous risk management technique must be implemented; otherwise, SRE risk is unlikely to be tracked to closure and new risks will be ignored. ***Ray C. Williams George J. Pandelios Sandra G. Behrens. 1999.*** • AI models are capable of resolving complicated and uncertain situations in the actual world. a system designed to pinpoint problems utilizing feedback from experts and data from experience. **(*Shikha Gupta. 2018)*** • Since risk management is crucial for project success, agile techniques do not frequently use it, and Scrum lacks defined protocols for its management, there is a need to explicitly integrate risk management. • The objective is to enhance the technique by mapping the principles of risk management, which can raise the project's success rate. However, the results have not yet been tested in a real-world development situation, so they cannot yet be confirmed. • A framework for corporate risk management based on values does not produce the ideal level of risk. ***Sim SegaRisk Management 2006.***

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		• It is necessary to build a dynamic control mechanism to enable quicker decision-making when any risk event happens. ***Dey, Prasanta & Kinch, Jason & Ogunlana, Stephen. (2007).***	
Dimension 2 Industry context of risk	Enterprise management system	IT projects	Software development processes
	• Based on the findings, the firms under consideration most frequently implement risk management practices in the areas of financial, operational, and strategic management. • The presentation of the management domains in which risk prevention activities are located and the identification of the distinctive preventive measures adopted by the analysed enterprises provide the main added value of the research's findings and allow risk management to be seen as an integrator of all business processes.	• Managing risks in information technology (IT) and software development projects has been the subject of numerous studies. • An integrated framework for managing risks in software development from the developers' perspective is required since software developers take on a sizable number of risks. • More methods were employed by software managers to reduce hazards. Indeed, academics and researchers need to put more effort into developing projects in this field. • We can use more models, such as neural networks, genetic algorithms, and other artificial intelligence techniques, in our future work to help reduce risks.	• A strong need for risk mitigation monitoring systems that are intelligent, independent of software development approaches, and capable of learning and changing their behaviour in response to events that occur throughout a project's life cycle. • Continuity in the application of risk management expertise from prior projects is ensured by the use of such a tool in subsequent projects. • Including all stages of the risk system in the software development process should be the objective. • Additional approaches and procedures, including Bayesian statistics, evolutionary algorithms, and neural networks, can be used to manage the risks associated with software projects.
Dimension 3 Highest-ranked risk factors	Environmental	Managerial	Organizational
	Personal Risks (personal shortfalls etc.), human behaviour risks, human factors, employee benefit, employee-related poor communication, social risks, (risks inherent in human collaboration • Human behaviour • Personnel shortfalls • Communication breakdown • Continually changing requirement • Time contention • Data loss • Miscommunication • Conflict between tasks and employee	Work environment, team formation, team turnover, team compatibility, team conflict, lack of tech skills by staff, absentees, job satisfaction • Less number of skilled people • Lack of clarity of roles and responsibility • Team conflict • Team compatibility • Team turnover • Improper management tasks • No proper planning for the project	Internal risks, workplace culture, critical risks, operational risks • It deals with internal, critical, operational risks • Insufficient resources • Workplace culture • Unrealistic expectation • Incomplete requirement • Diminished window of opportunity due to late delivery of software

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	• These deal with common Sdlc phases. This risk goes along every phase of development. • Highest ranked risks: Personnel shortfalls, work environment, team management, miscommunication			
Dimension 4 Techniques & methodologies	Qualitative techniques	Quantitative techniques	Hybrid techniques	Intelligent techniques
	Brainstorming, SWOT analysis, Variance trend analysis, root cause analysis, standardized assessment scale and criteria, matrix scaling technique, sensitivity analysis • Determining risk by root cause is the most efficient method of gathering risk data. In order to understand what causes a loss and where an organization is vulnerable, we must first understand the root cause of an incident. • Using root-cause categories gives useful context for choosing the right risk-mitigation measures. • Due to their lack of familiarity with risk management as a discipline and consequent uncertainty on how to speak about it, many risk managers find it challenging to include numerous departments. • It can be unnecessary to put up barriers when discussing the same basic causes, effects, or mitigations in different ways. • The residual index score of a risk can be calculated more easily when using a scale from 1 to 10. • By maintaining a system where risks are closely correlated with their controls, you can effectively oversee mitigation efforts. You have a valuable record of the dates and reasons why certain controls were developed with such a system. (***Lucy Brown, 2021)***	Quality tools, analytical and monitoring tools, subjective and objective measures, chi square metrices, Bayesian, cluster, Monte Carlo • Based on the findings of our initial risk analysis process, risk analysts can choose a risk analysis strategy. When performing an initial risk analysis, it is possible to analyze risk levels in great detail and choose the best risk analysis strategy for an organization's IT security, resulting in varied assessment values. ***Eom, Jung-Ho & Choi, Young-Hyun & Park, Seon-Ho & Chung, Tai-Myoung. (2010).*** • To help detect and minimize any risk that could potentially interrupt a project, analytical and monitoring tools like Gantt and PERT charts, financial ratios, and fault tree analysis can all be used. (**Ginny Edwards, 2010)** • In a Bayesian model, the analyst is required to apply prior probability to every feasible model. Once more, carrying this out in real life might be difficult. • The computation of the Bayes factors may include complex integrals that are computationally demanding. ***Ferson, Scott. (2005).***	Neural network, simulation, genetic, Fuzzy logic • Project managers can create a better risk management plan by using a risk matrix to represent the degree of software project risks with information about the likelihood that a risk will occur and how it will affect the performance of the project. The risk mitigation strategy for successful development for sustainable development is anticipated to be created to accomplish time efficiency improvements to access more resources for less money and so gain and maintain a competitive edge. • Including risk management strategies in your organizational design is the greatest method to lessen the detrimental effects risks may have on your company. • The ability to visualize risk graphically makes it possible to evaluate the effects of discovered risks and then rank them. ***Bhujang, Raghavi & Suma, V. (2012).*** • ANN, clustering, pattern recognition, evolutionary computation, fuzzy sets, multi agent system, data mining are some techniques which are implemented. Risk managers don't have perfect knowledge models based on efficient techniques.	Intelligent risk management tool, value based, knowledge based, decision support system • The same project activities that were ordinarily evaluated from a value point of view in the function analysis phase did not immediately relate to risks and their effects. Risk is assessed in this case at a later stage. Pasi Ojala (2009). • Additional artificial intelligence approaches, in addition to multiple regression, are utilized to model and manage distinct project risks at various stages. For various software development processes, there is a requirement for an intelligent risk assessment and mitigation technique. • Attempts have been made to identify all potential risk factors, determine how they are interrelated, and analyze the associated software risks using decision support systems. (***A. Aslam et al., 2017)***
Dimension 5 Research Methodology	SLR	*Case study*	Empirical study and survey	

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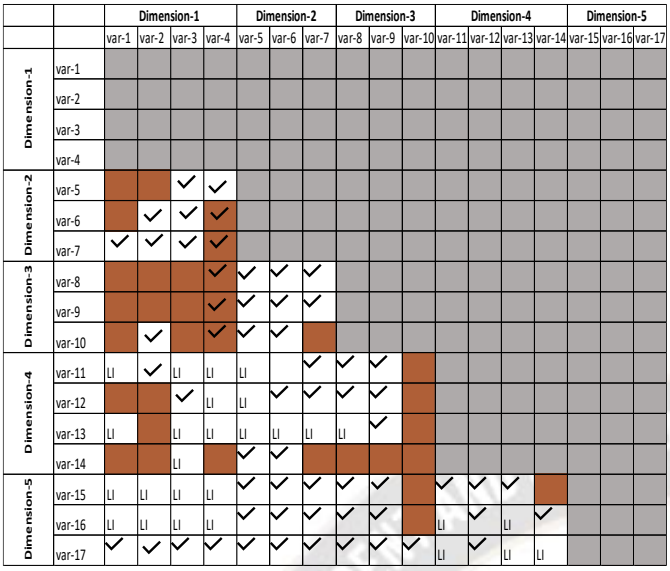

Figure 4. Variants Intersection Matrix revealing emergent research gaps.

Table 2 shows a MA framework as a comprehensive representation of the aforementioned dimensions and their related variants. The pertinent research from our total of 102 publications are summarized in a bulleted format in each cell of Table 2 that relates to a certain dimension, sub-dimension, and variant. Table 2 demonstrates how the 17 variants found under the 5 dimensions could be mapped onto the body of literature that was studied for this work. The process of identifying research gaps is made more structured and objective by crossing variants across dimensions [97]. Here, because the variants associated with a dimension share many of the same properties, relationships between them have not been taken into account. Crossing the variants Var 1 and Var 2, which are identified under dimension 1, for instance, does not show any significant gaps. Furthermore, not all relationships that result from combining variations across dimensions are logically sound, therefore it is crucial to spot and correct these contradictions [100]. The MA's aid in the methodical identification of these gaps using the VIM allowed us to estimate 33 research gaps for future study. Comparing the matched variations of various dimensions to one another allowed the gaps to be found. It is crucial to note that during this pairing process, no mention of direction or causality was made; instead, just the "mutual consistency" of the paired variations was examined [97]. We have emphasized logical inconsistencies as "LI", the existence of prior research as " ✓ ", and research gaps as brown boxes (Fig 4).

V. FUTURE RESEARCH DIRECTIONS FROM THE VARIANT'S INTERSECTION MATRIX

The discovery of a gap does not always mean that it will be of sufficient interest to scholars. Even while a few gaps can indicate a lack of research value, particularly if there isn't enough study in the relevant literature, we can still quickly spot actively investigated sections inside the MA framework representation. Therefore, before deciding that a gap warrants attention, its research value should be carefully considered. The gap spotting strategy described, according to which the majority incremental contributions are produced by discovering ignored or under-researched regions in the literature, serves as the foundation for our strategy of offering insightful study directions. It is challenging to discuss every gap in detail due to space constraints. As a result, we employed the next procedure for gap extraction. The authors identified the gaps in the data. After that, gaps were jointly explored to determine their level of theory/practice importance. Discussions were held to settle any differences, and examples of a final list of gaps were derived based on the authors' consensus, as shown in Table 3. [98] adopted a similar strategy. These holes have been discovered based on our assessment of their usefulness, and their research value can be assessed or even prioritized. People-related hazards are among the most frequent and high-ranking danger elements that obstruct project progress. These hazards frequently arise in project development, according to analyses using SLR, empirical research, expert reviews, and case studies. Therefore, it is crucial for the software development process to mitigate these types of risks using a wise strategy [37].

TABLE 3 SAMPLES OF VARIANT PAIRS FROM VIM REPRESENT RESEARCH GAPS

S.r. No.	Dimension pair	Variant pair representing research gap	Questions based on identified research gaps
1	D1 and D2	Var1-2 and Var 5	How complete risk model built for analyzing and describing an enterprise concept?
2	D1 and D2	Var1 and Var 6	How techniques are made efficient for complete risk processes in IT projects?
3	D1 and D3	Var1-4 and Var 8	Is the framework efficient for team management and work environment?
4	D1 and D4	Var1-2 and Var14	How frameworks/models are intelligently set for avoiding and reducing risk to an acceptable level
5	D2 and D3	Var 7 and Var10	What type of techniques can be used in the software development process for mitigating internal risks and critical risks?
6	D3 and D4	Var 8-10 and Var14	What are different intelligent tools used for risk assessment and mitigation of human behaviour risks in various software development processes?
7	D3 and D5	Var10 and Var15	How systematic literature review for internal, critical, and operational risks is done through mining of research?
8	D4 and D5	Var14 and Var15	DO intelligent tools and knowledge-based tools strengthen and make efficient risk mitigation approaches?

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What methods of risk mitigation, such as those that focus on internal and critical risks, can be used during the software development process? (S.R. No. 3), is one of the research topics we used. An investigation to address this issue will increase the theoretical understanding of risk management in software development processes by looking at the appropriate risk mitigation measures to be used. Finding the answers to another of our research questions, "What are different intelligent tools used for risk assessment and mitigation for human behaviour risks in various software development processes?" (Table 3, S.r. No. 6), will assist in understanding the role that the industry context plays in identifying human-related risks during the project development process. How frameworks/models are intelligently set for avoiding and reducing risk to an acceptable level? is the research question (Table 3, S.R. No. 4), and studying it will improve the theoretical understanding of intelligent techniques and their review and surveys through various statistical concepts. It will likely provide a methodological contribution to this subject because the majority of empirical research in the risk process of software development is based either on survey-based quantitative technique or qualitative methodology.

A. Conclusion and limitations

There are some issues with this study that may warrant further investigation. 102 publications were used to conceptualize and create the MA framework, however, it's conceivable that a few studies were inadvertently missed. Second, even if the VIM helped us find certain gaps, these gaps might still exist and contribute to the body of knowledge. Future research will be guided by and held to a maximum by these gaps. Studies in this field may be affected by the integration of risk mitigation systems into the project development process. In order to save the project from numerous obstacles and provide better time management and financial performance, it is crucial to underline that the software project development process must use finer techniques based on human behaviour risk mode and its mitigating aspects. Even if there are several research on risk management in numerous businesses and industries, there are only a few methods that are shrewdly integrated into the project development process to provide effective and efficient results. There are no attempts to review the same in order to offer an organized comprehension. This gap needs to be filled since project development risks could cause a corporation to lose more cost, time, and effort. The creation of quantitative and shrewd risk models requires greater work from academics and experts. To ensure that they won't jeopardize the project's success in the future, it is essential to identify important risks. We can use more models in the future to combine quantitative and intelligent risk models with different AI techniques to lessen risks [1].

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CONFLICT OF INTEREST

The authors certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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