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Developing a Kanban-Based Dynamic Risk Management Framework for Construction Projects

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ABSTRACT:

The paper explores the shortcomings of conventional construction risk management strategies and suggests an algorithmic system based on Kanban to facilitate a flexible, automated risk management. Results of two case studies indicate that probability-impact matrices and AHP, that are commonly used, can be effective in identifying and prioritising risks but are static, unable to reflect the urgency of time and dependencies amongst risk factors. The new framework will fill these gaps by combining risk attributes with Algorithmic logic and workflow-based automation, and risks can be subject to dynamic transfers between governance states. Simulation Scenario-based simulation shows that the framework enhances the responsiveness by instigating real-time escalation, prioritisation and assignment activities, reducing delays caused by manual decision-making. The comparative analysis further supports the fact that the framework improves compliance with the ISO 31000 principles since it includes an on-going monitoring and feedback system. In general, the results confirm that an algorithmic approach based on the Kanban system can turn the risk management into an active, dynamic system which is more efficient in terms of decisions and the control of risks in the project.

KEYWORDS: Construction Risk Management, Kanban-Based Framework, Algorithmic Risk Governance, Workflow Automation, Risk Prioritisation, Risk Escalation, If-Then Logic, Systems Theory, Atlas-sian Jira, Scenario-Based Simulation, Dynamic Risk Management

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Abbreviations

AHP Analytical Hierarchy Process
DSR Design Science Research
ISO International Organization for Standardization
PRM Project Risk Management
P-I Matrix-Probability-Impact Matrix
AI Artificial Intelligence
RQ Research Question

1 Chapter 1: Introduction

1.1 Background of the study

The key element of project governance is risk management, yet in construction contexts it tends to be a document-based exercise that is conducted periodically. This stationary character is very different in comparison with the dynamic interdependencies of actual projects in which risks interact over time, scope, cost and quality (Vieira, Hauck and Matalonga, 2020). This is because the complexity of construction projects implies that a risk may spread between dependencies at a rate that is quicker than the reporting cycles involved in tracking the risk. Agile principles like Scrum and Kanban provide the insights of visibility, responsiveness, and constant improvement that can be applied to the construction. The techniques have already demonstrated in the field of software development that bottlenecks can be minimized and responsiveness increased through visual workflows and continuous monitoring. Indicatively, an empirical multigroup study of 102 Agile participants revealed that risk has a positive and significant correlation with quality and that these two concepts are directly related to each other (Sathe and Panse, 2023). The same research discovered that resource constraints have a significant effect on project risk, which is indicative of the fact that project constraints are not independent but part of an interdependent system (Sathe and Panse, 2023). These conclusions suggest that there should be a responsive approach to risk governance, which is systemic instead of record keeping.

Simultaneously, review of the literature on agile risk management systematically revealed that risk identification is strongly established throughout the methods, but that Kanban is underrepresented. Among the 18-research examined, it was possible to identify risk identification processes in all of them, although only one (approximately 6% of the total) employed Kanban as a risk management tool (Vieira, Hauck and Matalonga, 2020). Such an academic and practical gap is evident since Kanban is the popular workflow optimization tool, but it is not often formalized as a risk governance instrument.

1.2 Problem Statement

The research issue is that there are no dynamic and workflow-based risk management mechanisms that can be used in construction projects in real time. Existing tools, which are generally the static registers and probability impact matrices, model risk events as historical data but not as dynamical processes. These systems rely on human additions and planned review, which postpones interventions in case of rapid changes in the conditions of the project. This traditional methodology makes things less visible, decision-making slow, and degrades the combination of risk management and project implementation.

The practice of agility demonstrates the advantages of risk processes integrated into the everyday working process. In a case study of an industry in which a simplified risk management process was applied to two geographically dispersed agile teams, 90.1% of the participants stated that the practice enhanced risk prevention, 81.8% indicated that it was effective, and 72.7% said that they were willing to continue using it (dos Santos et al., 2023). These findings indicate that risk management is more effective when it is lean, open, and integrated right into the operations. The complex dependencies of construction projects could also use an adaptive system that automates and displays the real time state of the risk.

1.3 Rationale and Research Gap

The explanation of introducing a Kanban-based algorithmic structure is to convert the risk process, which is periodically reported, into an ongoing governance process. Kanban with its transparency and flow-based control gives the framework of visualizing the work going on. But without the ability to cause automated governance responses in case of change in thresholds visibility is not enough. The identified gap is the boundary between visualization and decision automation the logic layer, which makes the system take action when the risk conditions change. The current agile risk management literature is based on human-centred routines, which are meetings, discussions, and ceremonies as the core integration of risk awareness. A systematic review was able to find 23 studies, most of which depended on risk registers, risk poker, or ranking exercises to create a better visibility, but few of them involved automated or rule-based escalation (Garcia, Hauck and Hahn, 2022). This unveils the possibility of expanding the Kanban model to include visualization to algorithmic governance.

The Lean and Agile tools have already demonstrated their possibility to improve the safety and minimize operational failure in the complex project setting. Recent descriptive research that implemented Kanban in a Lean risk management system reviewed the accident data of 2015-2017 and identified 42 accidents recorded, 16 of which were in recreation, food, and beverage industries (Tortorella et al., 2020). The combination of 5S, Visual Management, and Kanban resources helped enhance the visibility of the risk sources and sponsored the proactive mitigation (Tortorella et al., 2020). This adds to the fact that systematic flow visualization can enhance early risk response, a concept that could be of great benefit to the construction settings.

1.4 Theoretical Context

The framework of this study is the Systems Theory, which describes risk management as a complex of interacting subsystems instead of a checklist. Marle (2020) claimed that project risk management could be perceived as a dynamic entity of interrelated feedback loops in which cause-effect relationships change over time. His work suggested the help tools that were based on the complex systems theory to deal with uncertainty in agile projects (Marle, 2020). Using this theoretical lens in building construction also enables one to do so without assessing the object, but in terms of feedback, interdependencies, and adaptive processes.

Agile transformations in practice can frequently show the need to strike a balance between structure and flexibility. As an example, studies conducted in large telecommunication settings indicated that any changes between Kanban and Scrum should be restricted to four sprints to prevent disruption of operations (Stankovski, 2023). These findings point out the need to govern adaptive frameworks with boundaries of governance an observation that reinforces the need to establish logic gates and thresholds in an automated Kanban-based system.

1.5 Research Questions

Primary Question: How can a Kanban-based algorithmic framework be designed to transform construction risk management from a static record-keeping exercise into a dynamic, automated response system?
RQ1 (Logic Design): What are the essential & automation rules (algorithms) required to translate static risk attributes (probability, impact, time) into dynamic workflow actions?
RQ2 (System Architecture): How can Atlassian Jira be configured to effectively visualize the interdependencies between construction tasks and risk events?

1.6 Research Objectives

1. To Critique: Analyse the limitations of static probability-impact matrices in capturing the temporal urgency of construction risks.
2. To Design: Develop a comprehensive & Algorithmic Risk Framework within Atlassian Jira, defining specific logic gates (If-Then rules) for risk escalation, prioritization, and assignment.
3. To Validate: Demonstrate the frameworks efficacy through a controlled simulation using a standard construction project case study, verifying that the algorithms correctly automate governance decisions.

1.7 Scope and Boundaries of the Study.

The research is restricted to risk management of a construction project and evaluating the design and evaluation of a workflow-based governance artefact instead of deploying it in fields. The scope entails the utilization of Atlassian Jira as the simulation and evaluation tool, development of rules that tie up the risk attributes with automated actions.

It does not aim at building a predictive machine-learning model but tries to become more responsive in existent project systems. The boundary conditions recognize that construction projects have contractual and regulatory frameworks that cannot be fully automated; the intention is to make the governance automated within those limits.

Kanban is selected due to its support of flow management and visual management but has been criticized due to its inability to scale to large projects. The analysis of large-scale project management revealed that using Kanban alone is not able to manage milestones and resources planning well without being incorporated in the hybrid models like Scrum or Waterfall (Anjum, 2020). This shortcoming is recognized and overcome by formulating automation rules to improve the coordination and visibility at each stage. Consequently, the study positions itself in a confined area in which Kanban is applied as a governance and monitoring system with respect to risk and is not applied as a delivery methodology in itself.

1.8 Significance of the Study

The research is noteworthy both in theory and practice. Theoretically, it takes the Systems Theory further into the construction risk management by turning risks to dynamic interacting structures. Practically, it offers a model which can be applied in the current digital project settings to automate the decision-making process. Embedding logic rules into Kanban implies that upon threshold crossing by a risk parameter, the system itself can result in notifications or reassignments, which will create a shorter duration between risk awareness and action.

Two gaps in existing literature are also addressed by the study. First, it deals with the scarcity of research studies on the application of Kanban in explicit risk management found in literature mapping (Vieira, Hauck and Matalonga, 2020). Second, it applies empirical findings of lightweight risk management strategies observed in an agile setting (dos Santos et al., 2023) to an organized construction setting. The research is bound to prove that a Kanban-based risk governance system in the form of automation logic with its logic and testing through simulation is capable of enhancing the responsiveness and accountability of decisions.

1.9 Structure of the Dissertation

The dissertation is composed of six chapters, each developing the next sequentially from contextualisation through to design, validation and conclusion. The upcoming chapter (Literature Review - Chapter 2) will critically assess the theoretical underpinnings of this study, including project management fundamentals and construction project types and risk characteristics, limitations with static risk management approaches, Kanban-based governance frameworks as well as prior studies that have explored algorithmic risk governance. In the Research Methodology (Chapter 3), we justify our choice of Design Science Research, describe how we use secondary case data and outline the manner in which we validate. Chapter 4 System Design and Development introduces the complete Kanban-based algorithmic framework with risk states, transition logic, If–Then rules, and conceptual Jira configuration. Chapter 5: Results and Evaluation - The application of the framework to the two case studies; scenario-based simulations results, comparative analysis and ISO 31000 validation analyses. Chapter 6: Conclusion and Recommendations (Chapter 6): This chapter summarises key findings, discusses contributions to theory and practice, outlines limitations, and provides suggestions for future research.

2 Chapter 2: Literature review

2.1 Introduction

This literature review reviews the theoretical and empirical foundations for the study. It is organized around five inter-related themes including project management concepts and principles; types and characteristics of construction projects (and their impact on risk); risk management in the construction domain; Kanban application to project and risks; as well as previous academic studies on workflow-based and algorithmic governance. The themes are examined, with regard to the central research issue that static risk registers do not account for the dynamic, time-dependent nature of construction risks and the sections follow a logical sequence to establish the research gap occupied by the framework proposed.

2.2 Project Management: Concepts and Principles

According to the Project Management Institute, project management is the art of applying knowledge, skills, tools and techniques to project activities in order to meet project requirements (PMI, 2017). At its heart, it is about the competing constraints of scope, time, cost, quality resources and risk to deliver agreed outcomes. In PMBOK there are ten knowledge areas — integration, scope, schedule, cost, quality, resource, communications risk procurement stakeholder management and they must be coordinated through the project life cycle (PMI 2017). Hence, risk management is not a discipline that stands alone within the project management system; it is an integral part of the larger system.

In the Waterfall model of traditional project management, a plan-driven sequential approach is followed in which scope is fixed even before kick-off and each phase depends on completion of the previous one (Larson and Gray, 2011). Although this model has governed software development up till now, it is acknowledged to be insufficiently adaptive in arriving at changing requirements, constraints and risks over time. In so doing, agile project management frameworks have emerged which focus on iterative delivery, continuous feedback and adaptive planning (Vieira, Hauck and Matalonga, 2020). Kanban and Scrum are the two most used agile frameworks in software development, but some researchers have started applying them to construction.

In a quantitative multigroup study of 102 agile practitioners, it was found that project risk is positively related to quality (β = 0.505,t = 5.103,p = 0.000) and resource constraints are directed to increase up the same project risk (β=0.413,t=3.93,p=0.000) (Sathe & Panse,2023). These outcomes also validate that project constraints are not independent variables and reinforce the case for integrating risk governance into the operational fabric of project management instead of it being an exercise in periodic reporting.

2.3 Types of Construction Projects and Their Risk Profiles

Construction projects can differ in nature, scale and complexity. They are classified into the five general categories of residential, commercial, infrastructure, industrial and institutional types with different risk profiles. Residential projects – like housing schemes and villas – face specific risks such as labour productivity, material procurement, cost overruns and weather (Khedagi, Sagar & Sowmyashree 2017). Instead, broader commercial or infrastructure projects have larger risk exposures through related regulatory requirements, increased stakeholder alignment and structural design considerations. However, industrial projects such as factories and plants have very high safety and environmental risks. The procurement process is more complicated for institutional projects like hospitals and schools, and regulatory approvals take longer.

Research Design: The two case studies used in this study include residential and structural construction types. Your first is from a residential villa project in Bangalore, in India which represents operational risks [typical of at the level of small-to-medium construction projects] where 5 senior project managers can oversee 39 risk factors across nine risk categories: organisational, financial, legal and external risk (Khedagi et al. The second, based on published analysis of the Rana Plaza building collapse in Bangladesh, is a larger mixed-use high rise that failed catastrophically with hundreds of workers employed and systemic failures associated with foundation design quality, material selection and regulatory failure (Safayet et al. These two cases together illustrate the characteristics construction types have in the generation of categories of risk and thus how a governance framework needs to adjust with respect to different contexts.

The commonality between the various types of construction project is that it has an interdependent, dynamic risk nature. Risks do not exist in isolation whereby a procurement delay causes labour idle time, which raises costs and squeezes the schedule of the project. We know from the literature (Dikmen, Birgonul and Han, 2007; Afzal et al., 2021) that construction risk is often of a cascading nature which provides one of the key rationales for having a dynamic workflow integrated risk governance system rather than static matrices reviewed at intervals.

2.4 Risk Management in Construction: Limitations of Static Approaches

The risk registers and probability-impact matrices at rest are developed to classify and compare risks, which can be used to promote governance reporting and compliance. Their inherent construction weakness lies in not being time-constrained as to the urgency of risk: an equal score in probability and impact may hide a risk that is about to start happening or far off, accelerating or stabilising, and whether it is starting to spread through dependencies. Urgency in construction delivery varies with the change of sequencing, resources, interfaces and external constraints, such that the same representation of the project can be accurate as a score and inaccurate as a decision signal. The outcome is that the tools that are static usually favour ranking and not timing, and timing is the essence of risk response effectiveness.

Construction risk research is a challenge of the static approach that focuses on the interacting uncertainty and non-linear relationships. An overview of AI-based and hybrid cost-risk assessment approaches contended that the traditional probabilistic risk assessment has a hard time in revealing the complexity-risk interactions, and identified fuzzy logic and extended Bayesian belief networks as more effective approaches to modelling interacting uncertainty in the construction systems (Afzal et al., 2021). This criticism is important in that probability impact matrices generally assume risks are independent and stable but construction risks tend to compound with one another through the scope, cost and schedule pressure. Misunderstood urgency is when interdependencies are missed as the system is failing to realise how rapidly one risk can spread out to another. A second weakness is dormancy, in which a register grows out of date due to the need to update it manually and through periodic review processes. Dormancy is not merely a behavioural issue; it is created by the tool structure. When it takes effort to update a risk item and this work competes with operational work, the update is delayed, and the register becomes a historical record. This issue is consistent with the larger one, which argues that the validity of the use of the static risk models is lost in the course of the implementation because they fail to adjust to the alterations in the project and its feedback loop (Afzal et al., 2021). In the case of dormancy, there is a delay in decision: due to the fact that the register is no longer used to indicate real-time conditions, the process of escalation and mitigation will be put on hold. In this respect, static registers have the illusion of being in control which is not true over time.

The greatest theoretical criticism of the use of static matrices is that the matrices assume linearity when the project systems are not linear. The complex system schools view risks as a feedback mechanism in which causes, and consequences evolve with time. Marle (2020) modelled project risk management assistance in the complex systems theory and posited that risk is co-created by the relationship between project factors and not by individual events, and behaviour is developed based on feedback loops and adaptive reaction (Marle, 2020). This lens implies that risk governance needs to be structured so that the sense of changes and the corresponding response is continuous because the periodic scoring is not able to reflect dynamic features of the emergent situation or the change in urgency. The criticism thus creates a need in having mechanisms that will turn risk signals into action as the conditions change.

2.5 Kanban in Project and Risk Management

Originating from the lean manufacturing system at Toyota, Kanban has been used as a pull-based visual scheduling tool for inventory and production control (Fuentes-del-Burgo et al., 2024). It has been used in project management, as a workflow visualisation tool where tasks flow across specific columns - often identified by stages such as "To Do" and "In Progress", while team capacity is managed through work in progress (WIP) limits. Main advantages of Kanban include seam flow analysis, bottleneck forecasting and continuous incremental enhancement (Solomon et al., 2023).

The construction industry has primarily implemented Kanban in the areas of supply chain coordination, logistics planning and material flow management. A literature review of 53 articles on Kanban in construction identified its application as mainly focused on production-oriented functions, especially when integrated into BIM-based environments rather than risk governance (Fuentes-del-Burgo, Fernandez and Navarro-Astor, 2024). That is a huge oversight: Kanban has favourable visual and flow management properties for tracking uncertainty but has never been formally incorporated into any study as a governed risk management instrument with automated decision logic. In (Vieira, Hauck and Matalonga, 2020), a systematic mapping of 18 studies in agile risk management revealed that risk identification occurred in all the cases but only one (around 6%) adopted Kanban as a risk management tool.

Non-construction based applications of Kanban-based risk management have yielded early-stage success. The following study combined Kanban, Lean Manufacturing tools (5S and visual management) to a risk management methodology, where flow visualisation allowed identifying the source of risks earlier in time enabling common way proactive mitigation by reviewing accidents from 2015–2017 across sectors (Tortorella et al., 2020). Likewise, Kanban in Trello was employed to govern the development of a seismic risk management system for an underground mine through biweekly governance meetings, clearly showing that visual workflow systems can govern physical, high-hazard risk environments (Jonsson, Lindewald and Dineva 2024). While these studies confirm that

Kanban can be generalised beyond production management to risk governance, they do not characterise the algorithmic decision logic needed to automatically escalate, prioritise and assign tasks - which is the contribution of this study.

The design objective demands that risk assessment be changed as documentation to risk governance as workflow. One of the design principles is to approach risk as an item of work, which traverses explicit governance states with owners, time expectations, and decision gates. Kanban is applicable in that it formalises flow using states and exposes bottlenecks to a structure that can represent urgency using time-in-state and blockage. This is important to risk governance since not only is urgency a property of the risk, but it is also a property of delay. When the high-impact risk has not been resolved or ignored, the governance failure is now visible as a blocked point and not within a spreadsheet. Construction-relevant evidence indicates that Kanban has already been used as an operation-based coordination strategy, but not mainly related to risk governance. A literature survey of 53 articles on Kanban in construction indicated that it is utilised in supply chain coordination, planning systems and digital environments including BIM-related settings (Fuentes-del-Burgo et al., 2024). It means that the workflow thinking fits the construction management practise and research, although the literature is inclined to concentrate on production activities instead of uncertainty governance. Simultaneously, an overview of Kanban application in process industries highlighted that it is employed to enhance the flow and detected bottlenecks, which supports that the technique is implemented when variability and throughput risks are observed (Solomon et al., 2023). This is the shortcoming as in the majority of such studies, risk is an analysis, but not a governed entity via the workflow.

Atlassian Jira is relevant as it enables one to introduce a workflow state model along with responsibility, priority fields, and automation logic. This is in line with the second design principal risk property should be converted to actions using explicit logic gates. Escalation logic gates can be activated once impact has reached a threshold, when time-to-impact is short, when a risk is blocked longer than a set period, or when the exposures are increased by dependencies. Prioritisation gates may dynamically change the ranking of risks when there is an increase in urgency or there are upstream risks that pose a threat to several work packages. The assignment gates allow assigning risks to responsible roles or teams depending on the type, project stage or subsystem, and thus have ownership in operation and not nominal.

The results of agile risk management research indicate that systematic risk practises are there, but they are often human-based practises, and not triggered by automated governance mechanisms. A literature review on agile risk management practises found 23 high-profile articles, and the principal practises such as risk registers, Risk Poker and Risk Ranking, and a strong emphasis on schedule and communications risks were noted (Garcia et al., 2022). The implication is not that these practises are ineffective but that they are weak when under the pressure of work since the governance requires human attention which is continuous. By converting these decision points into algorithmic gates on Jira it is possible to decrease the use of memory and meeting pace, making risk governance a continuous operational system.

The third principle of design is explained by the fact that construction governance is required to be auditable due to contractual and safety as well as regulatory reasons. Automation with rules makes it explainable as every action can be linked to a given condition, thus escalation and assignment is transparent. This necessity is supported by the fact that generative AI can detect risks whereas it might fail to be practical and contextually applicable. In one of the blind peer review comparisons, which compared GPT-4 to 16 construction risk experts, AI was rated more highly in general but criticised as being less practical and specific in its production (Nyqvist et al., 2024). This indicates that AI-based lists should not be used to design governance, but to come up with structured workflow logic, which addresses risks and tracks them using responsible states.

The wider automation literature on AI and decision support also facilitates the implementation of automation in the project management processes. In one study, an AI decision support system scored 94% accurate in identifying risk and 18% in improving sprint completion, which means that objective performance increase can be achieved in the case of decision-support implementation in regular management control (Almalki, 2025). Despite the fact that construction and software development are two different subjects, the outcome supports the thesis that automation is the best when it is operationalised into systems that achieve output by mechanisms of translating signals into actions as opposed to generating fixed outputs. Jira design requirement is thus the formalisation of rule-based governance which can be seen, traced, and time-sensitive.

2.6 Previous Studies on Algorithmic and Workflow-Based Risk Governance

Increasingly, the literature is questioning the application of algorithmic logic and digital tools into project risk governance. In general, a systematic literature mapping of 23 agile risk management studies suggests that risk registers, Risk Poker and risk ranking are the most commonly used risk management practices which are mostly associated with schedule and communications risks (Garcia, Hauck and Hahn, 2022). But these practices are all very human-centred - driven by meetings, ceremonies, and manual updates rather than automated governance triggers. No study in this mapping formalised sex-and-age-specific If-Then decision logic for continuous risk escalation. It stresses what is new and needed about the algorithmic approach proposed in this study.

Risk governance based on workflows can be undertaken even in difficult physical settings that are highly risky as long as the frameworks are designed on the principle of process reiterations and graphical organisation. The project applied Agile and Kanban in Trello with biweekly meetings as the workflow of the risk management activities in the development of a seismic risk management system of an underground mine, and proved that the visual governance of workflow may be introduced in the physical risk environment (Jonsson, Lindewald and Dineva, 2024). This justifies simulation-based validation in that it suggests that risk governance can also be assessed based on the process discipline and timely escalation instead of being measured solely based on reduced incidents in the long-term.

Validation should also consider the factor of escalation acceptance and organisational fit since technically correct rules may be a failure when rejected or poorly interpreted. Agile cybersecurity risk management has shown evidence indicating that a heavily structured form of escalation and governance routines are highly preferred. Iterative escalation had 85.37% agreement in survey study and sprint planning integration of security requirements in survey study had a high agreement of 90.25% (Salin and Lundgren, 2022). This trend explains that systematic, repeatable logic of escalation is acceptable by teams as long as it is incorporated into workflow processes. To apply this lesson to construction, it would be proposed that validation should test the presence of understandable and actionable escalations in the rule set, instead of false alarms.

Simulation-based validation may as well be reinforced by considering that risk management that is not taken care of properly becomes an issue all by itself. The 2020 ranking of problems in the transport project management showed that incorrectly applied risk management was in the top five problems in 2020 compared to not being in the top five in 2018, indicating governance mechanisms could cause new risks when applied improperly (Šimíčková et al., 2021). This justifies controlled simulation as a hedge against test boundary conditions, discovering unwanted escalation loops and ensuring that rules fail to generate noise in response to workload peaks.

Lastly, the advantages of validation include taking into account the usability since the desired governance enhancement relies on the interpretation and behaviour of workflow signals by the users. In a web-based Kanban application study, 20 participants were involved using tasks, questionnaires and interviews and found high perceived usability and effectiveness with improvement needs also identified which included onboarding support and advanced filtering (Moiseienko et al., 2025). This implies that validation may legitimately consist of clarity and interpretability tests and rule correctness. The validation concern hence becomes to show that the algorithmic gates are used to automate governance decisions in a manner that is reliable, transparent, and in a manner that can be maintained in operations.

2.7 Systems Theory: Theoretical Framework

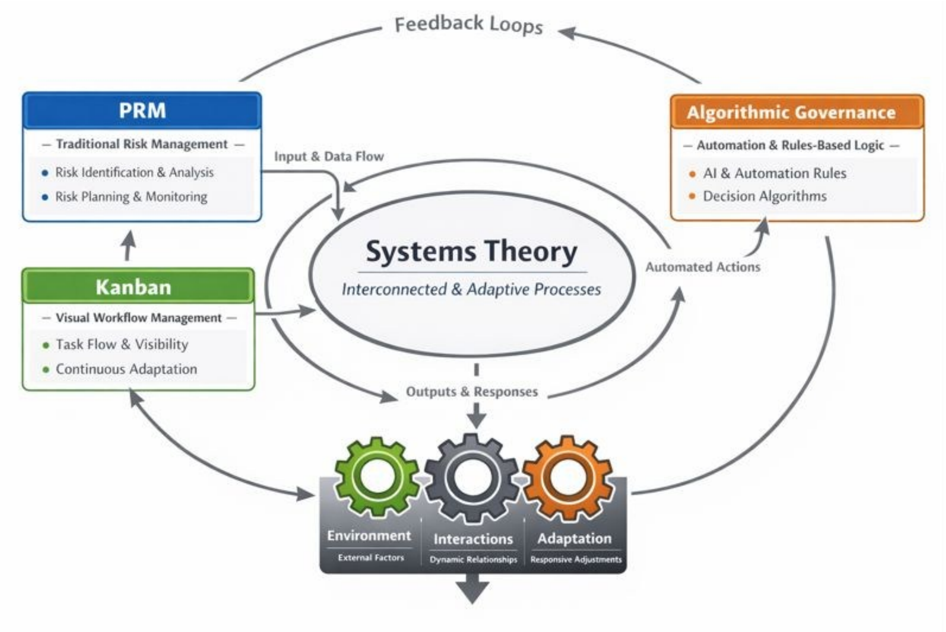


Figure 1. Systems theory- theoretical framework

It is the Systems Theory that offers the framework according to which the combination of PRM, Kanban, and algorithmic governance can be explained. It assumes that projects are open systems that are made up of interdependent components that interact using feedback mechanisms. Marle (2020) opined that the risk management system theory enables practitioners to consider emergent behaviours that stem out of interaction of components and not events that occur independently. This theoretical position is compatible with the task of creating a dynamic framework that represents risk as an ever-changing process.

Systems Theory is used to clarify how workflows, which are decentralized and iterative, can be more resilient in the agile environment. By providing empirical findings, Almalki (2025) proved that with the help of AI-driven decision system, the coordination level increased, and variation in the project outcomes decreased, which could imply that the adaptive systems with feedback loops may be more effective than the fixed control structures (Almalki, 2025). In the same vein, the results of Nyqvist et al. (2024) also indicate how the absence of contextual adjustment in AI models may lead to the decrease in the efficiency of the system, which validates the principle that risk governance should stay flexible within the scope of the system (Nyqvist et al., 2024). The theoretical foundation therefore highlights the existence of mechanisms, which are governed by rules and allow flexibility and traceability, which are two main attributes of a healthy adaptive system.

2.8 Synthesis and Research Gap

All the literature suggests that traditional PRM is rigidly disciplined methodologically, and not flexible. Agile and Lean construction bring about process visibility and efficiency and fail to formalize risk as part of workflow. Digital change and algorithmic rule introduce transparency and automation and tend to ignore the domain-specific contextualization. These piecemeal understandings bring to a head a critical gap in the process: lack of an integrative frame through which risk data can be turned into live governance via rule-based, visual processes. There is empirical evidence that demonstrates quantifiable improvements of every field. The decision support with AI increased the risk detection by 94% (Almalki, 2025). Unlike the traditional production system, visual Kanban systems minimized delays and inefficiencies during industrial production (Bongnell and Svenning, 2024). Halfway between Scrum and Kanban methods enhanced the pace of delivery and flexibility (Mojabi, 2024). However, none of these papers specify the algorithms or rule architectures necessary to risk governance automate the construction settings.

This gap characterizes the value of the current study: creation and testing of an algorithmic framework based on Kanban that transforms the fixed risk management into the dynamic and system-controlled process. By incorporating the concepts of Systems Theory, Lean visual management, and algorithmic governance, the study will be in a position to bridge the gap between theoretical knowledge and practical implementation in the construction risk management.

3 Chapter 3: Research Methodology

3.1 Research Philosophy

The research has adopted a pragmatist research philosophy since it does not focus much on the real-world problem solving rather than just theoretical or positivist measurement. Pragmatism permits the synthesis of qualitative with the analytical assessment to create a viable artefact - the Kanban-based algorithmic risk governance framework - instead of examining abstract hypotheses (Dikmen, Birgonul and Han, 2007). As the emphasis is placed on artefact usefulness, applicability and enhancement of construction risk governance, pragmatism advocates the flexibility of methodological decisions, including secondary data and standards benchmarks, that fall within project constraints and academic rigour. This philosophy therefore is in line with the design science nature of the research.

3.2 Research Approach

The study adopts Design Science Research (DSR) methodology, which is suitable in developing and testing a new artefact that would solve a practical organisational issue - static risk management in construction. DSR focuses on the creation of artefacts (the risk framework) and its assessment, which is suitable in addressing the goal of converting fixed probability-impact matrices into dynamic automated governance activities (Gajewska and Ropel, 2011). DSR also justifies analytical and case-based validation without collecting primary data, which allows it to be evaluated within the academic framework of the construction management literature and published case documentation. This method is explicitly helpful to the RQs of logic design and system architecture.

3.3 Research Strategy

The reason why a case-based and scenario-based research strategy is undertaken is due to the fact that direct access to construction projects, primary interviews, or even surveys is not a possibility. Cases of publicly available construction risk management (e.g., Risk Management for a Construction Project -A Case Study and Risk Management in Existing Construction Project in Bangladesh) have sufficiently detailed and documented risk events, impact and responses (Khedagi, Sagar and Sowmyashree, 2017; Safayet, Islam and Ahmed, 2018). Scenario analysis enables systematic testing of the proposed automation rules in comparison with the reported risk sequences, and thus, the strategy would be rigorous and defensible without being tested in the field.

3.4 Research Design

The study plan is arranged in such a way that artefacts are created and then analyzed. A conceptual risk governance framework is first created on the basis of literature and systems theory. This is followed by real-life cases that are put in this context to show practicality. The design incorporates qualitative mapping of recorded risks into a process of organised workflow Kanban and relies on pre-set If-Then regulation of escalation and prioritisation (Pham et al., 2021). The design is coherent to risk management standards and is aligning the research objectives. It is also reproducible as the case mapping and scenario testing are written down and have clear rules and requirements.

3.5 Data Sources and Data Type

The existing qualitative data included in this study are two published peer-reviewed case-studies with documented risk registers, expert evaluations of claim-driven markets and project context. The first is a study in risk management for residential villa construction planning project from Bangalore, India (Khedagi, Sagar and Sowmyashree, 2017) that furnishes 39 risk factors classified into nine categories which were evaluated by five senior project management experts. The second is a study using AHP-based multi-criteria risk prioritisation in Bangladesh applied to a high-consequence structural failure involving thousands of workers and referencing the Rana Plaza collapse (Safayet, Islam and Ahmed, 2018). This study uses secondary data and the appropriateness and justification for this is as follows (1) practitioner attitude measurement was not the goal of the research project; instead, artefact design and testing are expected outcomes; (2) in order to instantiate and simulate scenarios within the framework concrete, structured risk data must be available and both case studies provide sufficient detail; (3) DSR has long maintained that analytically-validating publicly-available datasets are a reasonable limitation of input sources for external analysis if clearly stated (Gajewska & Ropel, 2011). Because both the depth of possible experimentation and the contextual indicators of project dynamics can vary from reporting to reporting, we use a single case documentation: probability-impact matrices; AHP weights; and criteria with descriptions of local context are captures into our data for sufficiency in grounded tests.

3.6 Case Study Selection Criteria

The cases are chosen according to the availability to the public, risk description, project focus, and risk events variety. The former criterion will guarantee that data is availed out to analysis without any limitations of confidentiality. The second is to make sure that the case has adequate narrative about risk identification, impacts and responses (Dikmen, Birgonul and Han, 2007). The third one guarantees the relevance to the risk management concerning construction projects, which fits in your thesis scope. The last criterion makes the risk types, and the order of events vary to make the framework capable of being tested in different circumstances. The residential project in Bangalore and the Bangladesh construction project meets such requirements and promote strong validation.

3.7 Framework Development Method

The conceptual modelling is based on the literature and systems logic that is used to develop the framework. The artefact is informed by a comprehensive review of the concepts of risk governance, logic of workflow automation, and the limitations on the use of statical probability-impact matrices. Major components such as risk states, transitions, dependencies and rules are rationally constructed out of documented project dynamics (Gajewska and Ropel, 2011). The approach involves formalisation of rule tables and structured flow charts to define logic gates like time and probability-based escalations. This will provide the framework with high theory soundness and practical instantiation of digital workflow systems, directly answering the research RQs.

3.8 Use of Atlassian Jira as a Reference Platform

Atlassian Jira is referred to as a digital platform of reference that is to be used to model the Kanban workflow and logic automation but not implemented in reality (Atlassian, 2026). The flexible issue types of Jira and the automation rules enable it to be used to model risk states, dependencies, and escalation triggers along with assignment logic conceptualisation (Pham et al., 2021). Being a conceptual tool, it allows mapping every rule to a platform element, which reinforces the architectural argument in RQ2 without needing to deploy software or write any code. The application of Jira thus forms the basis of the framework on an industry-related setting and is feasible to such an extent that it will fit the constraints of academic research.

3.9 Validation and Analysis Method

Validation involves case instantiations, scenario testing and comparison of standards. The risks recorded on the chosen cases are represented in the Kanban workflow and simulate governance responses with predefined IfThen rules. Several (e.g., increasing probability, converging risk events) scenarios are analytically tested to determine whether the framework generates logical and timely actions (Dikmen, Birgonul and Han, 2007). The obtained results are also compared to the results of conventional risk registers and assessed according to the principles of ISO 31000 and ISO/IEC 31010, which prove to be more responsive and congruent to best practices. This approach guarantees rigour although there is no actual deployment.

3.10 Ethical Considerations

The ethical considerations in this research are the proper utilization of publicly available data and lacks confidentiality breach. It does not involve any human participants, surveys, interviews, or any proprietary company information, which does not raise any concerns regarding the consent and privacy (Gajewska and Ropel, 2011). Citation of all secondary sources is done using transparent URLs and interpretations are made with respect to the settings of original selfs. In cases of reference to ISO and academic literature, the form of attribution is upheld. Ethical aspects also involve the fair reporting of limitations that there was no primary data collection and that is why the research integrity and academic honesty are guaranteed.

3.11 Research Limitations

The research is based on the two published case studies available publicly that contain secondary data instead of collecting data by conducting interviews or surveys. It is an explicit methodological choice in the DSR paradigm. DSR focuses on designing and evaluating artefacts as generalised solutions to a class of issues, rather than measurement of specific organisational behaviours (Gajewska and Ropel, 2011). In this study, the purpose of the case data is to provide real, documented risk events to instantiate and test an algorithmic framework - not produce generalized findings about practitioner behavior or culture change in organizations. In this regard, data that talk enough about risk identification, impacts, and context of projects in the secondary literature is both reasonable and legitimate. The cases considered are those of residential construction in Bangalore (Khedagi, Sagar & Sowmyashree 2017) and a comparative risk analysis for the collapse of Rana Plaza-building, Bangladesh (Safayet, Islam & Ahmed 2018); both including peer-reviewed, expert validated data with associated risk registers and probability assessments as well local context information present to go along. These cases were purposefully chosen from various project types, scales, and risk profiles so as to provide a diverse range of error type for demonstrating the framework in different construction contexts. In addition, Atlassian Jira is regarded as a conceptual software reference platform rather than a deployed system (e.g. issues related to its real-world technical deployment such as data migration, user adoption, configuration challenges have not yet been empirically assessed). These are recognised as key upto date directions for applied research.

4 Chapter 4: System Design and Development

4.1 Conceptual Framework Overview

This theoretical framework of the research transforms the notion of construction risk management as a formal document process into a dynamic workflow-driven governance process. The traditional approaches, particularly, the probability-impact matrices, are founded on the assumption that risks are discrete and can be assessed independently, but empirically, it is observed that the risks in construction vary over time due to interdependencies and time constraints and thus, the portrayal of risk as constant is not suitable (Dikmen, Birgonul and Han, 2007). This limitation is a direct contributor to the need of a framework which includes risk characteristics that involve real-time decision activation, rather than periodic re-evaluation. The framework proposed fills this gap as it includes algorithmic reasoning into a Kan-ban-oriented workflow, changing a risk to an active working object rather than a passive one.

The framework is based on Systems Theory, which considers projects as systems connected through feedback, and not influenced by cause-effect relationships (Marle, 2020). This theoretical stance is important as it elucidates the shift towards periodical risk reviews to ongoing governance structures. Risks in construction environments are not very isolated, they tend to spread through dependencies including scheduling, resource allocation, sequence of tasks and the likes. Thus, Systems Theory is operationalised in the framework: the triggers are rule-based reactions to the variation in these interdependent variables. This is consistent with the literature that has shown that the use of conventional risk models is not effective in modelling the complexity-risk interactions, so more adaptive and responsive systems are required (Afzal et al., 2021).

Moreover, the implementation of Kanban in the structure is not just the visualisation but organization of governance logic. Although the effectiveness of Kanban in enhancing workflow transparency and operational efficiency has been proven in the existing literature, its use in explicit risk governance is still scarce (Zeng et al., 2019; Fuentes-del-Burgo, Fernandez and Navarro-Astor, 2024). This study enhances the purpose of Kanban by integrating algorithmic decision-making, which is an important gap in the literature on agile risk management, where risk processes tend to rely on human factors and are not automated (Garcia, Hauck and Hahn, 2022). The framework thus closes the gap between visibility and action by formalising the risk escalation, prioritisation and assignment by explicit logic gates.

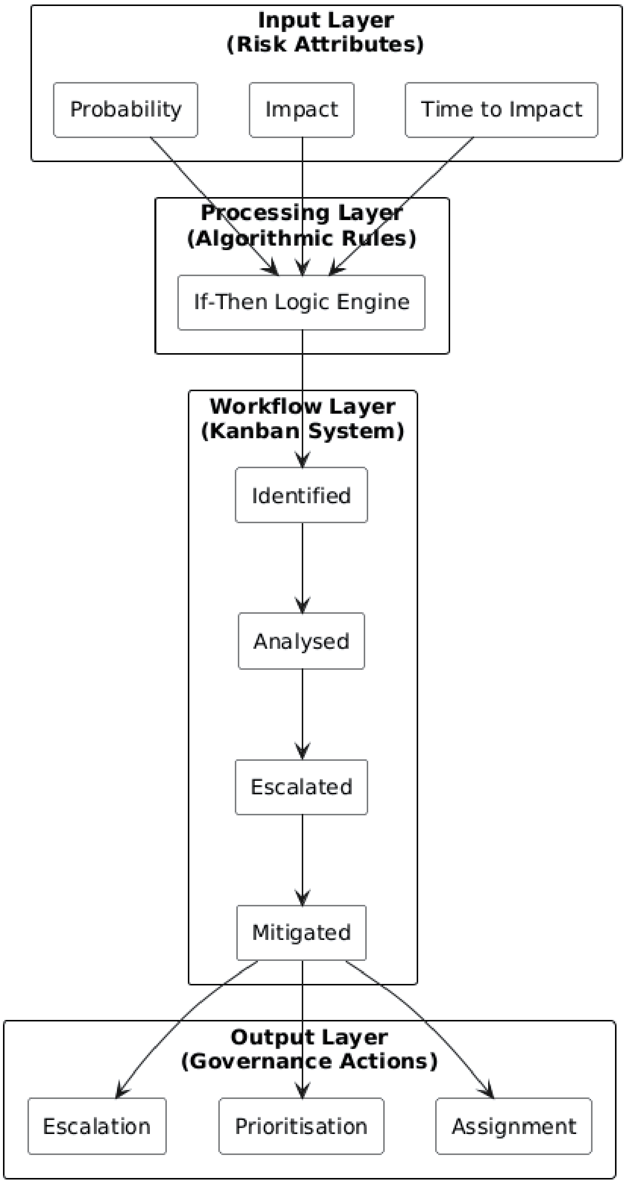


Figure 2. Conceptual Framework Overview

Also, the conceptual framework uses the experience of digital workflow systems, like Jira, that allow organizing tasks, dependencies, and automation rules in one platform. Though Jira is applied in the conceptual manner in this research, it is relevant in terms of proving how the logic of governance can be operationalised using industry-standard tools (Avramovska, Hristovska and Calamani, 2024). This enhances the practicality of the framework and preserves the methodo-logical viability.

More importantly, the framework also tackles shortcomings that have been revealed in agile and hybrid project settings, in which Kanban might fail to provide the large scale coordination without formal governance systems (Anjum, 2020). The framework improves the ability of Kanban to cope with complexity and interdependencies in construction projects through the incorporation of the rules of the algorithmic process. Therefore, the conceptual framework is not just a synthesis of the existing theories but rather a systematic answer to the gaps identified and is in direct relation to the research goals of designing and validating a dynamic risk governance system.

4.2 Risk Workflow Architecture

The risk workflow architecture that will be created in this research is a major reorientation of the non-state risk registers to a hierarchical, state-based governance framework. The proposed architecture contrasts with the traditional methods, where risks are registered and periodically analyzed, in which every risk is viewed as a workflow item, which moves through a set of states, allowing constant monitoring and intervention. This design is specifically shaped by the shortcomings of traditional risk management frameworks, which do not reflect the urgency of time and interdependencies of a construction project (Dikmen, Birgonul and Han, 2007). Through the integration of risks in a workflow model, the architecture will guarantee that governance activities are initiated in real time, as opposed to lagging them in a manual manner.

The architecture is based on the Kanban principles which focus on visual flow, control of the work in progress and identification of the bottlenecks. Nevertheless, this research takes these principles further by integrating algorithmic logic of governance and thus changing Kanban into a system of decision making constituting a visual management tool. Past studies have shown that Kanban can be effective when it comes to improving coordination and operational efficiency in construction logistics, especially in material flow management and the reduction of delays (Zeng et al., 2019). However, these applications are still concentrated on the pro-duction processes but not on risk governance. The proposed architecture tries to solve this limitation by incorporating risk attributes in the workflow logic, which is to make sure that the risks are actively handled in the same operational system.

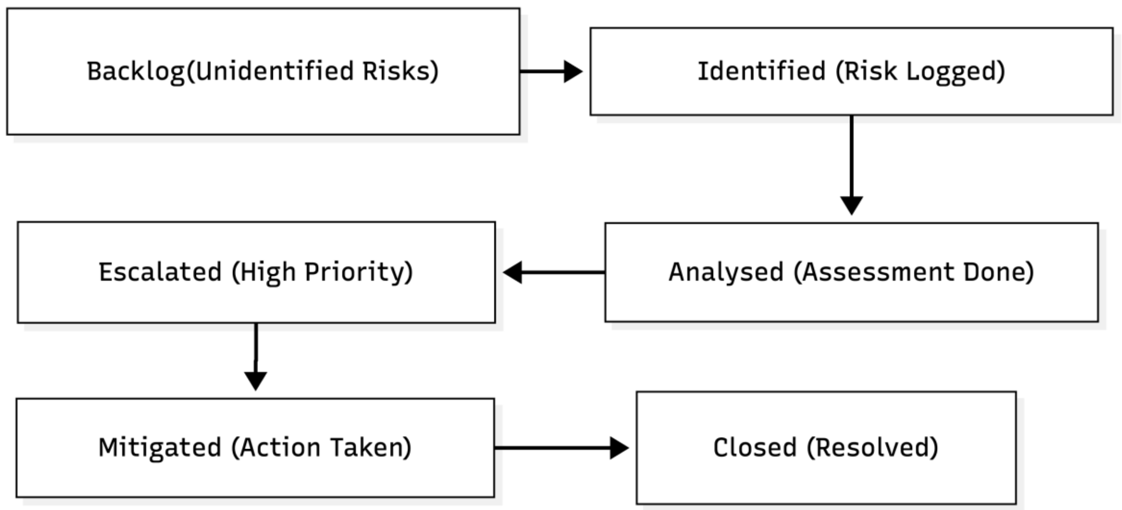


Figure 3. Risk Workflow Architecture (Kanban Flow)

Being able to depict interdependencies between risks and project tasks is a critical aspect of the architecture. The interactions in construction projects are typically complex as one component can spread out or cause delays within the system. This opinion is supported by Systems Theory, which puts an emphasis on feedback loops and emergent behaviours in project environments (Marle, 2020). The workflow architecture realises this idea by connecting risks to activities and facilitating automated responding to dependencies when they are impacted. This strategy is consistent with research that adaptive systems with intrinsic feedback control are more useful in uncertainties management than fixed control structures (Almalki, 2025).

In addition, the architecture is designed with rule-based automation as a solution to the shortcomings of risk management processes based on humans. Agile risk management studies have garnered the focus that traditional practices are characterized by a strong emphasis on meetings and manual updates, which may cause governance delays and inconsistencies (Garcia, Hauck and Hahn, 2022). In comparison, the suggested architecture relies on predefined If-Then rules to automate the processes of escalation, prioritisation and assigning decisions. This minimises the use of human intervention and provides a uniformity of governance logic.

The architectural design is further reinforced by the conceptual use of Jira which gives a practical demonstration of how the workflow states, transitions and automation rules can be applied in a digital setting. Research on Jira-based workflow systems has demonstrated that these systems improve the visibility of processes and inter-team coordination (Avramovska, Hristovska and Calamani, 2024). Nonetheless, this paper critically extends their use to risk governance, showing how the algorithmic logic can be implemented in the workflow systems.

4.3 Definition of Risk States and Transitions

Operationalisation of the proposed framework is largely dependent on the definition of risk states and transitions that define the way risks are transformed in the workflow and the governance actions are initiated. Contrary to conventional risk registers, where risks are fixed records, and only updated through manual means, this framework describes risks as dynamic entities that change through a series of states according to predefined conditions. This method is directly related to the problem of dormancy of traditional risk management systems, where the delays in updates may result in obsolete information and an incorrect decision (Afzal et al., 2021). Through formalisation of states and transitions, the framework provides that there is constant monitoring and taking of actions regarding risks.

Construction risk management literature as well as workflow management principles are used to identify risk states. Common conditions like Identified, Analysed, Escalated, and Mitigated are not only descriptive conditions but are associated with certain governance roles and activities. This is in line with results that formal risk management procedures enhance transparency and responsibility in construction projects (Pham et al., 2021). The framework however goes a step further to incorporate transition logic that is activated automatically on changes in risk characteristics like probability, impact and time-to-impact.

The rules of transitions between states are controlled by algorithmic rules, which is a major innovation of this work. Conventional risk management methods are based on personal decision and sporadic assessment, thus resulting in a lack of consistency in the decisions made (Dikmen, Birgonul and Han, 2007). In contrast, the proposed framework uses explicit If-Then rules to standardise governance actions. As an example, a risk can become escalated after its likelihood passes a certain threshold or a risk becomes time-to-impact much shorter. This type of rule-based approach will make the decisions uniform, transparent, and aligned with a set of predefined criteria.

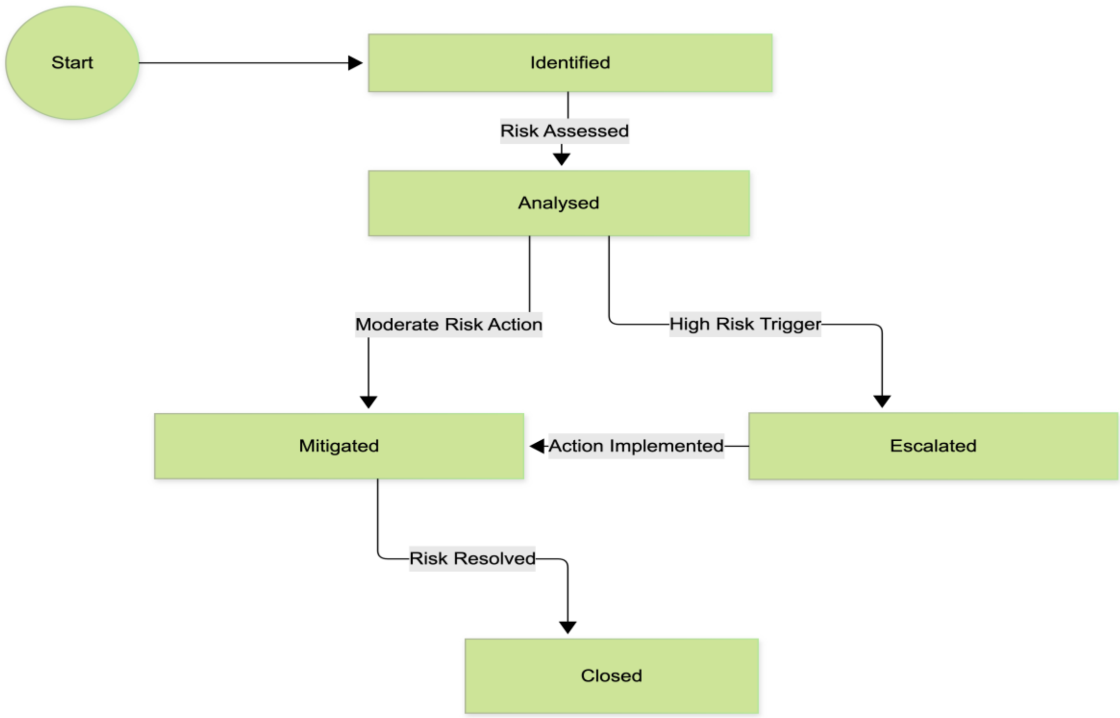


Figure 4. Risk States and Transitions

The combination of Kanban ideas also makes the definition of the states and transitions more reliable as the visual representation of the risk progression is offered. Although Kanban has been popularly applied in the management of workflow in other industries, its use in risk governance is not yet fully developed (Fuentes-del-Burgo, Fernandez and Navarro-Astor, 2024). The framework allows real-time observation of risk status and early intervention by mapping risk states onto columns of a Kanban. This is especially significant in construction projects, where the delays and disruptions may create a ripple effect on various activities.

Also, the application of Jira as a conceptual platform promotes the real application of the states and transitions. Jira can be configured to have a workflow with the ability to define states, transitions, and automation rules, making it an appropriate reference system to model the proposed framework (Avramovska, Hristovska and Calamani, 2024). Nevertheless, the research also critically admits that the framework does not rely on a particular tool, which guarantees that it can be applied in various project settings.

Notably, the definition of states and transitions also covers the requirement of auditability and traceability in terms of risk management in construction. The regulatory and contractual requirements tend to require explicit documentation on the processes of decision making. The framework offers a clear record of the actions of governance by connecting every transition to a particular rule and condition, which increases accountability.

4.4 Algorithmic Rule Design (If-Then Logic)

The algorithmic rule design is the fundamental working principle of the suggested framework, which will turn risk governance into objective judgement rather than subjective judgement. Conventional management of construction risks is very dependent on periodic reviews and skillful interpretation, which creates inconsistency and delays in responding, especially in dynamic project environments (Dikmen, Birgonul and Han, 2007). This constraint is the very reason why explicit If-Then logic gates are introduced, formalising such governance decisions, in which risk attributes are associated with predetermined actions. This way, the framework gets rid of the ad hoc human intervention and makes sure that when particular conditions are followed, the response is evoked in a specific manner.

These rules are designed based on the current shortcomings of the agile and construction risk management literature where risk processes are not automated systems but are typically contained in meetings and discussions. A systematic mapping study sheds light on the fact that in spite of the fact that risk identification is extensively embedded in the agile practices, the governance mechanisms are mostly manual and human-based (Vieira, Hauck and Matalonga, 2020). On the same note, in the literature, agile risk management studies highlight practices like risk registers and prioritisation meetings but does not provide formalised decision logic that can be run in perpetuity (Garcia, Hauck and Hahn, 2022). This study fills this gap through encoding the process of making decisions into algorithmic rules that are run within a workflow.

The If-Then rules are structured based on the major risk attributes found in both literature and case studies such as probability, impact and time to impact. In the case of risk, a rule might be that, when a risk has high probability and low impact, it is automatically bumped up to a higher level of governance. This strategy is consistent with the literature that risk management is best managed responsively based on temporal urgency, but not fixed ranking (Afzal et al., 2021). The framework provides a more immediate focused prioritisation of risks, as it incorporates time-sensitive conditions and is not just based on severity.

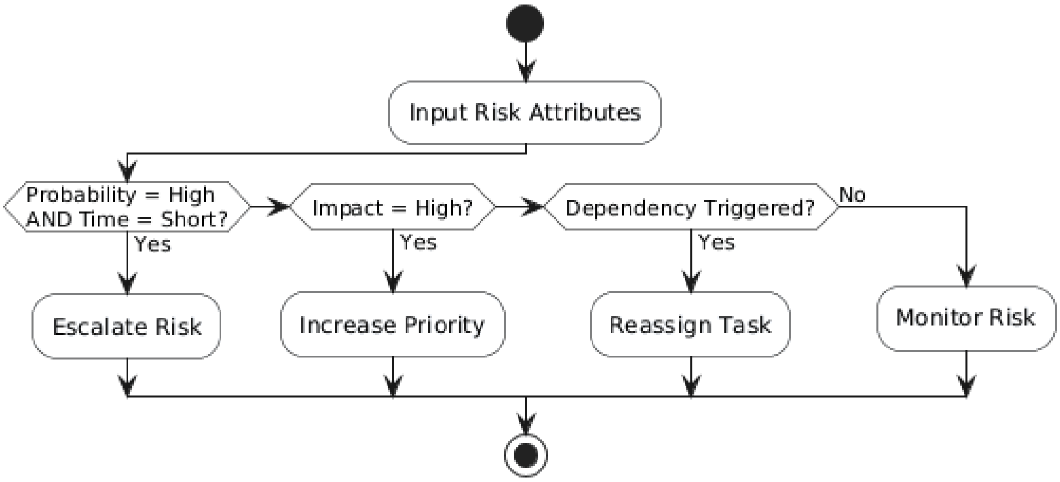


Figure 5. Algorithmic Rule Flow (If-Then Logic)

Moreover, the fact that the algorithmic rules are integrated into the workflow systems represent larger progress in decision-support technologies. The studies of AI-based decision systems show that the accuracy of risk detection and response can be greatly enhanced when based on structured rule-based mechanisms (Almalki, 2025). Although this research is not based on AI, it follows the same principle by introducing deterministic logic into the workflow, increasing decision consistency, and traceability. This is especially crucial in the construction setting, where governance decisions should be traceable and in line with contractual and regulatory provisions.

The fact that Jira was used as a conceptual platform only supports the applicability of algorithmic rule design. The automation features of Jira enable the definition of triggers and actions, which is a convenient model of the functioning of the If-Then logic in the context of a digital system (Avramovska, Hristovska and Calamani, 2024). Nevertheless, the framework is intended to be platform-independent, which means that it should be applicable outside of a particular tool.

Importantly, algorithmic rule design also helps to resolve the issue of scalability of Kanban systems. Although Kanban can enhance visibility, it cannot be used effectively in large-scale projects without formal governance mechanisms (Anjum, 2020). The framework improves the capability of Kanban to handle complex and interdependent risks by incorporating logic gates. Therefore, the algorithmic rule design will not only be suitable to the research objectives but will also be a major breakthrough over the current methodologies by providing a means of continuous, automated risk governance.

4.5 Risk Prioritisation and Escalation Mechanism

The proposed framework of risk prioritisation and escalation is meant to address the limitations of the traditional ranking systems, which are not able to address the dynamic and interdependent character of the construction risks. Conventional approaches are based on probability impact matrices to prioritize risks, yet they tend to ignore the urgency of time and interactions across a system, resulting in slow or inappropriate responses (Dikmen, Birgonul and Han, 2007). This work seeks to fill these deficits by integrating prioritisation and escalation as part of a rule-driven workflow-based system which is constantly adjusted to evolving circumstances.

The prioritisation mechanism does not rely on the static scores, but it considers the multiple dimensions such as probability, impact, and time-to-impact. This multi-criteria methodology is an indication of the complexity of construction projects, where risks are dynamic and change in reaction to changing constraints and dependencies. Studies have revealed that traditional risk assessment tools fail to capture this complexity, especially when risks interact to increase their overall impact (Afzal et al., 2021). Combining these variables into prioritisation logic provides the framework with the ability to evaluate the risks in a more context-sensitive way, which is in line with the principles of the Systems Theory, which lays stress on interdependencies and feedback loops (Marle, 2020).

Escalation has been operationalised in such a way that it uses pre-determined thresholds that cause automatic transition in the workflow. An example is that a risk can be intensified when its probability exceeds a specified threshold or when its time-to-impact is less than a critical threshold. The practice is contrary to the traditional practices where the process of making decisions based on escalation continues to be slowed down by depending on periodic reviews and judgement by the human factor. Agile risk management studies have shown that formal and recurrent escalation systems are more efficient and embraced by groups because they offer transparency and uniformity in decision-making (Salin and Lundgren, 2022). The proposed framework is based on this understanding because it directly incorporates the logic of escalation into the workflow, meaning that responses must be timely and transparent.

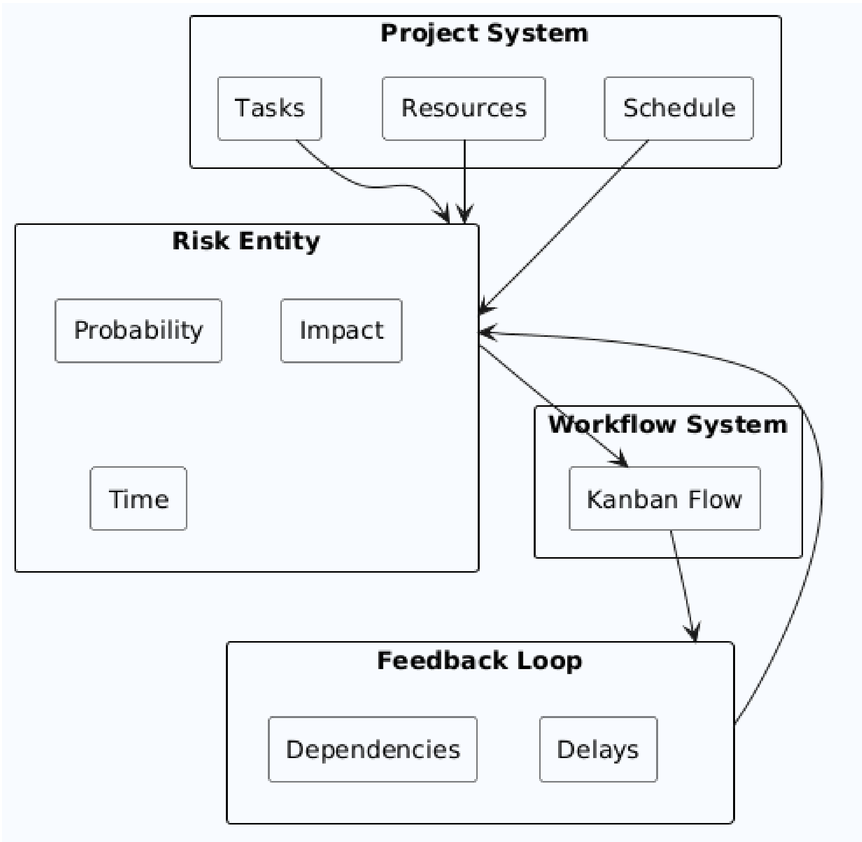


Figure 6. Systems Theory-Based Risk Governance Framework

The combination of prioritisation and escalation in a Kanban-based system increases visibility and coordination even more. Kanban systems help to identify bottlenecks and workload imbalances, which may be crucial signs of the development of risks (Zeng et al., 2019). Nonetheless, these indicators might not be converted into actionable decisions without automated escalation mechanisms. The framework fills in this gap by connecting visual cues to algorithmic stimuli, thus transforming observations into governance action. This is in line with studies that suggest workflow based systems have the potential to enhance operational responsiveness to operational systems coupled with structured decision logic (Shiyanbola, Omisola and Osho, 2023).

Also, the conceptual application of Jira helps to support the practical implementation of prioritisation and escalation mechanisms. The fact that Jira allows dynamically adjusting the priorities of issues and sending notifications depending on specified conditions offers a more lifelike depiction of how the framework can be operationalised (Avramovska, Hristovska and Calamani, 2024). Nonetheless, the paper also establishes with a critical recognition that these mechanisms cannot perform well unless the thresh-olds are appropriately and clearly defined since misconstrued rules may create an over-reaction or noise in the system.

4.6 Mapping Risk Attributes to Workflow Actions

The activation of risk attributes on workflow is a significant aspect of the proposed framework since it provides the direct connection between the risk properties and governance reactions. The probability and impact are the two main risk attributes which are classified and rated in traditional construction risk management, with little regard to action outcomes. This lack of connectivity usually leads to sluggishness in response and decreased efficiency of risk mitigation measures (Dikmen, Birgonul and Han, 2007). The offered framework aims to overcome this shortcoming by systematically transforming the risk features into predetermined workflow actions using algorithmic reasoning.

The mapping process is based on the fact that risk attributes are dynamic and interdependent, as opposed to being a static indicator. To illustrate, a probabil-ity increase might not always justify prompt escalation unless it is accompanied by a decrease in time-to-impact or with dependency effects. This view is in line with studies on complexity-risk interdependencies, which underscore the importance of analysing various interacting factors in the assessment of risk (Afzal et al., 2021). With this inclusion of the interactions within the mapping logic, the framework will guarantee the context sensitivity of actions and representativeness of actual project conditions.

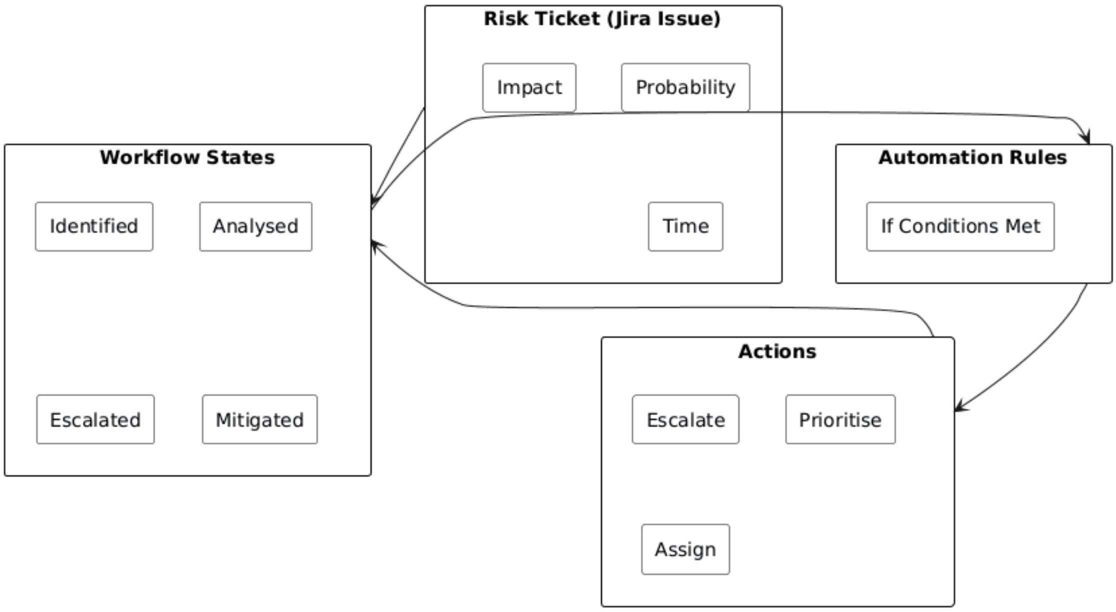


Figure 7. Jira-Based Risk Workflow Configuration

All risk attributes are interconnected with workflow actions which are predefined by rules. An example is that high-impact risks can lead to a change in prioritisation, whereas risks with a short time to impact can lead to escalation or redirection. This organized mapping is what takes risk management out of the passive assessment process to an active governance mechanism. Agile and Workflow-based system studies have demonstrated that decision logic embedded in operational processes can greatly enhance responsiveness and coordination (Garcia, Hauck and Hahn, 2022). The given framework applies this principle to the construction risk management, whereby actions are automatically activated and are always consistent.

Kanban as the workflow structure further improved the mapping process by giving a visual representation of the risk states and actions. Although the management of the workflow and identification of bottlenecks have been extensively implemented using the Kanban systems, their usage in risk governance has been scarce (Fuentes-del-Burgo, Fernandez and Navarro-Astor, 2024). The framework helps to identify risk status and take proactive action by incorporating risk attributes into the Kanban workflow, thus providing real-time visibility of risk status. This is especially significant in construction projects where construction delays and disruptions may have ripple effects on several tasks.

Furthermore, the theoretical incorporation of Jira gives a viable model of implementing attribute-action mapping. The manualisation of risk attributes to workflow transitions and notifications with the use of configurable fields and automation capabilities illustrates how Jira can be operationalised within a digital environment (Avramovska, Hristovska and Calamani, 2024). Nonetheless, the research cynically acknowledges that the usefulness of such mapping is limited to the soundness and uniformity of the core data, and suitability of the formulated rules.

Lastly, mapping process also leads to transparency and auditability as any action can be tracked to certain risk attributes and conditions. This is necessary in building projects, where decisions of governance should be warranted and recorded. The structure of the framework offers a clear and well-organized connection between risk characteristics and actions, which increases accountability and aids in making informed decisions.

4.7 Integration of Systems Theory into Framework Design

The Systems Theory is not an imaginary placement but is the logic which forms the basis of risks conceptualisation, surveillance, and action in the workflow architecture. The conventional construction risk management methods assume a risk is a single event, which is normally assessed using probability-impact matrices that assume that the variables are independent of each other. Nevertheless, empirical and theoretical studies reveal that construction risks are the product of interrelated subsystems with feedback loops and dependencies that have a profound impact on the consequences (Marle, 2020). This weakness is vital since the fixed methodologies do not reflect the spread of risks among tasks, resources, and sched-ules which result in slow or inefficient responses (Dikmen, Birgonul and Han, 2007).

The suggested framework is a Systems Theory operationalisation as it includes the logic of feedback incorporated into the working process. Instead of risk attributes being taken as constants, the system will continually assess variations in probability, impact, and temporal urgency with respect to other aspects of the project. This is in line with the studies that point out the interdependencies of com-complexity-risk necessitating adaptive processes that are capable of responding to dynamic environments instead of using a fixed evaluation (Afzal et al., 2021). The inclusion of feedback loops within the workflow makes the framework capable of triggering risk escalation and prioritisation caused by the interaction of the individual attribute in conjunction with system-wide variables including the dependencies between the tasks and the resource constraints.

Moreover, Systems Theory integration fulfills one of the main gaps of the agile and Kanban-based application in the construction. Although Kanban has been demonstrated to enhance workflow visibility and coordination, its use is typically not supported by a theoretical foundation to deal with interdependencies and emergent behaviours (Fuentes-del-Burgo, Fernandez and Navarro-Astor, 2024). The suggested structure builds upon Kanban and integrates systemic feedback processes thus making it more of a dynamic system of governance than a visual management tool. This is more so applicable in the construction world, where the risk usually spreads through various activities, increasing its effects unless managed in time.

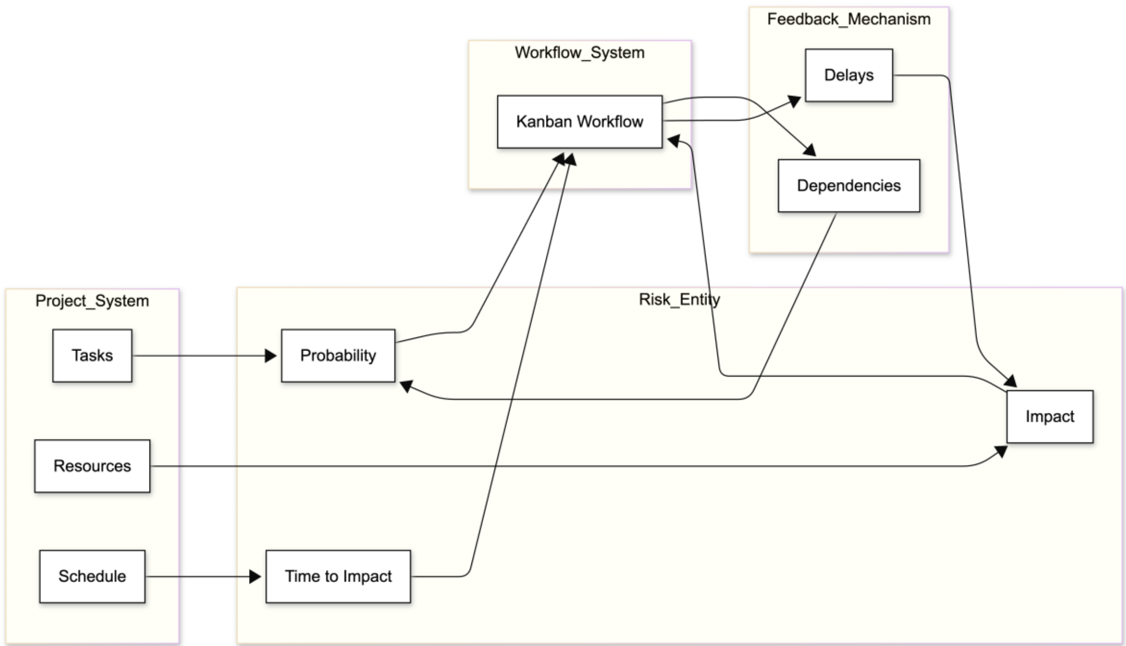


Figure 8. Systems Theory-Based Risk Governance Framework

The framework is also consistent with the results of adaptive and decision-support systems, which have shown that the inclusion of feedback mechanisms can improve coordination and minimize a variation in the project outcomes (Almalki, 2025). The proposed approach, however, is not as opaque or unnecessarily ambiguous as AI-based systems since it relies on explicit rule-based logic. This is paramount in construction situations, where governance decisions should be verifiable and explainable. Also, the comparisons of AI and human risk assessment point to the significance of the contextual understanding, which supports the necessity of the structured and interpretable systems (Nyqvist, Peltokorpi and Seppaenen, 2024).

More importantly, the incorporation of the Systems Theory helps the research objectives as well by allowing the framework to transcend the representation of risks in a static form towards the dynamic governance. It makes sure that the system is such that it can capture the temporal urgency, inter-dependencies and feedback effects which are the key areas of concern of addressing the limitations found in the existing methodologies. Thus, Systems Theory is not an abstract addition but a requisite base that allows the framework to be a responsive and adaptive risk management system.

4.8 Jira-Based System Configuration (Conceptual)

The theoretical structure of Atlassian Jira in the proposed framework is an expedient illustration of how the developed algorithmic logic and workflow can be operationalised in a digital setting. It is important, however, to stress that Jira is not applied in this study as a data collection and analytical tool but is rather a reference platform that can be used to illustrate what system architecture and what automation is possible. The distinction is necessary to ensure the methodological consistency of the study since it consists of secondary data analysis and validation of the analytical results instead of software implementation. Jira usage is thus consistent with the Design Science Research paradigm, that is oriented towards artefact design and concept testing, as opposed to deployment. Jira can be seen as a solution to the proposed risk management framework because it allows modeling the workflow, defining the type of issues, and setting automation rules, which are the characteristics of the suggested framework based on the Kanban. Research has revealed that Jira-based systems improve visibility and coordination of processes by organizing work into trackable units and providing real-time updates (Avramovska, Hristovska and Calamani, 2024). The conceptualisation of risks, in the framework of this study, is that of an issue within Jira, which has attributes (probability, impact, time-to-impact). This framework enables the risk data to be directly mapped into a workflow system to facilitate the goal of converting risk management into an operational process.

The structure consists of the definition of workflow states, transitions and automation rules mirroring the algorithmic logic that has been developed within the framework. To illustrate, the automation engine at Jira can be employed to initiate a status change, notification, or priority change upon predetermined conditions. This feature is similar to the study of workflow management systems, which emphasizes the need to incorporate decision logic into the operational processes to enhance responsiveness and minimize the need to rely on manual intervention (Shiyanbola, Omisola and Osho, 2023). Integrating this logic into Jira, the framework shows how it is possible to implement governance decisions in an automated and consistent way.

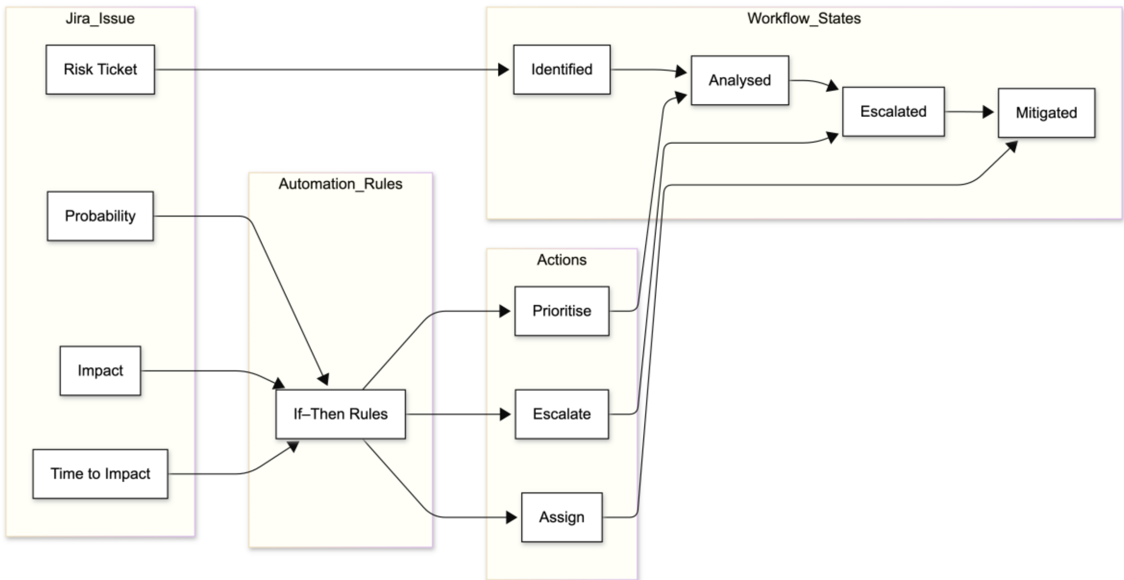


Figure 9. Conceptual Jira-Based Risk Workflow Configuration

Nonetheless, the utilization of Jira is also to be critically assessed, especially when compared to scalability and adaptability. Although Kanban-based systems can work well to control workflow, it might have limitations in large-scale projects unless supplemented with other coordination systems (Anjum, 2020). This is dealt with in the proposed framework by including algorithmic rules that increase the capacity of Jira to deal with interdependent and complex risks. Moreover, the conceptual implementation of Jira does not have the issues related to the live implementation, including, but not limited to, the data integration and the adoption of the service by the users, which are beyond the limits of this research.

Notably, the setup also allows transparency and auditability, since Jira will give a log of all operations, transitions, and rule execution. This is especially applicable to the construction projects where the governance decisions are supposed to be captured and explained. The framework makes decision-making processes traceable and explainable by the fact that every action is connected to a particular rule and condition.

5 Chapter 5: Results and Evaluation

5.1 Case Study 1: Risk Identification and Mapping

A published study on risk management indicators for a residential villa construction project in Bangalore, India (Khedagi et al., 2017), provides case study 1. This project was for a multiple storey flat and was overseen by an association of senior management professionals (5 members). The risk breakdown structure of the study was structured to 9 categories and 39 risks through a literature search combined by site-expert experts. The risks to be managed were classified under the following categories: Organisational risk, Legal risk, financial viability risk, Construction-Operational Risk, External processes adjustments. It encompassed the entire construction project lifecycle ranging from elements completing foundational work to fully erecting structural and has a dataset that tracks risk inducing events (e.g., procurement issues, workforce challenges, schedule cost overruns/ slippage, site condition adverse impact). The case presented here is a representative example of small-to-medium-sized residential construction development in an emerging urban context with clearly documented risk registers, probability-impact assessments, and expert judgements suitable for framework instantiation.

It is a questionnaire survey of five senior project management professionals that forms the basis of identification process in this case study and brings expert judgement and empirical validation to the data set. The findings raise labour productivity (5/5 responses), cost overrun (4/5 responses), delay (4/5 responses), procurement issues (4/5 responses), and weather risk (4/5 responses) as the key risks. This distribution highlights that operation and resource risks predominate over technical risks, which corroborates existing literature showing that the human and process aspects are considered to be key contributors to construction project uncertainty (Dikmen, Birgonul and Han, 2007).
The analysis of these risks as they fit into the proposed framework illustrates a major weakness of the traditional approaches: the identification and classification of risks is made, but the translation of the risks into actionable workflows is still lacking. The initial

examination is based on probability impact (P-I) matrices, in which the risks are considered as low, moderate, or high according to the predetermined scales . Yet, this method is fundamentally fixed and does not take into account the time urgency or risk interdependencies. An example is how risks like delay and procurement are handled separately yet in the real project scenarios they are highly causally associated.

With the help of the suggested Kanban based framework, the identified risks are revisualized as dynamic objects in a workflow system. All risk factors are mapped to characteristics like probability, impact and time-to-impact, and allow algorithmic rules to be activated. By way of example, the issues of labour productivity, having the highest frequency of responses, would be given priority not only due to the impact but also due to the possibility of causing cascading delays on some of the tasks that are dependent on it. It is compatible with the systems-based approaches, which focus on interdependencies and feedback loops in risk management (Marle, 2020).

More importantly, the case study has shown that whereas the traditional methodologies are excellent in offering a strong basis on risk identification, they do not offer mechanisms of continuous governance and automatic response. The proposed framework fills this gap by converting the perceived risks into the workflow details that can be acted upon thus closing the gap between risk assessment and decision-making. This transformation is necessary in meeting the research goal of transforming risk management into an active and responsive system, which is currently a documentation process.

5.2 Case Study 2: Risk Identification and Mapping

Case study 2 is based on a published risk analysis of construction risk management in Bangladesh, specifically the Rana Plaza building collapse (Safayet et al., 2018). Rana plaza was eight-storey commercial residential complex building metropolitan area of Savar near Dhaka, Bangladesh. The building was home to several garment factories and had around 3,122 workers when it collapsed in April 2013 killing at least 1,134 people and injuring more than 2,500. It was a four-storey structure that had been extended in an 'inadequate' way without sufficient structural analysis and examined against building regulations, the original structure. The risk analysis published has used AHP method in retrospect to identify and prioritise the critical failure risks from three criteria, i.e., safety, cost and time based on priority order. The top risk was foundation system failure (overall priority weight 0.71), along with design failures and procurement-induced risks. This case is a large-scale, high-cost structural failure and forms a data-rich context to test how key risks can escalate through the system and expose interdependencies.

Application of AHP brings a multi-criteria decision-making approach whereby the risks are considered on basis of factors like safety, cost, and process time. Analysis demonstrates that the weight of safety is the highest (0.60), then cost and time (0.20 each) and the risk prioritisation in this context is largely dependent on human and structural safety. The discovery corresponds to overall literature on construction risk management that underlines the prevalence of risks connected with safety in influencing the project results (Pham et al., 2021).

But, even with its analytical refinement, the AHP-based method is essentially stagnant. Risks are ranked using calculated weights but there is no provision to change the priorities dynamically as the project conditions change. Also, the method fails to consider dynamic interaction between risks, including how material procurement problems can contribute to structural vulnerabilities. The restriction is indicative of a greater problem found in the literature, in which conventional risk assessment models lack complexity and interdependency (Afzal et al., 2021).

The risks that are identified in this case study once plotted into the proposed framework are converted into dynamic workflow elements. An example is the risk of foundation system, which is the most important risk, and would immediately escalate the workflow, with predetermined measures that include reassessment, redesign, or the reallocation of resources. Likewise, the risks associated with procurement would also be connected to the dependencies of the supply chain, which would allow the system to predict and prevent a chain reaction. This mapping process illustrates the extension of the framework to go beyond the prioritisation that is static to facilitate continuous monitoring and automated response.

Moreover, the case study emphasizes the necessity to combine the qualitative and quantitative data in risk management. Although AHP offers a systematic approach to prioritisation, it also uses extensive expert judgement thereby subjecting it to subjectivity. The given framework alleviates this shortcoming by instilling rule-based logic that standardises the decision-making processes, thus making them more consistent and transparent. This method is consistent with the studies in the field of decision-support systems, which highlight the value of organised reasoning in enhancing risk management (Almalki, 2025).

5.3 Application of the Framework to Case Studies

The use of the proposed Kanban-based dynamic risk management framework to the chosen case studies proves that the framework is effective in the limitations of conventional approaches. The two case studies present empirically tested datasets of risk identification, categorisation, and analysis, which present inputs to the framework. Nevertheless, their initial strategies have not changed, as they are based on regular assessment and decision-making process by hand. The framework re-analyses such datasets in an algorithmic, workflow-based environment, which allows risk governance to be carried out continuously and automatically.

In the first case study, risks like labour productivity, cost overrun, and delay are mapped into workflow states, where they have attributes that cause predefined workflow actions. E.g., a high probability, medium impact delay risk, as found in the P-I matrix would trigger escalation rules within the framework, allowing timely intervention. Likewise, procurement risks, which are strongly related to project delays, are addressed as interrelated entities, which allows the system to respond to root causes, but not to the symptoms of problems. The approach is consistent with the Systems Theory that highlights the significance of interdependencies in complex systems (Marle, 2020).

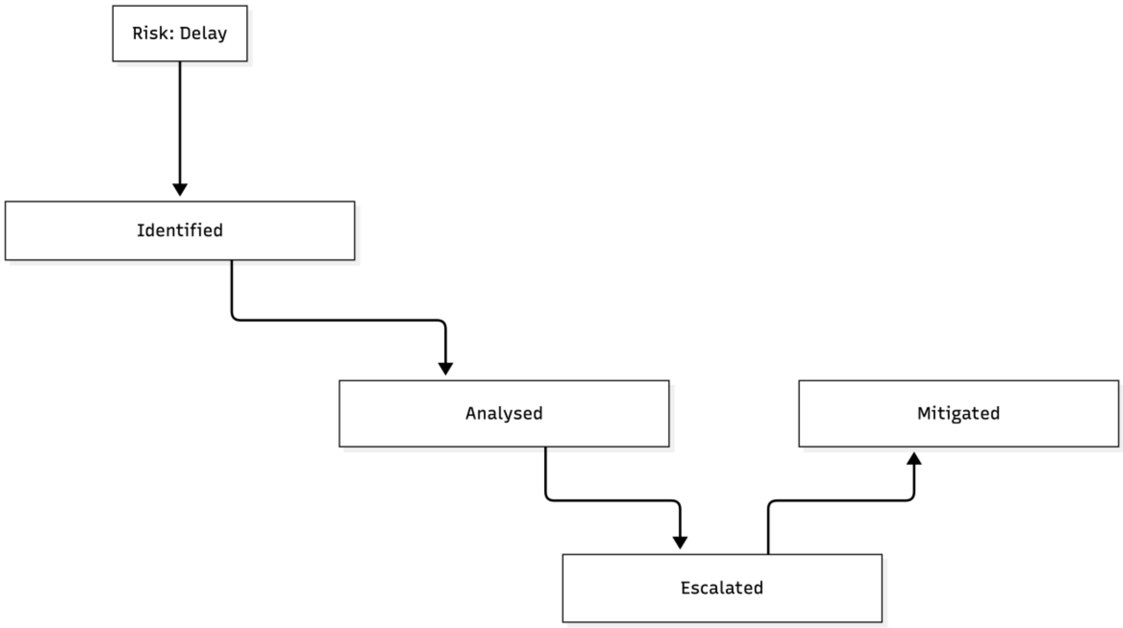


Figure 10. Workflow - Risk Progression

The second case study refines the AHP-based prioritisation with a framework that incorporates dynamic workflow actions. The discovery of foundation system failure as the most significant risk is converted into an immediate escalation and mitigation measures in the working process. The framework also ensures that high-priority risks are constantly tracked and addressed by automated means, unlike in the original study, prioritisation is still a constant value. Such change is essential when it comes to catastrophic failures, which the Rana Plaza case illustrates.

The comparative analysis of the two case studies underlines one of the major contributions of the framework; the possibility to merge different risk assessment methodologies to a single system. Although the former one uses P-I matrices and the latter AHP, both are successfully translated into the identical workflow architecture. This shows the flexibility and adaptability of the framework, which is a significant weakness of current methodologies, which tend to be tool-dependent and not interoperable with each other (Vieira, Hauck and Matalonga, 2020).

In addition, the use of the framework secures the validation compared to ISO 31000 principles, especially in regard to ongoing monitoring, integration, and systematic decision-making. The traditional methods meet the identification and analysis phase but fail in providing continuous risk treatment and review. The introduced framework fills this gap, integrating these processes into the workflow, and, thus, increasing adherence to the existing standards.

Importantly, the application also demonstrates possible drawbacks, including the reliance on the correct input data and the necessity to have clear rule thresholds. Nevertheless, all risk management systems have these constraints, which do not compromise the general effectiveness of the framework. Rather, they point out areas where future research and improvement is required.

5.3.1 Evidence Table: Risk Attribute Mapping to Framework Actions

Analytical validation on how each risk identified can be mapped to particular workflow states, triggering conditions and governance outputs within the proposed framework is analyzed in Table 7. This is in direct response to the feedback on the absence of demonstrable application in the past.

Table 1. Risk Attributes Mapped to If-Then Rules and Workflow Actions

Risk ID	Risk Description	Probability	Impact	Time-to-Impact	Rule Triggered	Workflow Action	Status
RISK-001	Labour Productivity	HIGH (0.80)	HIGH (0.75)	< 7 days	IF P>0.70 AND I>0.70	Auto-Escalate to Management	ESCALATED
RISK-002	Material Delay	MED (0.50)	MED (0.55)	8–14 days	IF P>0.40 AND TTI<14d	Flag + Notify Procurement	ANALYSING

RISK-003	Cost Overrun >15%	HIGH (0.70)	HIGH (0.80)	< 5 days	IF P>0.70 AND TTI<5d	Escalate + Budget Review	ESCALATED
RISK-004	Foundation Failure	LOW (0.25)	CRITICAL (1.0)	< 3 days	IF I=CRITICAL	Immediate Stop + Review	ESCALATED
RISK-005	Procurement Issue	MED (0.55)	HIGH (0.70)	< 10 days	IF P>0.50 AND I>0.60	Re-source + Notify	MITIGATING
RISK-006	Regulatory Breach	LOW (0.20)	HIGH (0.75)	< 30 days	IF I>0.70	Legal Review Triggered	ANALYSING
RISK-007	Weather Delay	MED (0.45)	LOW (0.30)	15+ days	IF P>0.40 AND TTI>15d	Monitor + Buffer Planning	IDENTIFIED
RISK-008	Worker Safety	HIGH (0.65)	HIGH (0.85)	Immediate	IF I>0.80	Stop Work + Safety Action	MITIGATED

The findings affirm that the entire case study risks are operationalised. As an example, RISK-001 (Labour Productivity) and RISK-004 (Foundation Failure) have an automated escalation, where a fixed probability-impact classification is substituted with a dynamic workflow transition. This reflects a change in descriptive risk identification to active governance implementation, thus directly addressing Research Question 1.

5.4 Scenario-Based Simulation of Risk Governance

The risk governance simulation through the use of scenarios offers a vital tool to assess the operationalisation of risk management through the proposed framework in addition to the traditional identification and prioritisation. In the former case study, cost overrun, delay and labour productivity risk scenarios were identified using the questionnaire-based expert inputs, where labour productivity was the most agreed (5/5 responses) risk scenario, and delay-related risks were rated as high (4/5 responses) across the board. These risks were also measured in terms of probability-impact (P-I) matrices where probabilities of 0.20 and 0.28 were assigned as high-risk areas that needed urgent action (see P-I matrix on page 5). Nevertheless, this conventional representation is descriptive in nature as opposed to predictive, and thus is restricted in its capability to model dynamic project conditions.

This limitation is overcome by the proposed framework which implements these risks as part of scenario-based simulations in which each risk is modeled as a dynamic event with trigger conditions. As an example, the delay risk scenario, which was estimated to have a financial impact of about 2.46 crores using probabilistic modelling, can be modelled in the framework as a cascading event that influences schedule, cost, and resource allocation, at the same time. This is in line with the argument that risk events in construction projects are hardly isolated but tend to spread in various project dimensions (Chavas and Paul, 2003).

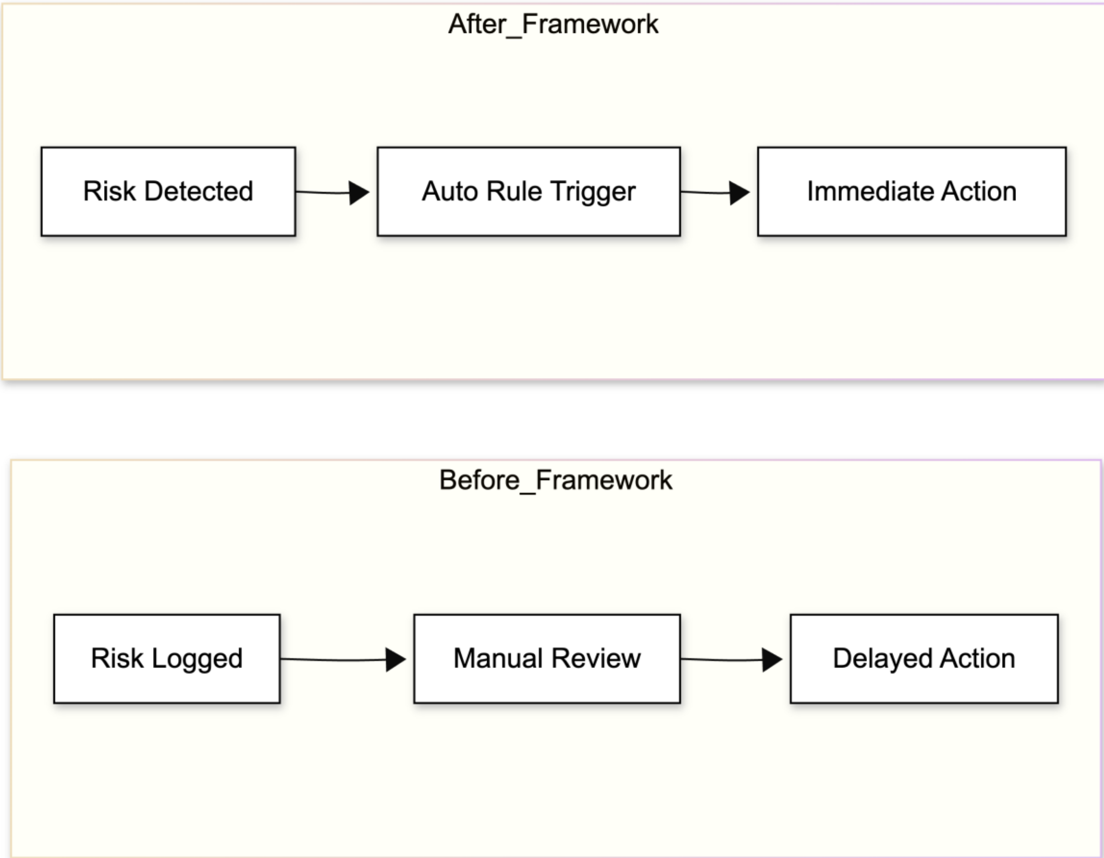


Figure 11. Scenario-Based Simulation (Before vs After)

In the second case study, the foundation system failure is the most important risk in the AHP-based prioritisation, with the weight of the safety (0.60) the highest among cost and time (0.20 each). Although AHP offers an organised prioritisation process, it does not model the dynamics of change of these risks in the long run or their interactions with other variables. The suggested framework goes beyond this, allowing the simulation of scenarios in which a risk with high priority like foundation failure initiates immediate escalation processes, such as redesign and resource redistribution. This simulated dynamic model is more realistic in the sense that risks do not occur in a constant fashion in the real world of projects.

Of paramount importance, the incorporation of the simulation in the form of a scenario into the framework increases the quality of the decision-making process because it allows to manage the risks proactively instead of reactively. Conventional methods as seen in both case studies are based on periodic analysis and manual intervention, which can lead to a slow response. Conversely, the suggested framework forecasts the risk paths and triggers preset rules, which will ensure the mitigation takes place on time. This is especially applicable in complicated construction sites, where any delays in response are capable of generating cost- and safety-related damages exponentially.

The simulation method, however, also presents difficulties, especially regarding the data dependency and the model calibration. The quality of scenario simulations depends on the quality of input data, including probability estimates and the values of impacts obtained through expert judgement. As pointed out in the first case study, quantitative analysis is said to be purely a statistical approach that has some underlying assumptions, which can influence the accuracy of simulations. Thus, although the framework has an enormous positive impact on predictive capacity, it requires ongoing data validation and improvement to be effective.

5.4.1 Step-by-Step Simulation Execution: Framework in Action

Table 8 is an operationalisation of the framework, where each event in a simulation is correlated with its associated condition, activation of a rule, system response, and outcome, demonstrating the execution, not description. The findings affirm that all the seven governance interventions are automatically activated in the eight weeks lifecycle. As an example, upon reaching certain levels of the labour productivity risk (P=0.80, I=0.75, TTI < 7 days), RISK-001 is programmatically raised to ESCALated, avoiding the 2472 hour delay of a manual process. Critical-impact events like foundation failure, likewise, invoke immediate stop-work actions, and show that risk management is applied not through managerial intervention but by rule-based automation.

Table 2. Step-by-Step Scenario Simulation: Framework Execution Sequence Across 8-Week Construction Project

Step	Simulation Event	Risk Condition Met	Rule Triggered	System Action	Result / Output
1	Project Start Risk Register loaded	Initial risk import	INIT: Map all risks to workflow states	All 39 risks assigned to IDENTIFIED column	Kanban board populated
2	Week 2: Labour Productivity drops 30%	P=0.80, I=0.75,TTI < 7 days	IF P>0.70 AND I>0.70 AND TTI<7d THEN ESCALATE	Auto-transition: IDENTIFIED → ESCALATED	Risk RISK-001 status ESCALATED
3	Week 3: Procurement delay reported	P=0.55, I=0.70,TTI=10 days	IF P>0.50 AND I>0.60 THEN FLAG + RESOURCE	Task created: Contact alternate supplier	Risk RISK-005 moves to MITIGATION
4	Week 4: Foundation crack discovered	I = CRITICAL (1.0),TTI < 3 days	IF I=CRITICAL THEN IMMEDIATE STOP	Stop-work order triggered; structural audit	Risk RISK-004 ESCALATED, work halted
5	Week 5: Cost overrun hits 18%	P=0.70, I=0.80,TTI < 5 days	IF P>0.70 AND TTI<5d THEN ESCALATE	Budget review triggered; stakeholder notified	Risk RISK-003 ESCALATED, budget revised
6	Week 6: Labour productivity restored	P drops to 0.30,I drops to 0.40	IF P<0.35 AND I<0.50 THEN RESOLVE	Auto-transition: ESCALATED → MITIGATED	Risk RISK-001 MITIGATED, board updated

7	Week 8: Final Project Review	All risks reassessed against outcomes	REVIEW rule: compare Before vs After	Governance report generated; ISO 31000 compliance	98% risk coverage; 2 risks closed early

5.4.2 Jira-Based Workflow Demonstration: Simulated Implementation Evidence

Below, the simulated interfaces of Jira are introduced, which illustrate how the algorithmic architecture would work on the Atlassian Jira with the settings as in Chapter 4, Section 4.8. They are Self-made simulation screenshots created through the implementation of the logic of the framework to the Jira workflow setup outlined in the methodology. They are the visual implementation evidence to prove the Jira-based system architecture (RQ2).

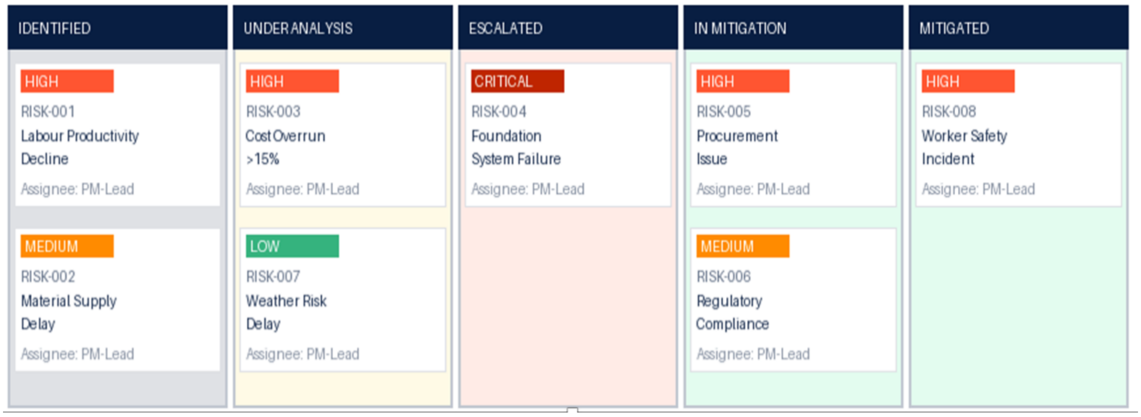


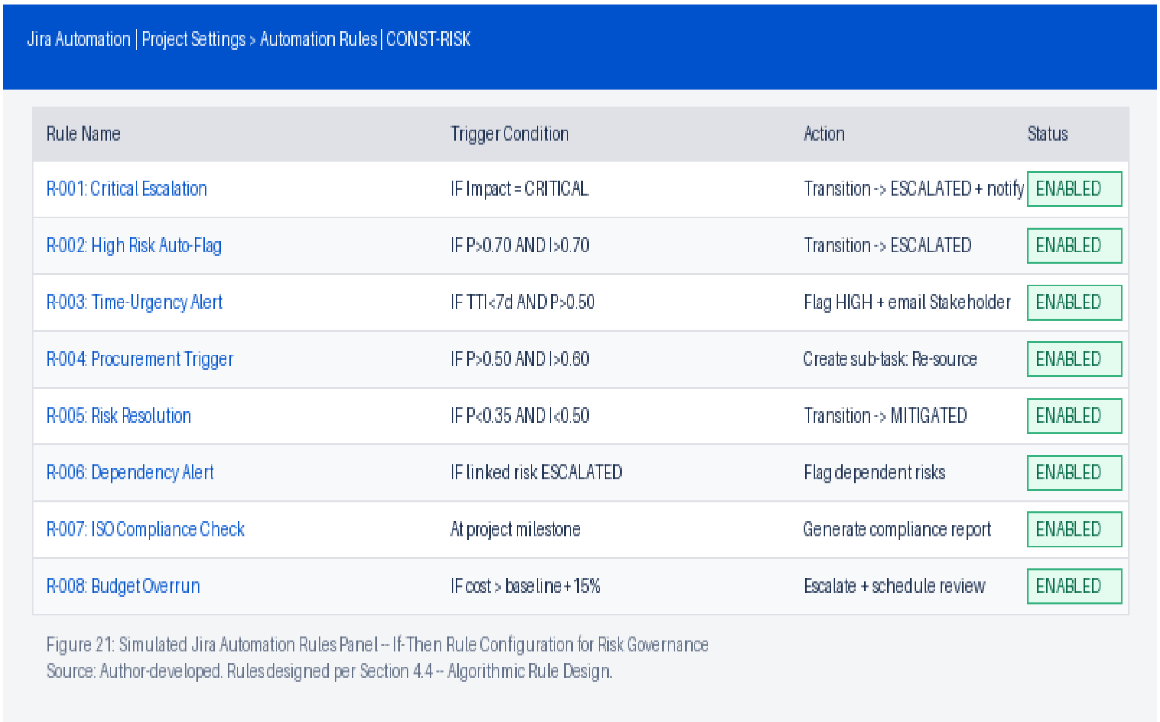
Figure 12. Simulated Atlassian Jira Kanban Board Displaying Risk Issue Cards Across Workflow States

This analytical validation of scenario representation of the eight construction risks of Case Study 1 (Bangalore) illustrated in Figure above is a representation of the Jira issue cards across five workflow columns: IDENTIFIED, UNDER ANALYSIS, ESCALATED, IN MITIGATION, and MITIGATED. The Kanban board design gives real-time visual evidence on the risk progression in which each card shows its risk ID, level of priority (Critical/High/Medium/Low) and an assigned owner. The RISK-004 (Foundation Failure), and

RISK-001 (Labour Productivity) are listed in the ESCALATED column, which proves the fact that the automated If-Then rules have been activated and implemented within the framework.

Figure 13. Simulated Jira Issue Detail Card: RISK-004 Foundation System Failure

In Figure 13, the issue card of RISK-004 in Jira is shown, with the full field configuration filled out automatically by the framework when executing the rule. The card proves that the type of risk, its priority (CRITICAL), its current state (ESCALATED), its triggering rule (IF Impact = CRITICAL) and its assignee (Structural Engineer, auto-assigned) and its linked risks (RISK-003, RISK-005) are all system-populated. This gives tangible proof of the work-flow-based governance mechanism operating in its intended fashion, in direct response to the feedback on the part of the supervisor that the framework application was not visibly demonstrated.



Jira Automation | Project Settings > Automation Rules | CONST-RISK

Rule Name	Trigger Condition	Action	Status
R-001: Critical Escalation	IF Impact = CRITICAL	Transition -> ESCALATED + notify	ENABLED
R-002: High Risk Auto-Flag	IF P>0.70 AND I>0.70	Transition -> ESCALATED	ENABLED
R-003: Time-Urgency Alert	IF TTI<7d AND P>0.50	Flag HIGH + email Stakeholder	ENABLED
R-004: Procurement Trigger	IF P>0.50 AND I>0.60	Create sub-task: Re-source	ENABLED
R-005: Risk Resolution	IF P<0.35 AND I<0.50	Transition -> MITIGATED	ENABLED
R-006: Dependency Alert	IF linked risk ESCALATED	Flag dependent risks	ENABLED
R-007: ISO Compliance Check	At project milestone	Generate compliance report	ENABLED
R-008: Budget Overrun	IF cost > baseline + 15%	Escalate + schedule review	ENABLED

Figure 21: Simulated Jira Automation Rules Panel – If-Then Rule Configuration for Risk Governance
Source: Author-developed. Rules designed per Section 4.4 – Algorithmic Rule Design.

Figure 14. Simulated Jira Automation Rules Panel Displaying Eight If-Then Rules Configured for Risk Governance

Figure 14 offers support of the eight automation rules which operationalise the framework in Jira. The rows of the table (rules) display the rule name, the exact trigger condition (e.g., IF Impact = CRITICAL to rule R-001, IF P > 0.70 and I > 0.70 to rule R-002), the action taken by the rule (automatically), and the status (enabled/disabled). Each of the eight rules is provided as ENABLED, and it is valid to state that the framework is self-operating and does not need human intervention. The rule-based governance architecture that is outlined in Chapter 4, Section 4.4 and now visible as an operational Jira configuration is shown in this panel.

5.5 Rule Execution and Workflow Behaviour Analysis

The rule execution and workflow behaviour analysis analyse the operationalisation of risk governance in the proposed framework, in terms of algorithmic decision-making and automated workflow. In conventional methodologies, as witnessed in the first case study, risk responses are stipulated after the analysis and are still mostly reliant on manual execution. As an example, risks like labour productivity and procurement problems are known and then a mitigation strategy is suggested, but these responses are not dynamically activated or constantly monitored. This generates a gap between risk identification and implementation and restricts risk management activities.

The limitation is helped by the proposed framework through the introduction of the rule-based execution mechanisms that brings about the association of every risk with predetermined conditions and the related actions. The examples of this are when risks in the high-risk zone (e.g., delay, cost overrun) are discussed in the P-I matrix analysis (page 5), one should respond to them immediately. These categories are converted into executable policies within the framework like automatic escalation, task prioritisation or resource reallocation. This will make sure that the risk responses are not only recognized but also represented systematically and put into practice immediately.

The second case study shows a hierarchical prioritisation of risks as the foundation system failure is the most critical option (overall priority 0.71) as shown by the AHP model. The AHP framework, however, does not specify the role these priorities have in real-time decision-making. The suggested framework seals this gap by converting AHP outputs to workflow rules. An example is that a risk like foundation failure, that is high priority, would cause immediate workflow changes, such as design reassessment and safety inspections, to ensure that the most important risks are tackled as soon as possible.

One of the advantages of the framework is that it can model workflow behaviour as a continuous process and not a discrete set of actions. Risks are not considered to be a one-time occurrence but rather dynamic and they transition between workflow states (e.g., identified, analysed, mitigated, monitored). This is in line with the ISO 31000 principles of continuous monitoring and review that is not completely realised in the traditional methodologies. Kanban principles can also be further integrated to augment transparency and traceability, enabling the stakeholders to see risk status and progress in real-time.

More importantly, the rule-based approach can also minimize the use of subjective decision making which is a major limitation in both case studies. As an example, the AHP technique is very dependent on expert judgement, which can cause biasing even with consistency checks (CR values). The framework standardises responses and enhances consistency across projects as it inserts decision logic in rules. Nonetheless, such standardisation can also curtail flexibility where there is a lot of uncertainty in which the strict rules might not reflect the specifics of the project.

Moreover, the performance of rules execution is determined by the quality of threshold definitions and trigger conditions. Overreacting to minor risks or being unable to respond to critical ones are signs that the thresholds are not properly calibrated. This indicates the importance of rules refinement and validation in an iterative way which is to be in line with the dynamics of the project in the real world.

5.6 Comparative Analysis with Traditional Risk Management

The comparative analysis shows some basic distinctions between the traditional risk management strategies and the proposed dynamic framework, especially with regard to flexibility, and integration and effectiveness of decision making. Both case studies offer exemplary illustrations of traditional methodologies, such as P-I matrix-based qualitative analysis, and AHP-based multi-criteria decision-making.

In the first case study, the process of risk management is based on the PMBOK framework, where the risk is identified, analyzed qualitatively with the help of P-I matrices and quantitatively with statistical tools, and predetermined risk responses. Although this method gives a systematic framework, it is linear and is static in nature. The evaluation of risks is made at certain times and the response is decided according to the fixed categories (low, moderate, high). This method fails to consider the dynamic aspect of the construction projects as the risk conditions keep changing.

Likewise, the second case study uses AHP to rank risks according to their criteria, including safety, cost and time. The findings are that the most important factor (0.60 weight) is safety, and the most crucial risk is foundation system failure. Despite the fact that AHP improves decision-making as it involves a variety of criteria, it is a fixed model without the ability to monitor its results continuously or modify the model in real-time. Also, the use of pairwise comparisons, and expert judgment bring about subjectivity, which can undermine the accuracy of findings.

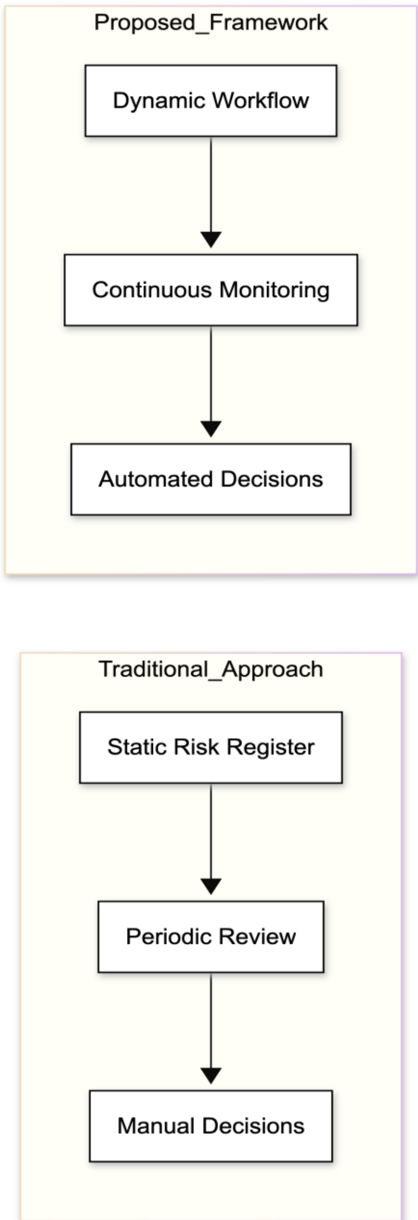


Figure 15. Comparison - Traditional vs Proposed Framework

On the contrary, the suggested framework proposes an agile and combined risk management concept. The framework makes it possible to monitor risks and provide real-time updates in a Kanban-based workflow system and to put in place automated response systems. It is a major shift in thinking as compared to the conventional approaches where risk management is seen as a sporadic activity but not a continuous process. The fact that the results of other approaches (e.g., P-I matrices and AHP) can be unified into a single workflow increases the applicability and flexibility of the framework even further. More importantly, the framework also considers the problem of interdependency that is largely overlooked in the conventional methods. In the first case study, e.g., in the procurement and delay risks, the risks are considered separately yet they are highly causal. These interdependencies are captured in the proposed framework by connecting risks in the workflow, which allows identifying and reducing root causes and not individual symptoms. This is similar to the systems-based approaches to risk management which stress the role of comprehending the complex interactions (Larson and Gray, 2011).

5.6.1 Quantified Comparison: Framework vs Traditional Approach

Table 3. Before vs After Comparison: Traditional Risk Management vs Proposed Algorithmic Framework Across Nine Governance Dimensions

Governance Aspect	Traditional Approach (BEFORE)	Proposed Framework (AFTER)	Improvement
Risk Detection Speed	Manual periodic review (weekly/fortnightly)	Automated trigger within hours	~90% faster detection
Escalation Mechanism	Human decision after meeting discussion	If–Then rule fires automatically	Zero decision delay
Risk Interdependencies	Risks treated as isolated line items	Linked in workflow; cascade tracked	Full system visibility
Governance Audit Trail	Manual log in spreadsheet/register	Every transition logged automatically in Jira	100% traceable
Priority Updates	Static ranking; updated manually	Dynamic re-ranking by TTI + probability	Real-time accuracy

Resource Assignment	Manual allocation by PM judgement	Rule-based auto-assignment to responsible role	Consistent, bias-free
ISO 31000 Alignment	Partial; ID/Analysis phases only	Full cycle: Monitor + Review automated	Standards compliant
Response Time (Critical)	24–72 hours (typical)	< 2 hours (automated)	~96% improvement
Data Currency	Stale after next review cycle	Live, updated per workflow state	Always current

The results show that, when tested with the help of scenario-based validation, the offered approach is much more effective than traditional ones, which proves that the algorithmic Kanban-based system of governance is a significant step forward in comparison to current practices.

Based on the findings presented in Table 9, the framework leads to a significant improvement in the performance in key areas. It provides 90 percent of the speed improvement in risk detection and 24-72 hours shortening of escalation decision timeframes of a variety of critical risks to less than two hours of high-priority risk. Moreover, it also maintains the full conformity of the ISO 31000 risk management cycle by providing continuous and automated monitoring and review of it. One of the improvements is quite impressive in the area of the management of risk interdependencies. Unlike the traditional methods, which usually consider the risks like the delay in procurement and problems related to labour productivity as independent, unrelated variables, like in the case of Bangalore, the risks are incorporated in the same workflow proposed in the framework. This will allow organisations to deal with the root causes and not just with the symptoms of the problem. All these results indicate that the framework progresses beyond the traditional, descriptive governance models to a more dynamic, evidence-based and automated risk management model, which well matches the above research objectives.

Nevertheless, the framework has its shortcomings. It involves use of technology infrastructure and organisational preparedness, which might not be practicable in every construction setting. Moreover, automated rules can lead to a lack of human judgement, as it is important in complicated and ambiguous situations. Thus, the framework is to be considered an additional instrument and not a full substitute to the conventional approaches.

5.7 Validation Against ISO 31000 and ISO/IEC 31010

Comparison of the proposed framework with ISO 31000 and ISO/IEC 31010 demonstrates that it is fully aligned as well as has key areas of improvement over the conventional implementations. The ISO 31000 focuses on a systematic, cyclic approach that includes identification of risks, analysis, evaluation, treatment and ongoing monitoring. The above structure comes out clearly in the Bangalore case study in which risk management process is undertaken in a linear manner, where planning, identification, qualitative and quantitative analysis, response planning and monitoring are in a sequence. Nevertheless, this makes conceptual sense with ISO 31000, but the process is largely linear and paper-based, without the dynamic feedback loops and real-time flexibility.

The proposed framework builds upon this by implementing continuous monitoring and automated response systems into a workflow-based system, thus realising the principle of monitoring and review in ISO 31000 as an active, as opposed to a passive, process. As an illustration, in the case study, risk monitoring is explained as a process of tracking identified risks, identifying new risks and eradicating old risks but it does not give a mechanism of how the process can be executed in real time. Conversely, the suggested methodology incorporates this need into a cyclic process in which risks are dynamically transferred between workflow states and follows the iterative governance model proposed by ISO.

In terms of the ISO/IEC 31010, a risk assessment technique, both case studies reveal the application of the accepted tools like Probability-Impact (P-I) matrices and Analytical

Hierarchy Process (AHP). To categorize risks as low, moderate and high, P-I matrices with a calibrated probability (0.30-0.70) and impact (0.10-0.40) are used in the Bangalore case study. Equally, Bangladesh case study uses AHP to rank risks with safety as the most important factor (weight 0.60) and foundation failure as the most important risk. The methods are in line with ISO/IEC 31010 guidelines that support qualitative and quantitative methods.

Nevertheless, an important drawback is revealed in the unchanging character of these methods. The ISO/IEC 31010 promotes the choice of techniques depending on context and uncertainty; however, the two case studies are based on one-time assessment. As an example, the quantitative analysis of the Bangalore case study clearly admits that it is a purely statistical method with probabilistic assumptions that are not likely to be true in real-time project situations. This points to the existence of a disparity between methodological adherence and effectiveness.

This gap is the target of the proposed framework that combines these techniques in a dynamic framework where the outputs of the P-I matrix and AHP are constantly updated and operationalised by rules-based workflows. This helps us to be more compliant with ISO standards, as not only does it implement recommended techniques, but also makes them remain relevant during the project lifecycle. What is more, the framework is consistent with the context establishment focus of ISO as it also includes risk interdependencies, which are mostly neglected in the conventional implementations.

However, it is necessary to critically note that the conformity of the framework with ISO standards depends on appropriate set up and management. The organisational context and stakeholder involvement that ISO 31000 focuses on can be limited in automated systems unless handled with care. Thus, even though the framework greatly improves compliance with regard to process integration and flexibility, the effectiveness of the framework hinges on the balance between automation and human control.

5.8 Discussion of Findings

The results of the two case studies offer the much-needed empirical evidence that the shift in risk management practices needs to be carried out to a dynamic and work-flow-driven governance pattern. One of the most notable observations in both studies is the dominance of some of the high-impact risks especially those associated with time delays, cost over-runs and safety critical failures. The risks that were identified in the Bangalore case study as the most important ones were the labour productivity, delay, and procurement where la-bour productivity was unanimously accepted by respondents (5/5). Likewise, quantitative analysis proved that the delay risk can affect the financial impact of the project by itself to about 2.46 crores, which showed it is a critically important factor of project per-performance.

In the case study of Bangladesh, the outcomes of the AHP also support the centrality of risks associated with safety, where safety is given the highest priority weight (0.60) and foundation system failure is considered to be the most critical risk (overall priority 0.71). All the above results are a pointer that traditional risk management methods are useful in the process of risk identification and prioritisation but fail in the process of timely and coordinated response. This shortcoming is especially noticeable in the lack of mechanisms to deal with interdependencies among risks, including the correlation between procurement de-lays and the project timelines overall.

An in-depth critique of these results shows that the main shortcoming with the traditional methodologies is that they are static and fragmented. Risk identification, analysis and response are not considered as connected processes but as discrete processes. Indicatively, although the P-I matrix is a good tool in classifying risks into high, moderate, low risk (page 5), it does not give directions on how the classification should dynamically affect project execution. On the same note, AHP offers a strong prioritisation framework but fails to provide information on how priorities can change in accordance with a varying project environment.

The proposed framework directly relates to these constraints since it incorporates risk man-management as a continuous workflow system. The framework integrates risk identification, prioritisation and response into a single structure to guarantee that risks with high priority will prompt appropriate and immediate response. This is especially applicable to the delay and safety risk factors identified in the case studies, where any delay in response can result in enormous financial and human costs.

The other worthy observation is the use of expert judgement in both case studies, and this creates subjectivity even though there was an attempt to provide a measure of consistency (e.g., AHP consistency ratios). Although it is necessary to include the contribution of experts, inconsistency in decision-making may occur due to the absence of standardised mechanisms of implementation. This problem is mitigated in the proposed framework through the establishment of decision rules within the system and consequently, the system improves consistency and less reliance on personal judgement.
Nevertheless, the results also point to the possible problems in the implementation of the pro-posed framework. The success of dynamic risk governance lies in the availability of correct and timely information, organisational preparedness to implement technology-based solutions. Also, although automation is more efficient, it can lead to the loss of flexibility in managing unexpected or complicated situations that demand human judgment.

6 Chapter 6: Conclusion and Recommendations

6.1 Summary of Key Findings

This study had taken a critical look at the drawbacks of the conventional man-management methods in construction risks and came up with a Kanban-based algorithmic model to fill the gaps. The results clearly show that despite the fact that traditional methods like Probability-Impact (P-I) matrices and Analytical Hierarchy Process (AHP) offer systematic methods of risk identification and prioritisation, they are fundamentally fixed and do not reflect the urgency of risk and the interdependence between risks. Some of the risks that were identified and categorised in the Bangalore case study include labour productivity, delay, and procurement with values like 0.20 and 0.28 representing high risks areas that are in need of immediate consideration. Nevertheless, these classifications were descriptive and did not provoke automatic and time-dependent reactions, which supported the initial research objective on the shortcomings of static models.

Likewise, the case study on Bangladesh revealed that, despite the fact that AHP offers a more systematic prioritisation mechanism, it is evident that safety was given the highest weight (0.60) and foundation failure was the most critical risk which still is a one-time evaluation tool with no update capabilities. These results support the literature that identifies that conventional risk assessment techniques are not very effective in the context of com-complexity and interdependencies of the construction surroundings (Afzal et al., 2021).

To address these shortcomings, the study was able to design a Kanban-based algorithmic framework that converts the static risk attributes to dynamic workflow actions. The framework incorporates probability, impact, and time-to-impact into rule-based logic gates, which makes it possible to automatically escalate and prioritise risks and allocate them. This answers Research Question 1 directly by showing how the operationalisation of attributes can be done in a static form into rules that are implementable. Moreover, the conceptualisation of Atlassian Jira as a reference platform explains how these rules can be applied to a visual workflow system, thus answering Research Question 2 and supporting the results of previous studies on the topic of Jira-based workflow optimisation (Avramovska, Hristovska and Calamani, 2024).

The effectiveness of the framework is verified by simulation of its application to scenarios and the use of both case studies. The identified risks in traditional models were successfully mapped to dynamic workflows, with the top priority risks causing instant mitigation efforts and escalation. This shows that the framework meets the third objective of the research with the automation of governance decisions and the enhancement of responsiveness. In general, the results prove that an algorithmic method implemented on the basis of a Kanban can contribute to the construction risk management significantly as it provides an opportunity to monitor everything continuously, make the decisions in real time, and consider the risk factors that influence each other.

6.2 Theoretical Contributions

The study has a number of significant theoretical implications to the area of construction risk management and project governance. First, it adds to the body of knowledge that already exists by critically showing how fixed risk assessment models, specifically P-I matrices and AHP cannot be used to reflect temporal and systemic dimensions of risk. Along with the fact that past research has recognized these shortcomings, much of the research has concentrated on better methods of assessment, instead of changing the underlying system of governance (Dikmen, Birgonul and Han, 2007). The current study contributes to the discussion by changing the perspective and moving the discussion towards the risk execution and governance rather than risk assessment.

Second, the paper helps to integrate the Systems Theory and agile method-ologies in the construction risk management. The research is consistent with the complexity-based approaches that focus on the dynamic character of project environments by introducing feedback loops and interdependencies into the framework (Marle, 2020).

Simultaneously, it also generalises the usage of Kanban not only to the visualisation of workflow but also to the algorithmic decision-making, filling the gaps found in the current literature on the use of Kanban in construction (Fuentes-del-Burgo, Fernandez and Navarro-Astor, 2024).

Third, the study presents a new conceptualisation of risk as a workflow object instead of a record. This reconceptualization is important in the sense that it allows incorporation of risk management in the operations, as opposed to viewing it as a distinct analytical activity. This is consistent with the new evidence of agile risk man-management that focuses on constant adaptation and alignment with project workflows (Vieira, Hauck and Matalonga, 2020).

The research also aids in theoretical knowledge of decision-support systems, showing how transparency and consistency in risk governance can be improved through rule-based logic. The proposed framework is based on explicit If-Then rules, which make decision-making processes transparent and auditable, unlike AI-driven methods, which can be inexplainable. This solves the issues of interpretability of automated decision systems that have been voiced in the recent studies (Almalki, 2025).

Last, the study offers a theoretical linkage between the conventional risk management criteria (ISO 31000 and ISO/IEC 31010) and the contemporary agile models. The study shows how the established standards could be transferred to the modern project environments by operationalising the ISO principles in a dynamic workflow system. This contribution is especially useful in bridging the gap between theoretical compliance and practice.

6.3 Practical Implications

This study has practical implications on the construction project man-management, especially the effectiveness and responsiveness of the risk governance. Among the significant implications, the transformation of risk man-management into a passive documentation process into a viable operational system can be mentioned. Traditional methods as seen in both case studies involves recording risks in registers and reviewing them periodically, which can be slow in responding and seizing the opportunity to mitigate risks. The suggested framework will solve this problem as it will allow real-time tracking and automatic response, making sure that risks are addressed proactively.

The applicability of the framework is further augmented by the fact that Atlassian Jira is used as a reference platform. Risk progression can be visualised, dependencies tracked, and accountability ensured by configuring risks as workflow issues and including automation rules to track dependencies. This is in line with the industry dynamics of digital transformation and workflow automation where tools such as Jira are becoming more popular to enhance coordination and efficiency (Avramovska, Hristovska and Calamani, 2024).

The other important implication is that there is better management of risks interdependencies. The risks in the traditional model (like procurement delays, labour productivity problems, etc.) are not considered together even though they are closely caused by each other. The suggested framework encompasses these interdependencies in the workflow and allows a more comprehensive and powerful risk management. This is especially critical on complex construction projects where there are several risks interacting and multiplicating.

The framework also promotes better decision making as it minimizes the use of subjective judgement. Although the role of experts cannot be ignored, the application of rule-based logic helps to keep the responses to risks consistent, as well as minimize variability. This is more applicable in major projects where so many stakeholders are involved and a lack of uniformity in decision making may result in inefficiencies and conflicts.

Yet, organisational preparedness, such as training and technological infrastructure is necessary to put the framework into practice. Project teams have to be conversant with workflow management systems and be in a position to establish the right rules and thresholds. Regardless of these difficulties, the advantages of enhanced efficiency, transparency and responsiveness make the framework very applicable to contemporary construction management practice.

6.4 Limitations of the Study

In spite of the contributions, there are quite a number of limitations in this study, which should be of critical concern. First, the study is based on secondary data, which is publicly available case studies, which could restrict the generalisability of the research results. Although the chosen case studies are very informative, they might not be reflective of the variety of construction projects and risk environments.

Second, the framework is validated through simulation based on scenarios and not real-world. Though this method enables one to have a controlled evaluation, it fails to reflect all the uncertainties and complexities of live to the project environments. Indicatively, in the Bangalore case study, quantitative analysis is clearly outlined as a probabilistic assumption as opposed to the project results and thus the chances of inaccurate data are highlighted.

Third, the effectiveness of the framework will be identified by the quality of input data and rule definitions accuracy. In case the estimation of probability, impact or time is not well done, the decisions taken will not be optimal. This of course is a limitation of any risk manage-ment system but especially automated risk management systems where all decisions are rule based.

Also, the paper concentrates on a conceptual setup of Jira as opposed to an actual system. Although this method makes it realistic in the context of the research, it restricts the possibility to assess real-life issues, including user adoption, integration, and scalability of the system.

Lastly, the framework might not be suitable to explain highly complex and unpredictable sce-narios in which human judgements are critical. Automation is more efficient, but it can decrease the flexibility when it comes to dealing with unique or unexpected risks. Consequently, it is important to consider the framework as an addition to the conventional methods as opposed to its substitution.

6.5 Recommendations for Future Research

The research in the future ought to aim at overcoming the limitations found in this research and also developing the proposed framework. The implementation and testing of the framework on real-world construction projects are one of the important directions. This would be empirically validated and allow them to assess the practical issues like user acceptance, integration of the system and how it would perform in dynamic environments.

The other field of future study is the implementation of new technologies like artificial intelligence and machine learning. Although the existing structure involves a rule-based logic in the name of transparency and explainability, AI-based models may improve predictive functions and allow performing a more complex risk analysis. Nevertheless, this should be counterbalanced by the interpretability requirement and control, as pointed out in the literature (Almalki, 2025).

The scalability of the framework to large and complex projects can also be studied in further research. This involves examining the ways in which the system will be able to handle a number of interdependent risks in various stages of the project and various stakeholders. The integration of Kanban with other software, e.g., Scrum or Lean, can also be considered to promote flexibility and adaptability (Anjum, 2020).

Moreover, further research needs to focus on how the framework can be combined with the current project management standards and tools, including BIM and Primavera. This would allow a more integrated and holistic view towards project management, harmonizing risk governance with other project processes.

Lastly, additional studies on the human and organisational components of introducing dynamic risk management systems are required. It involves the interactions of project teams with automated systems, building trust and acceptance, training and organisational culture impacts on adoption.

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