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Strategic Decision-Making Under Uncertainty Using A Game-Theoretic Approach

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ABSTRACT

Decision-making under uncertainty represents a critical challenge for organizations operating in dynamic and competitive environments. Traditional decision-making models often fail to adequately capture the strategic interactions among multiple stakeholders with conflicting objectives. This paper explores the application of game theory as a framework for supporting strategic decision-making under uncertainty. The study reviews key game-theoretic concepts, including Nash equilibrium, cooperative and non-cooperative games, and mixed strategies, and discusses their relevance to business and economic decision processes. Particular attention is given to situations characterized by incomplete information, market competition, and resource allocation problems. The paper demonstrates how game-theoretic models can help decision-makers evaluate alternative strategies, anticipate competitors' actions, and reduce uncertainty in complex environments. The findings indicate that game theory provides a robust analytical framework for improving strategic planning and enhancing decision quality in uncertain economic contexts. The study contributes to the growing body of literature examining analytical approaches that improve organizational adaptability and strategic resilience.

1. Introduction

The increasing complexity of contemporary economic systems has intensified the challenges associated with strategic decision-making. Organizations operate in environments characterized by rapid technological change, global competition, market volatility, regulatory uncertainty, and evolving stakeholder expectations. Under such conditions, decision-makers are frequently required to formulate strategies without possessing complete information regarding future events or the actions of competing actors. Consequently, uncertainty has become one of the most significant determinants of organizational performance and long-term sustainability.

The classical models of decision-making assume that decision-makers can judge alternatives objectively, being endowed with enough information to choose the one that maximizes expected utility. Regardless, these models still serve a purpose when one can estimate the probabilities with sufficient accuracy, but when uncertainty comes from the strategic behavior of more than one interacting agent then this use becomes less viable. In many practical situations, results for an organization represent not only the internal decisions makers, but also reflections of the actions of competitors, regulators, suppliers, customers and other parties whose actions cannot be fully anticipated (Debnath et al., 2018).

Risk versus uncertainty continues to be a fundamental distinction in strategic management research. Risk is the uncertainty in a situation where there is an established probability distribution of possible outcomes. However, while both deal with situations where people cannot pay wages in the way they are used to (for example, introducing a new currency), uncertainty appears when decision-makers can not attach appropriate probabilities to future events or that other actors would behave unpredictably and strategic interactions between agents comes into place (Gorelik & Zolotova, 2023).

Against the backdrop of greater interconnection amongst economic environments, organizations are faced with types of uncertainty that go beyond simple probabilities requiring even more complex analytical paradigms. Findings showed that trust and perceived ease of use have a positive significant effect on digital financial adoption; loss aversion has a negative significant effect on engagement to complex fintech products and services. Meanwhile, overconfidence generated effect of contradiction. Higher confidence limited some

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people from experimenting with fintech applications, but on the flip side of this higher confidence also gave users a riskier financial behavior while paying less attention to their digital security practice. These findings suggest that greater intensity of digital interaction does not mean more rational behaviour or more financial sustainability.

The study additionally highlighted the close relationship between trust and perceived financial risk within emerging digital financial ecosystems. Users frequently interpreted financial risk through broader perceptions of institutional credibility, regulatory protection, and technological transparency. This suggests that digital financial participation depends not only on platform functionality, but also on whether users perceive digital financial environments as institutionally trustworthy and behaviorally safe.

One of these is offered by game theory. Ever since the classic Nash (1951) paper, game theory has developed into a sophisticated analytical framework for studying rational player strategic interactions. Unlike conventional optimization, game-theoretic models state that the success of a given strategy is determined not in isolation but in conjunction with each of the choices of others. Such a view enables analysis of competitive behavior, cooperation, negotiation and conflict resolution, market positioning and resource allocation within the same theoretical framework.

Game theory wasn't only for economics anymore, and new developments in the field had made it even more relevant. Game-theoretic models have been used in the energy domain to maximise peer-to-peer electricity trading opportunities and higher degrees of decentralization (Tushar et al., 2018). Likewise, game-theoretic mechanisms have been applied to blockchain and distributed environments (Liu et al., 2019), which also reflects incentive alignment, security and network governance. Recent research also showed the applicability of game theory to construction management, where project stakeholders face interdependent decision making coupled with uncertainty in cost, risk and operational parameters (Shehadeh & Alshboul, 2025).

The objective of this paper is to examine the role of game theory in supporting strategic decision-making under uncertainty. Specifically, the study investigates how game-theoretic concepts can improve the evaluation of strategic alternatives, facilitate anticipation of competitor behavior, and contribute to more robust organizational decision processes. The paper also explores the differences between traditional and game-theoretic approaches to uncertainty, identifies key limitations of game-theoretic models, and discusses emerging applications across various sectors.

Based on recent literature review and modern applications, this paper attempts to show that game theory continues to be the most powerful analytical framework for understanding strategic behavior under uncertainty. With organizations facing ever more challenges of greater complexity, leveraging predictive interaction analysis and scenario evaluation to design adaptive strategies is likely to be a powerful source of advantage.

2. Literature review

2.1. Foundations of Strategic Decision-Making

A strategic decision is one of the most crucial management functions in organizations, as it determines how resources will be utilized, objectives achieved, and sustainable competitive advantages built over time. In contrast to operational decisions, which typically involve routine procedures and clearly defined outcomes, strategic decisions are characterized by long-term implications, substantial resource commitments, and elevated levels of uncertainty. Consequently, strategic decision-making requires managers to evaluate multiple alternatives while considering both internal organizational capabilities and external environmental conditions.

Traditionally, classical decision-making theories relied on the rationality assumption according to which the rational decision maker strives to optimize utility through a systematic and comprehensive evaluation of all information available. From this perspective, organizational actors define goals, develop alternatives, evaluate consequences and choose the one that maximizes expected utility. Practical decision environments, however, rarely match up to these idealized assumptions. There might be incomplete information, conflicting interests among stakeholders, and in many cases the future can only be loosely inferred.

The concept of bounded rationality offers a more realistic depiction of manager behavior. Decision makers tend to settle for satisfactory over optimal solutions, satisfying acceptance performance criteria rather than searching for the best possible solution. This effect is most pronounced when uncertainty about the possible future scenarios ramps up, when information-processing capabilities are limited, or when decision-makers operate under tight time constraints. The answer to this question: strategic decisions often result from MIND driven by the merger of brains – analytical reasoning, experience and organization learning (badged in intuition).

Recent research from 2023 focused on the importance of problem-solving using an interdisciplinary approach and adaptive thinking within complex decision environments. Research in education on sustainability and interdisciplinary teaching emphasizes the importance of engaging students with complex problems that require somewhat more than balancing trade-offs and estimating long-run consequences (Bărbulescu et al., 2026; Minoiu et al., 2026). While these studies stem from outside the strategic management

literature, they lend support to our more general argument that good decision-making is increasingly contingent upon system-sensing and uncertainty-generation across intersecting contexts.

Furthermore, research concerning transformational leadership emphasizes the role of adaptive managerial capabilities in navigating volatile environments. Organizations characterized by strong leadership and collaborative cultures are often better positioned to respond effectively to uncertainty and environmental change (Enachescu & Petcu, 2025; Pham et al., 2025). Such findings suggest that strategic decision-making should not be viewed solely as a technical process but also as a social and organizational activity influenced by communication, trust, and stakeholder engagement.

2.2. Understanding Uncertainty in Strategic Contexts

The concept of uncertainty occupies a central position in strategic management literature. Although often used interchangeably with risk, uncertainty represents a distinct phenomenon requiring different analytical approaches.

Risk is defined in contrast to uncertainty, as being an event where the future outcomes and probabilities can be estimated reasonably accurately. An example would be calculating insurance for earned statistical distributions or investment based on historical stock data. In these contexts, decision-makers can take advantage of probabilistic models in order to assess alternatives and maximize expected outcomes.

Conversely uncertainty is when probabilities cannot be reliably given, or really lack of information to make relatively accurate predictions. Even in these circumstances, ambiguity lies not only at the probable future but also its impact on the organizations. This distinction is especially relevant in strategic contexts marked by technology disruption, geopolitical uncertainty, regulatory turbulence, and consumer preference evolution.

Gorelik and Zolotova, 2023In contrast to other types of uncertainty, decision-making under probabilistic uncertainty should be analyzed analytically if there are external conditions that can not be controlled by decisions. In a related vein, Madani and Lund (2011) point out that uncertainty is often due to the interplay between multiple objectives, stakeholders and environmental variables, which means neither conventional optimization techniques nor associated solutions are apt at resolving complex strategic problems.

The increased complexity of the environment in which digital ecosystems operate further enhances uncertainty. Decentralised technologies and digital platform economies, as well as Artificial Intelligence systems create settings where the behaviour of many interdependent actors influences organisational outcomes. The existing studies on blockchain governance also show that strategic uncertainty often emerges from the incentive structure and coordination challenge among participants when interacting within a decentralized network (Liu et al., 2018; Nguyen et al., 2022).

2.3. Game Theory as a Framework for Strategic Decision-Making

Game theory provides a formal analytical framework for examining situations in which outcomes depend upon the actions of multiple decision-makers. Unlike traditional decision models that focus primarily on individual choices, game theory recognizes that strategic behavior occurs within interactive environments where each actor's decisions influence and are influenced by the decisions of others.

Modern game theory is often said to have been started with von Neumann and Morgenstern; and Nash's (1951) formulation of the framework for the Nash equilibrium proved to be one of the most influential concepts in strategic analysis. Nash equilibrium theory states that there is a stable outcome if participants are unable to improve their payoff by independently changing their strategy if other participants keep their strategies unchanged.

The importance of game theory is that it explicitly models strategic interdependencies. Whereas competitors in classical economics are considered as passive elements of the environment, game-theoretic models include the likely responses of competitors in decision-making. This aspect renders game theory especially useful for investigating competitive markets, negotiations, partnerships, and resource allocation problems.

Recent studies show that game-theoretic methods are becoming increasingly relevant in various settings. Tushar et al. (2018) demonstrate the role of game theory to trade energy through a peer to peer way, ensuring that incentives among decentralized players align without losing efficiency in total system. Similarly, Wang et al. (2024) demonstrate how game-theoretic frameworks facilitate stakeholder coordination of decisions to ensure renewable energy integration in the face of technological and market uncertainty.

In emerging green certificate markets, strategic interactions among power-generation companies create complex competitive dynamics that influence investment decisions, pricing strategies, and market outcomes. Cheng et al. (2025) demonstrate that game-theoretic approaches provide valuable insights into how firms respond to changing regulatory frameworks and environmental incentives.

Beyond traditional industries, game theory has increasingly been applied to artificial intelligence systems. Sefeni et al. (2024) explore game-theoretic approaches for controllable text generation in large language models, demonstrating how strategic frameworks can support decision-making processes in advanced computational environments.

2.4. Key Differences Between Traditional and Game-Theoretic Approaches to Decision-Making Under Uncertainty

One of the most important debates in contemporary strategic management concerns the distinction between traditional decision-making models and game-theoretic approaches.

Traditional decision-making frameworks usually assume that uncertainty is due to environmental sources and are independent of the actions taken by the decision-maker. All of these models are calculation-based and center around estimating probabilities, evaluating expected payoffs, and selecting options to maximize expected utility.

Game-theoretic approaches adopt a fundamentally different perspective. They take uncertainty not as an external force but rather see it often as a by-product of the strategic behavior of other actors. As a result, decision-makers have to take into account not only the environmental conditions but also potential responses from competing businesses, partners, regulators and stakeholders.

Table 1. summarizes the principal differences between these approaches

Dimension	Traditional Approach	Game-Theoretic Approach
Source of uncertainty	External environment	Strategic interactions
Decision focus	Individual optimization	Interdependent optimization
Information structure	Often assumed known	Frequently incomplete
Analytical objective	Maximize expected utility	Anticipate strategic responses
Treatment of competitors	Environmental factor	Active strategic players
Preferred solutions	Optimal choices	Equilibrium outcomes

Source: Authors' own research.

These differences explain why game theory has become increasingly relevant in competitive and dynamic environments where organizational success depends heavily upon anticipating the actions of others.

2.5. Collaborative Governance and Strategic Decision-Making Under Uncertainty

Collaborative governance has emerged as an important complementary perspective for addressing uncertainty in complex systems. Rather than focusing exclusively on competition, collaborative governance frameworks emphasize stakeholder engagement, collective problem-solving, and adaptive learning processes.

Research indicates that collaborative arrangements can reduce informational asymmetries and facilitate coordinated responses to uncertain conditions. Through dialogue, trust-building, and shared decision-making mechanisms, stakeholders can collectively generate solutions that may be unattainable through purely competitive interactions.

The collaborative governance framework proposed by Emerson, Nabatchi, and Balogh emphasizes four interconnected dimensions:

Table 2. The 4 Dimensions of the Emerson, Nabatchi, and Balogh Model

Metric	Description
System Context	Political, legal, economic, and social conditions
Collaborative Dynamics	Shared motivation and principled engagement
Collaborative Actions	Joint implementation and adaptation
Systemic Impact	Long-term outcomes and performance

Source: Authors' own research.

These governance mechanisms become particularly important when uncertainty cannot be resolved through analytical optimization alone. In such situations, learning, adaptation, and stakeholder participation contribute significantly to organizational resilience.

2.6. Limitations of Game-Theoretic Approaches in Strategic Decision-Making

Despite its significant contributions to strategic analysis, game theory is not without limitations. Although game-theoretic models give a firm foundation for analyzing strategic behavior, their application requires an overlay of the value and complexity of the real-world scenario onto the model.

Out of all the many limitations often discussed, the most common is the assumption of rational behaviour. Game theory classically assumes decision-makers are rational agents who seek to maximize some utility function. Evidence from behavioral economics and organizational behavior shows that people often make decisions based on cognitive biases, emotional reactions to new information, bounded rationality or heuristics. This means that true decisions might vary greatly from the theoretical predictions that are based on models of pure rational behaviour.

An additional limitation revolves around information needs. A common assumption in many game-theoretic models is that players have enough information about strategies, payoffs and the organization of the game, prior to taking action. Organizations, in practice, never work with complete, perfect or symmetric information. Although some of these issues are resolved by using Bayesian and incomplete-information games, estimating the competitors' objectives and capabilities reliably is still often unattainable to practice (Gorelik & Zolotova, 2023).

Another challenge concerns computational complexity. The larger the number of players and strategies and uncertainty variables, the more intractable game-theoretic models become to solve. Such large-scale strategic interactions with multiple players may be intractable without advanced computational methods and/or vast data resources, thus rendering them inaccessible to many organizations.

Finally, fast-evolving technological contexts pose challenges for equilibrium-based approaches. Digital platforms and AI systems payoffs, which build on decentralized networks, tend to change so quickly that strategic conditions evolve faster than equilibrium solutions can be identified and executed. Consequently, organizations are in more need of adaptable frameworks which can mould to facilitate continuous learning and make switches on a strategic level instead of solely relying on equilibrium based concepts as mentioned earlier.

Despite these limitations, game theory remains one of the most influential analytical frameworks for understanding strategic interaction. Its greatest value lies not necessarily in predicting exact outcomes but in helping decision-makers structure complex problems, identify strategic dependencies, and anticipate potential responses from other actors.

2.8. Contradictory Findings and Emerging Debates in the Literature

The literature on strategic decision-making under uncertainty reveals several important tensions regarding how uncertainty should be conceptualized and managed.

A first debate raises the question of what uncertainty itself means. From the game-theoretic tradition, we often find that uncertainty can be framed more as a strategic element of the game than something to be reduced through better information, model-building methods and equilibrium analysis. In the energy market as well as infrastructure management, and resource allocation game theory researchers identifying optimal or near-optimal strategies that perform well against uncertainty (Tushar et al., 2018; Cheng et al., 2025; Wang et al., 2024) learn at best achievable performance level.

By contrast, the scholars of collaborative governance contend that uncertainty cannot always be eradicated through analytical optimization. Instead, we should embrace uncertainty as a part of complex systems that demands ongoing adaptation and stakeholder engagement, collective learning. The question concerned successful decision-making: how can it be possible, which solutions would be optimal, where to look for answers has become less important than the focus on institutional capacities development for resilience and adaptation (Emerson et al., 2012).

The second debate is about efficiency vs. adaptability. Quantitative game-theoretic models often focus on efficiency by finding strategies that maximize expected payoffs or minimize losses. Rather, scholars of complex interventions have recently argued that the focus on optimization may stymie flexibility within the organization [6]. Such that under the highly uncertain conditions, adaptive iterative approaches can outperform rigid optimization frameworks if decision makers are dynamic and responsive to emerging information.

A third area of disagreement concerns assumptions regarding rationality. According to classical game theory, actors behave strategically and consistently with their preferences. However, empirical research has shown time and again that emotions, social norms, organizational culture, and cognitive biases affect even the choices of real-world decision-makers. So, the reality of strategic action differs from theory.

The growing application of game theory within artificial intelligence provides further evidence of this convergence. Recent studies demonstrate that game-theoretic mechanisms can support adaptive learning systems capable of adjusting strategies dynamically in response to changing conditions (Sefeni et al., 2024). These developments suggest that future research may increasingly focus on hybrid models combining equilibrium analysis with adaptive and learning-based approaches.

3. Methods

The study uses a qualitative conceptual research method based on an integrative literature review. It is not about testing an empirical hypothesis but rather synthesizing recent knowledge on game theory in strategic behaviour under uncertainty to frame major implications, managerial contributions and research directions.

We have applied an integrative review approach as this allows insights from the existing, but generally separate streams of literature across strategic management, economics, governance studies, energy systems, construction management, artificial intelligence and interdisciplinary decision sciences to be synthesised. In view of the multi-faceted aspect of uncertainty and strategic interaction, it is not possible to analyze the phenomenon under study with too narrow an analytical perspective.

This study is prepared based on peer-reviewed journal articles, conference proceedings, academic books and recent scholarly publications published primarily from 2016 to 2026. One exception is Nash (1951) since it represents a developmental basis of modern game theory.

The literature selection process was guided by three principal criteria. First, to be featured in our results, publications must have addressed strategic decision-making, uncertainty, game theory or closely related concepts. Research on competitive underpinning of resource allocation, governance regimes of resources, strategic behaviours in planning processes and decision support systems were the most salient studies.

Second, consideration was given for recent publications to highlight advancements in theory and practice. Most of the studies included for analysis were published after 2018, meaning that our search captures emerging uses of game-theoretic methods in fast-moving fields.

Third, the review wanted studies from different sectors and disciplines. This allows for a more holistic understanding of the application of game-theoretic principles in various organizational situations and decision environments.

The final corpus includes contributions from energy systems, blockchain governance, construction management, artificial intelligence, educational sciences, sustainability studies, and strategic management research.

To strengthen analytical rigor, evidence identified within the literature was classified according to the relative strength of support provided for specific claims.

Table 3. Evidence Strength by Claim

Claim	Evidence Strength	Representative Sources
Game theory models strategic interdependence effectively	High	Tushar et al. (2018); Liu et al. (2019); Debnath et al. (2018)
Nash equilibrium supports strategic prediction	High	Nash (1951); Cheng et al. (2025)
Distinction between risk and uncertainty is essential	High	Gorelik & Zolotova (2023); Madani & Lund (2011)
Collaborative approaches improve resilience	Moderate	Emerson et al. (2012); Enachescu & Petcu (2025)
Adaptive strategies outperform static solutions in highly uncertain environments	Moderate to High	Shehadeh & Alshboul (2025); Sefeni et al. (2024)

Source: Authors' own research

This classification does not imply absolute certainty but rather reflects the degree of consistency observed across the reviewed literature.

Based on the literature synthesis, the study proposes a conceptual relationship linking uncertainty, strategic interaction, game-theoretic analysis, and organizational outcomes.

Based on the reviewed literature, Figure 1 illustrates the proposed conceptual framework underlying strategic decision-making under uncertainty. The framework demonstrates how uncertainty generates strategic interdependence among actors, which can be analyzed through game-theoretic mechanisms to support strategic decision-making and improve organizational outcomes. The model also emphasizes the importance of learning and adaptation as feedback mechanisms that continuously influence future strategic choices.

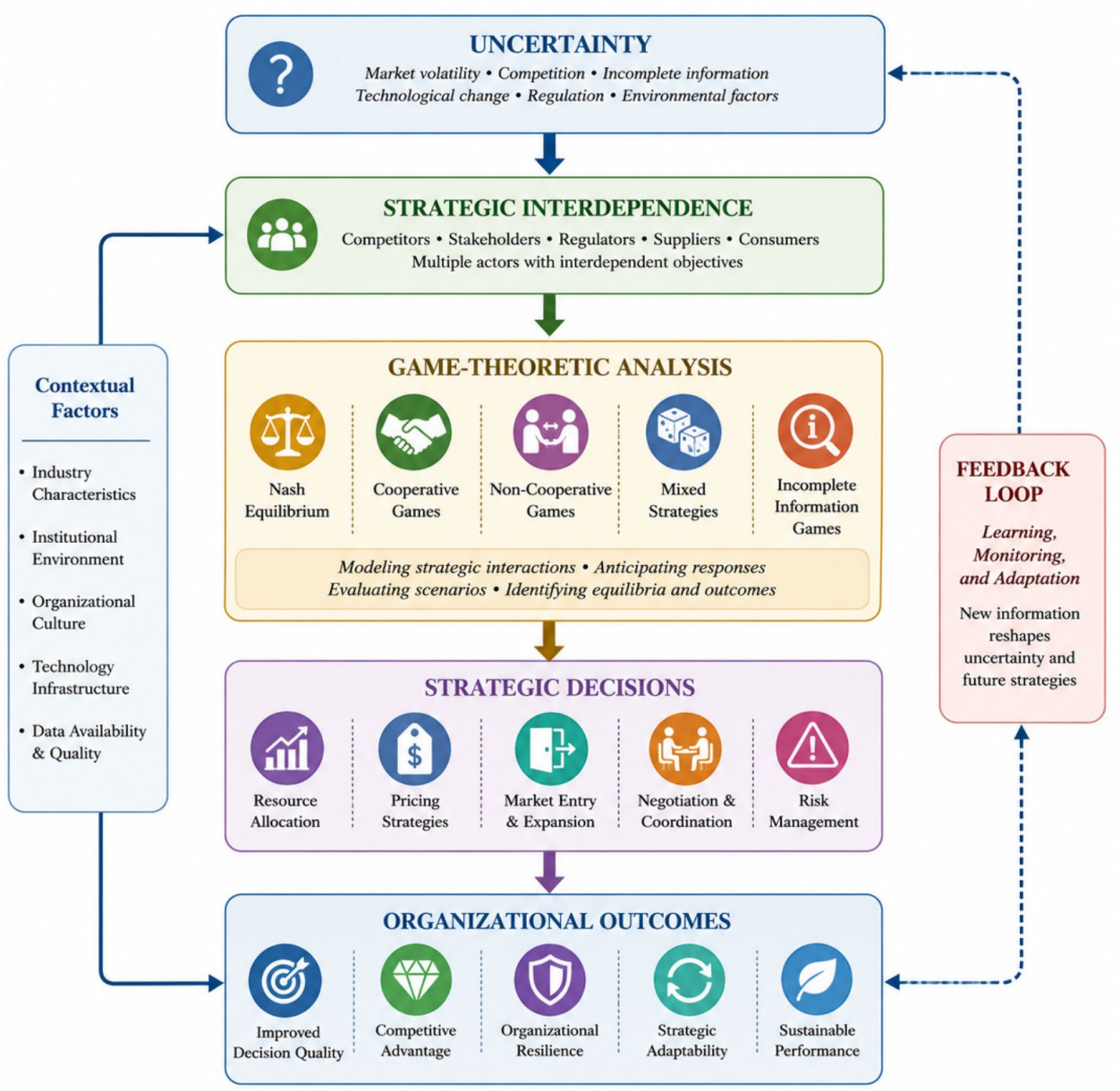

Figure 1. Conceptual framework linking uncertainty, strategic interaction, game-theoretic analysis, and organizational outcomes
Source: Authors' own research

As illustrated in Figure 1, game theory functions as an intermediary analytical layer between environmental uncertainty and organizational outcomes. By modeling strategic interactions among stakeholders, decision-makers can identify more robust strategies, anticipate competitive responses, and enhance organizational resilience under uncertain conditions.

Under conditions of uncertainty, decision-makers face incomplete information regarding future events and stakeholder behavior. Game-theoretic frameworks facilitate the analysis of strategic interactions by modeling potential responses and identifying equilibrium conditions. These insights support more informed strategic choices, which in turn contribute to improved organizational performance, adaptability, and resilience.

4. Results

The literature reviewed in this paper suggests game theory offers a strong analytical basis for supporting decisions made under uncertainty. In diverse domains of application, including energy systems, blockchain governance, construction management, artificial intelligence and environmental policy, game-theoretic methods have been shown to model strategic interdependence, quantify the value of alternative decision options and improve quality of decisions.

One of the main findings coming out of this analysis is that environmental uncertainty never occurs in a vacuum. Uncertainty, instead, often stems from the interactive behavior of multiple actors whose decisions

affect one another. As a result, organizations that include strategic interaction in their decision making processes are usually forward thinking and adept to change.

The further argument is that game-theoretic models are especially viable in settings with conflicting goals, limited resources, partial information, and competitive dialogue. In such settings, optimization practices may have struggled to drive towards a solution because of the intricacies of how stakeholders interact with each other in these environments, while game theory explicitly captures that strategic behavior in the analysis.

Results also suggest that the practical utility of game-theoretic methods relies on information quality, modeling assumptions suited to the policy context, and decision-makers' judgment in integrating analytical results into larger organizational processes.

One of the strongest findings identified in the literature concerns the role of strategic interdependence in generating uncertainty. Most decision-making models are predicated on the assumption that uncertainty is driven by developments outside of an organisation - e.g., market dynamics, technological change, or regulatory evolution. The challenges you had to consider from a strategic standpoint in many of the reviewed studies were because organizational outcomes depend on the decisions taken by actors other than themselves.

More specifically, in peer-to-peer energy trading systems, each individual continuously adapts their behaviour based on expectations of the actions of others in the market. Tushar et al. It is with this theory which by the work of (2018) demonstrate how game-theoretic frameworks enable efficient coordination, while incorporating these strategic dependencies in mind. You see similar sequences of action and reaction with blockchain ecosystems, where the decentralized participants were completing transactions with each other based on incentive structures to affect network stability, security, and performance (Liu et al., 2019).

Another example that illustrates this is construction management. The outcome of a project relies on the coordinated actions of contractors, suppliers, investors, regulators and project managers. Subsequently, as shown by Shehadeh and Alshboul (2025), the strategic interactions among such stakeholders play a major role in determining how costs sharing, risks management and project execution take place.

These findings indicate that strategic interdependence should be treated as a core aspect of uncertainty, not simply an afterthought. A failure to take into consideration how competitors and stakeholders will respond causes organizations to underestimate risks and overestimate the results of what they are trying to do.

The literature review also reveals that Nash equilibrium remains particularly valuable as a decision-support tool rather than as a precise predictive mechanism. In many real-world contexts, organizations use equilibrium analysis to identify plausible strategic scenarios rather than to forecast exact outcomes.

The reviewed literature demonstrates the versatility of game-theoretic approaches across multiple domains.

One of the most actively explored area of contemporary game-theory research is the energy markets. The shift towards decentralized energy production has complicated interactions between stakeholders, necessitating analytical frameworks that can support distributed decision-making.

Blockchain technologies lay the groundwork for decentralized governance systems with strategic incentive mechanisms. Liu et al. According to (2019), game theory is a critical lens through which we can analyze the balance of incentives, sanctions, and governance mechanisms that drive behaviors among network participants. They have concluded that game-theoretic methodologies lead to better system security, higher participant cooperation and more efficient incentive alignment.

Construction projects have multiple stakeholders with competing objectives and different risk attitudes. Game theory can be used to assist in coordinating strategy and minimizing contestability over costs, schedules, and contributions of resources etc., (as shown by Shehadeh & Alshboul) 2025 allowing projects to realize greater outcomes.

Recent advances in Artificial Intelligence (AI), have opened up new possible applications of game-theoretic ideas. Sefeni et al. Strategic frameworks that foster controllable text generation and adaptive decision-making processes in LLMs (2024); Implications of this research suggest that game theory could become more important in the governance and optimization of intelligent systems.

Traditional approaches remain effective when uncertainty originates primarily from environmental variability and when probabilities can be estimated with reasonable accuracy. In such situations, expected utility models and probabilistic forecasting techniques provide valuable decision support.

However, as strategic interdependence increases, the limitations of traditional approaches become more apparent. Organizations must account not only for environmental conditions but also for the adaptive behavior of other actors. Game theory addresses this challenge by incorporating strategic responses directly into the analytical process. As a result, decision-makers gain insights into competitive dynamics that are often absent from conventional decision models.

Table 4. Comparative Findings

Criterion	Traditional Approaches	Game-Theoretic Approaches
Handles environmental uncertainty	Strong	Strong
Handles strategic uncertainty	Limited	Strong
Models competitor responses	Weak	Strong
Predictive precision	Moderate	Moderate
Adaptability to dynamic interactions	Limited	High
Computational simplicity	High	Moderate to Low

Source: Authors' own research.

The findings indicate that neither approach should be viewed as universally superior. Instead, the effectiveness of a particular method depends upon the nature of the decision problem and the sources of uncertainty involved.

A recurring theme across the reviewed literature is the relationship between strategic decision-making and organizational resilience.

Organizations operating in uncertain environments must develop capabilities that enable adaptation, learning, and strategic flexibility. The literature suggests that game-theoretic analysis contributes to resilience by encouraging decision-makers to consider multiple scenarios and anticipate alternative stakeholder responses.

The reviewed evidence therefore suggests that resilience should be viewed not merely as the capacity to withstand disruption but also as the ability to anticipate, adapt, and learn from evolving strategic conditions.

5. Discussion

These results substantiate the value of game theory as a conceptual framework for exploring strategic confrontation in circumstances characterized by ambiguity. Traditional decision-making models (which are often much more precise than the generalizations of game-theory-based approaches) tend to scale well except in a few limited environments but traditionally optimize individual choices under easily known or estimated conditions; this is because outcomes of decisions very often depend on actions, expectations and responses of multiple actors, something that classical thinking in decision theory does not take into account. This distinction is especially salient with modern organizations competing in a world of dynamic competition, globalized supply chains, digital disruption, and organized stakeholder-consumer relations dynamics.

The review shows that uncertainty does not always lend itself to an outside environmental condition. Most of the time, uncertainty comes into play because decision-makers are unable to either track or anticipate how one or a combination of competitors, collaborators, regulators and consumers is going to act. This kind of strategic uncertainty is qualitatively distinct from probabilistic uncertainty, since it derives from the actions of intelligent agents that are always reassessing their position relative to changing conditions. As a result, strategic planning must adopt analytical tools that can accommodate those feedback loops.

Certainly, the increasing use of game-theoretic methods in various fields lends credence to this interpretation. Whether it is decentralized energy systems, blockchain networks, construction management or artificial intelligence, organizations increasingly find themselves in environments where the strategic interactions of actors determine outcomes. In such contexts, game theory provides a systematic framework for filtering options and determining both reactive moves as well as strategic approaches that work across scenarios.

The implications of the results also go beyond prediction: Additive representations are not new. While equilibrium concepts aid in the investigation of stable strategic configurations, they may contribute even more to improving strategic thinking. Game theory is a tool applied to push decision-makers into considering interactions through the lens of multiple stakeholders which provides a more complex view of challenges within an organization.

One of the most important insights emerging from the literature concerns the changing nature of uncertainty in modern organizations. For the longest time, uncertainty was interpreted as a result of incomplete knowledge about external conditions. Managers tried to home in on obliviousness with sensemaking methodologies, estimation models, measurable systems and chance evaluation approaches. Although these approaches continue to provide considerable value, they are becoming less adequate in settings where outcomes depend heavily on the actions of other players.

The reviewed studies indicate that strategic uncertainty frequently arises because competitors and stakeholders possess objectives, information, and capabilities that are not fully observable. In such situations,

organizational success depends not only on making effective decisions but also on anticipating how others will respond.

For example, these firms in emerging green energy markets have to cater for strategic responses from competitors, regulators, investors, and consumers when they are constructing their investment strategies (Cheng et al., 2025). In a similar way, blockchain governance systems also must assess incentives and expected actions of many decentralized actors whose choices co-determine network results (Liu et al., 2019).

These examples illustrate that strategic uncertainty cannot be eliminated altogether. Instead organizations need to build capabilities that let them foresee other probabilities and pivot accordingly as conditions change.

The comparison between traditional decision-making models and game-theoretic approaches reveals fundamental differences in how uncertainty is conceptualized and managed. Traditional models generally presume that decision-makers act without coordination and strive to maximize expected utility according to the information at hand. With this way of thinking, uncertainty is seen as a feature of the environment rather than an outcome of strategic interaction.

Game theory takes an opposing view. Because outcomes are a function of the simultaneous choices of multiple actors, it directly embeds responses into an analytical framework. This difference helps in understanding why game-theoretic models are often useful for such competitive and common interest environments.

The results suggest that game theory offers three major advantages over traditional approaches. First, it makes clear strategic interdependence. While examining alternative actions, decision makers are advised to think about others' aid competitive reactions rather than focusing myopically on their own objectives. Secondly, scenario analysis is another process facilitated by a commitment to game theory. Organizations can identify vulnerabilities and craft more resilient responses to uncertainty by exploring different strategic options. Third, game-theoretic models enhance strategic predictions. Organizations can evaluate how what they do dramatically changes the behavior of others rather than only responding passively to environmental events. These benefits are part of the reason we see game-theoretic methods gaining a foothold in sectors with lots of interconnected dynamics, and high rates of change.

An important theme emerging from the literature concerns the relationship between competition and collaboration. Traditionally, classical game theory is used to model competitive interactions where actors act in self-interest. But the very real challenges many organizations face today involve cooperation among stakeholders, whose interests do not always fully align. Such as in climate governance, energy transitions, infrastructure development, management of digital platforms and delivery of public policy.

The collaborative governance literature provides evidence that collective learning, stakeholder engagement and information sharing can often alleviate uncertainty more effectively than optimization in competition. Based on this way of thinking, it is not in conflict with game theory. Cooperative game-theoretic models demonstrate how actors can attain mutually beneficial outcomes through coordination of strategies (the form and content) and sharing resources. Such approaches are especially useful in contexts where joint outcomes are prioritized over competitive success and the pursuit of long-term relationships is emphasized. The findings thus support an extended interpretation of game theory that includes competition and collaboration. Organizations that are able to strike the right balance on these fronts will more likely find themselves more resilient and adaptable in uncertain environments.

The results of this study have several important implications for managers and organizational leaders. Managers should incorporate strategic interaction analysis into planning processes. Decisions should be evaluated not only according to internal objectives but also according to the likely responses of competitors, customers, suppliers, and regulators.

Traditional risk management frameworks often underestimate strategic uncertainty. Integrating game-theoretic reasoning can help organizations identify hidden risks associated with stakeholder behavior and competitive dynamics.

Game-theoretic models provide valuable insights into how resources should be allocated under conditions of uncertainty. By evaluating multiple strategic scenarios, decision-makers can develop more flexible and resilient investment strategies.

Many organizational decisions involve negotiations among parties with divergent interests. Game theory offers structured approaches for identifying mutually beneficial solutions and reducing conflicts arising from strategic interactions.

The literature suggests that exposure to strategic simulations and game-based environments can improve analytical capabilities and decision quality. Educational research demonstrates that structured interaction with uncertain scenarios strengthens critical thinking and long-term reasoning skills (Bărbulescu et al., 2026; Nguyen et al., 2025). Consequently, organizations may benefit from incorporating simulation-based learning methods into leadership development and strategic planning programs.

Although the literature demonstrates substantial progress in understanding strategic decision-making under uncertainty, several opportunities for future research remain. First, greater integration between game theory and behavioral decision-making theories is needed. Many existing models continue to rely on

assumptions of rationality that do not fully capture real-world behavior. Future studies should explore how cognitive biases, emotions, and social influences affect strategic interactions. We need to integrate better game theory with behavioral decision-making theories.

Theoretical models have long rested on an assumption of rationality that is inadequate to fully reflect human behavior in real-world scenarios. Future statements should investigate the impact of cognitive biases, feelings and social drinking on tactical communications. Second, as artificial intelligence continues to grow in importance we can demonstrate the potential for game-theoretic models that learn about changing strategies from nature. As organizations increasingly adopt digital technologies, research on strategic decision making in intelligent systems may be of ever-greater importance. Third, broaden interdisciplinary approaches. This novel framework, which encompasses educational, governance, and organizational perspectives may allow one to develop more comprehensive frameworks capable of dealing with the myriad aspects of uncertainty.

This study needs further empirical studies to assess the applicability of game-theoretic approaches in practice under different industries and organizational settings. Although conceptual and theoretical contributions are important, evidence from real-world applications will enhance our understanding of the parameters under which game-theoretic models achieve maximum value.

The discussion highlights that game theory offers a powerful framework for addressing strategic uncertainty because it explicitly incorporates interactions among decision-makers. Unlike traditional approaches that focus primarily on environmental uncertainty, game-theoretic models recognize that many organizational outcomes depend on the behavior of other actors.

The findings indicate that game theory improves strategic planning, enhances anticipation of competitor responses, and supports more robust decision-making under uncertain conditions. At the same time, limitations related to rationality assumptions, information requirements, and model complexity suggest that game theory should be applied alongside complementary approaches emphasizing learning, adaptation, and collaboration.

Ultimately, the evidence suggests that the most effective organizations are those capable of combining analytical rigor with strategic flexibility. In increasingly complex and interconnected environments, success depends not only on identifying optimal strategies but also on continuously adapting those strategies as new information emerges and stakeholder behaviors evolve.

6. Conclusions

Strategic decision-making in the face of uncertainty is one of the most difficult tasks that organisations and their leadership have to deal with today. Recent years have experienced rapid techno-social developments, growing market complexity, changing stakeholder expectations (including consumers and investors), and worldwide interconnectedness which has widened the gap between uncertainties that decision-makers need to tackle. While traditional decision making models remain a powerful analytical aid, those are rarely applicable in situations where the outcome relies on the actions of multiple players who may have both conflicting objectives and incomplete information.

This study investigated the role of game theory as a framework for assisting strategic decision-making with uncertainty. Our literature review showed that, game-theoretic approaches help in an important way by explicitly modeling strategic interdependence among the participants. Whereas conventional decision models mostly treat uncertainty as an external environmental condition, game theory posits that uncertainty often arises from interactions with other players - competitors, collaborators, regulators and others. So, you are provided with a better outlook to examine complicated decision circumstances.

The findings indicate that concepts such as Nash equilibrium, cooperative and non-cooperative games, mixed strategies, and games with incomplete information remain highly relevant for contemporary strategic management. These concepts allow organizations to weigh alternative actions, forecast future behavior from other actors, and find points of stability in strategic forms. The application of game-theoretic methods in different fields (energy systems, blockchain governance, construction management, environmental markets and artificial intelligence) proves the versatility and practical importance of this method.

The analysis also underscored the fundamental difference between risk and uncertainty. Risk can usually be treated with probabilistic models and expected utility calculus, while uncertainty needs methods that are able to deal with incomplete information over time and interaction among strategic agents. In this sense, game theory serves as an important complement to traditional decision-making frameworks since there are dimensions of uncertainty that statistical analysis cannot fully capture.

At the same time, the study identified several limitations associated with game-theoretic approaches. Assumptions regarding rational behavior, information availability, and equilibrium stability may not always reflect real-world organizational conditions. Furthermore, the complexity of modern decision environments can make the application of game-theoretic models computationally demanding and difficult to implement in practice. These limitations suggest that game theory should not be viewed as a universal solution but rather as one component of a broader decision-support toolkit.

Another important conclusion concerns the growing importance of adaptation and resilience. The literature increasingly suggests that successful decision-making requires more than analytical optimization.

Organizations must also develop capabilities for learning, collaboration, and strategic flexibility. Collaborative governance frameworks and adaptive management approaches complement game-theoretic analysis by emphasizing stakeholder engagement and continuous adjustment in response to emerging information.

The study further demonstrated that interdisciplinary perspectives contribute meaningfully to understanding strategic decision-making. Research in education, sustainability, leadership, and organizational development highlights the value of systems thinking, critical reasoning, and adaptive problem-solving skills in uncertain environments. These perspectives reinforce the broader conclusion that effective decision-making requires both analytical rigor and the capacity to respond dynamically to changing circumstances.

Overall, the evidence supports the argument that game theory remains one of the most influential and useful frameworks for understanding strategic behavior under uncertainty. By helping organizations anticipate interactions, evaluate competing alternatives, and develop robust strategies, game-theoretic approaches contribute to improved decision quality and enhanced organizational resilience. As uncertainty continues to shape economic and organizational landscapes, the integration of game-theoretic reasoning with adaptive and collaborative approaches is likely to become increasingly important for achieving sustainable strategic success.

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