USING GAME THEORY TO TRANSFORM RISK INTO OPPORTUNITY

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ABSTRACT

Game theory is a fascinating subject applied in various academic fields, including economics, management, biology, psychology, and sociology. This paper aims to apply game theory to problem solving and risk management, highlighting the relationship between game theory, strategic planning, and risk management. Combining game theory with risk management theory can capture opportunities that businesses can turn risks into opportunities. Game theory helps managers deal with large amounts of data and helps them solve problems, make strategic decisions, and manage risks. In today's complex world, critical infrastructures are interdependent and vulnerable to various risks. Classic risk analysis methods, which primarily use empirical models and statistical data, may not be suitable for assessing risks arising from intelligent adversaries like terrorists, criminals, or competitors. Game theory offers a paradigmatic framework for strategic decision-making when two or more rational decision-makers are involved in cooperative or conflicting decision situations. By linking risk analysis and game theory, the quality of forecasts and risk assessments can be significantly improved. Our study indicates how game theory helps managers to solve the problems, make strategic decisions and manage risks.

Keywords - Data mining; Game theory; Risk management; Strategic planning.

INTRODUCTION

Each organisation possesses a distinct purpose or objective. The leader of an organisational unit is responsible for ensuring that the organisation possesses the necessary capacities to successfully achieve its objective. Organisations operating within the same market should collaborate in order to prevent chaos and disorder. By considering each organisation as an agent, we may examine the coordination of organisations in a multi-agent system. This system involves two factors that contribute to uncertainty: the actions of the known agents, which are organisations currently operating in the market, and the unpredictable conduct of other autonomous agents, which are either unknown or freshly founded. Hence, the agents are engaged in a game characterised by unpredictability (Wang et al. (2022)

A robust risk management procedure is a crucial element of effective organisational management. The primary objective of an organization's risk management process should be to safeguard the organisation and its capacity to fulfil its mission. An efficiently organised risk management technique, when implemented successfully, can assist management in identifying suitable controls to ensure the needed security capabilities for the mission.

If organisations are able to identify and mitigate risks, they will have a favourable chance to enhance their situation. We propose the use of a risk control model to assist managers in effectively resolving issues and making informed decisions.

Make strategic choices and oversee risk management. We streamline the risk model by focusing on the reduction in payout. In the field of game theory, rational individuals strive to achieve Nash equilibrium, which represents a stable outcome for each individual agent. In a hypothetical market, organisations strive to achieve equilibrium, which may be subject to rapid changes. We propose a technique that facilitates the achievement of a Pareto efficient and Nash equilibrium for rational agents in all conceivable games. This model necessitates a meticulously organised data warehouse (Arulampalam et al. 2022).

Game theory is a conventional theoretical framework used to model important decision-making processes in various fields, including economics, social sciences, finance, project management, computer science, civics, and epidemiology. It has been recognized that there is an optimal strategy in the context of complex interactions between two or more parties (players) that can lead to a predictable outcome (payoff). In practical situations, this outcome can often be quantitative and amenable to arithmetic operations (cost, number of infected people, number of vaccinated people, etc.), but often it can be qualitative in nature (such as risk, readiness level, health state, etc.).

To understand the state-of-the-art in game-theoretic applications in defence and to analyze the types of games used in such contexts, a review is needed. To the best of our knowledge, such a review spanning different applications of game theory in a variety of military domains is lacking. The goal of this paper is to present a review that will provide a better understanding of the multitude of defence problems in which game theory can be successfully applied. Moreover, the multidimensional classification of the types of games used in different contexts will provide researchers insights into new ways of applying game theory in related problems.

Risk analysis typically defines the risk of an event as a function of its probability of occurrence, potential negative consequences, or the vulnerability of the element at risk. However, this approach is only effective when dealing with random risks, such as throwing dice, weather forecasts, technical failure rates, and simple investment decisions. Practical risk management relies on optimal adaptation to empirical distributions for random events.

However, this approach can lead to misjudgments and flaws when dealing with risks arising from deliberate choices of two or more rational and interacting individuals. Game theory, originally a mathematical theory, can be applied to complex strategic decision situations by modeling human interactions and analyzing the reasoning process of rational actors. It has applications in economic markets, cooperative arrangements, competitive situations, crimes, and recently, terrorism.

IN PROJECT MANAGEMENT, WHAT DOES RISK MANAGEMENT MEAN?

When it comes to project management, risk management begins with the identification and analysis of the risks (i.e. unpredictable events) that are associated with a particular project. Following this, a plan that is centred around resources is developed in order to minimise (or mitigate) those risks. From a fundamental standpoint, the goal of risk management is to reduce the likelihood of occurrences that could potentially get you into trouble, as well as the consequences of such occurrences.

Game-theoretic reasoning offers a unique advantage over classic risk analysis in defending against adversarial risks. It involves considering the opponent's motivation, which underlies all of their actions, allowing defenders to direct scarce resources to specific elements of critical infrastructure where the opponent's motivation is strongest. Classic risk analysis focuses on vulnerable elements where the defender has experienced the highest losses in the past.

Foreign hotspots can often coincide with future hotspots, making forecasts from classic risk analysis and game-theoretic approaches similar. However, in a real-life decision-problem, game-theoretic reasoning can improve protection. The example is a modified version of the sequential defender-offender-game, considering a railway station frequented during rush hour but sparsely during rush hour. The deterministic version of this defender-offender-game is easy to solve due to its unique solution.

WHY WOULD RISK MANAGEMENT EMPLOY GAME THEORY?

When conducting a risk assessment, we take into consideration a wide variety of problems, some of which do not quite fit under the purview of risk management. Taking into consideration the dispute that arises between two different project teams, how is it resolved? Who is who? When everything is said and done, a quarrel of this nature can easily cause you to lose time, money, and importantly, quality!

As a result, game theory is utilised in the field of project management in order to simulate the decision-making process of the numerous stakeholders who interact with one another. These players include project managers, investors, clients, contractors, sub-contractors, and governments. The fact that their interests may frequently conflict is the reason why we examine different project management scenarios and model them in accordance with those scenarios.

When you integrate game theory with risk management, you will be able to successfully seize every chance that your company may have to transform risk into possibility. When it comes to managers who are responsible for dealing with a massive amount of data, game theory is merely an additional perspective on the process of issue solving (Arulampalam et al. 2022).

WHAT DOES PROJECT MANAGEMENT GAME THEORY ENTAIL?

Game theory works well in project management because it is applied both at the outset of the project—during contract negotiations and project management!

The "old" game theory method would have examined scenarios in which one person outperforms another at the expense of the other, but that isn't very accurate in the modern world where we're looking at a wide range of scenarios including people, computers, and other entities.

RISK AND RISK ANALYSIS

Risk is a term that encompasses both the possibility of making losses and gains. It is defined by various authors, including Knight, Bonß, Ayyub, Kaplan and Garrick, Haimes, Aven and Renn, and others. All activities, whether in private or business life, carry risks, and risk management is an integral part of this process. Risk management involves identifying, assessing, and prioritizing risks, followed by coordinated and economical application of resources to minimize, monitor, and control the probability and impact of unfortunate events.

Key principles of risk management include creating values, being part of the decision-making process, explicitly addressing uncertainty, based on available information, and taking human factors into account. Risk analysis is a key element of risk management, which can be represented qualitatively, semi quantitatively, or quantitatively. There are various risk analysis tools and methods, such as brainstorming, expert intuition, expert audits, Delphi method, structured whatif technique (SWIFT), probabilistic risk analysis (PRA), failure modes and effects analysis (FMEA), fault-tree analysis (FTA), event-tree analysis (ETA), Bayesian networks, and Monte Carlo simulation (Sharma et al. 2013).

Risk analysis approaches are based on intuition and/or probabilities, and risk can be categorised based on its origin, cause, severity, and controllability. This distinction highlights that some categories of risk can arise from natural or aleatory uncertain hazards, while others can arise from rational and intelligent adversaries. Overall, risk management is an iterative, cyclic, multi-step process that involves risk analysis as one of its key elements.

REVIEW OF LITERATURE

Sharma et al. (2013) According to the literature on knowledge management, the knowledge ecosystem of an organisation is made up of strategic situations in which the individual behaviours of its knowledge workers exhibit potential conflicts with what would be best for the organisation given the circumstances. By taking a game theoretic perspective, the purpose of this work is to investigate the ways in which such behaviours in terms of knowledge flows can be modelled and conducted analysis. The application of game theory in knowledge management has been the subject of some investigation in previous studies; nevertheless, a thorough understanding of the organisational eco-system has not yet been researched nor developed. Consequently, in order to investigate the exploratory nature of the research issue, a qualitative inductive approach was chosen as the method of investigation. There are four organisational knowledge dilemmas that have been identified through critical assessments of major literature in the fields of knowledge management and organisation theory. These dilemmas are referred to as "silos of knowledge," "tragedy of the knowledge commons," "knowledge friction," and "knowledge toxicity." In order to produce five scenarios that are frequently seen in organisations, these conundrums were employed in a variety of different combinations. The PARTS framework was utilised to conduct a game theoretic analysis of these scenarios, which resulted in a valuable understanding of the flow of knowledge inside organisational eco-systems. To be more specific, the analysis resulted in the development of important insights and prescriptive guiding principles that were utilised in the formulation of knowledge strategies and policies. These were designed to tackle the major knowledge issues that impede successful knowledge distribution inside organisations.

Kifokeris's (2013) An examination and assessment of risk using game theory. It is inevitable that an organisation will make decisions that include risk over its entire existence. This risk is dispersed among the aforementioned organization's manpower components, which in turn influences those components in the appropriate manner. An investigation into the question of which is the probability of cooperation within the organisation, from the point of view of a risk-based decision, taking into consideration the potential for the maximisation of individual, group, and collective profits as they accrue (or do not accrue) from the aforementioned cooperation, has not yet been conducted in the current bibliography. Using the methodologies of Game Theory, Decision Theory, Probability Theory, Organisational Theory, and Human Resource Management Theory, this dissertation investigates an approach to a probable answer to the question that was presented before. A first step is to provide an introduction to the fundamental ideas behind organisational discretization, human resource management, decision making, uncertainty, and risk, as well as the fundamental definitions of decision theory and game theory. Following that, a series of previous applications and research subjects are examined, in which Game Theory was utilised either on its own or in conjunction with other techniques. Following the conclusion and application of the findings that were derived from the aforementioned subjects, the remainder of the dissertation is written. Game theory is finally used to model an organisation that serves as an example. The previously conducted theoretical and bibliographical investigation served as the source of the problem's framework, frame, and organisational, mathematical, and other conditions. Using a probabilistic technique and the Pareto distributions, the results that were obtained from the modelling in question are processed. Consequently, the processing approach comes to a close with an evaluation of the probability that a cooperative solution can be implemented. One possible answer to the fundamental question that served as the impetus for the theme of this dissertation is this cooperative solution.

Pineiro (2016) This study presents a novel approach to reputational management as a driver of entrepreneurial sustainability. It does so by integrating three dimensions of reputation through the use of game theory. The analysis is framed as a prisoner's dilemma schema, which is solved by defending against reputational threats from entrepreneurial sustainability. This is the first step in the process. If the entrepreneur views reputation as a source of risk, the analysis is framed as well. In the second scenario, the analysis is presented as an innovator's problem that can be resolved by obtaining reputational prospects from entrepreneurial sustainability. This is the case if the entrepreneur views reputation as a competitive advantage. Third, in the event that reputation is regarded as a strategic asset, the analysis is framed as a coordination game schema. This schema leads to the development of a reputational intelligence talent, which has the potential to become essential for the achievement of success in the realm of entrepreneurial sustainability. As a result, this paper offers a novel multidisciplinary examination of reputational management by establishing a connection between well-known theoretical results from game theory and the realities of organisations.

Ghavamifar et al. (2017) The study of game theory is quite interesting. It is used in a wide range of academic disciplines, including as sociology, psychology, biology, economics, and management. This work aims to apply game theory to risk assessment and issue solving. We begin by providing a brief introduction to game theory and demonstrating how it relates to risk management, strategic planning, and game theory. In order to seize any chance that a corporation might convert a risk into an opportunity, game theory and risk management theory are merged. Game theory is just another way of looking at the problem-solving process for managers who work with massive amounts of data. Our research demonstrates how game theory aids in problem solving, strategic decision making, and risk management for managers.

Yue Gao et al. (2018) Numerous environmental risk issues arise during the production process for manufacturing enterprises. Companies must strike a balance between capital planning issues and risk limitations by minimising risks in response to severe environmental requirements and demands for safe industrial procedures. To lessen these risks, environmental pollution liability insurance, or EPLI, may be helpful. In order to minimise risk, manufacturing companies typically want to spend less on investments. Conversely, insurance providers aim to maximise benefits by offering a greater range of options to meet the demands of manufacturing enterprises. One way to conceptualise the relationship between a manufacturing company and an EPLI provider is as a two-player game. In order to mitigate corporate environmental risk through EPLI, a game theory strategy is put out in this study. The game theoretic model's parameters can be adjusted to reach a desired equilibrium. The use of the suggested approach is illustrated through a case study of a pharmaceutical company.

Marks (2018) In today's business world, it is crucial to consider various scenarios when deciding on strategies to increase market share. For instance, lowering prices may lead to a price war, causing customers to treat your product or service as a commodity and switch to the lowest cost source instead of respecting your innovative offering. This could erode your margins and negatively affect your share price, spooking investors. Alternatively, if your engineering team struggles to produce a full range of next-generation products, focusing on a limited range may help you gain a lead in innovation and market share. However, it is essential to explain this to investors to prevent them from selling your stock. Alternatively, hiring more people to support the full range may be necessary, even if it means your product will not be available for several months after competitors'. These decisions are critical decisions that require careful consideration of both your actions and those of other parties.

Kifokeris (2021) The process of making strategic and managerial decisions inside an organisation can have a significant impact on the entire entity; nevertheless, it is uncommon for the employees of the organisation to be involved in an equal manner across all levels of the organisation. The result is the ostracism risk, which is the danger that arises from the lack of satisfaction of underprivileged employee groups during the decision-making process. This risk is what is addressed in this paper as the ostracism risk. Considering that the prospect of being shunned could put the organization's credibility in jeopardy, it is imperative that adequate therapy be administered. The purpose of this study is to verify a conceptual approach that has been offered as a methodology for estimating the probability of organisational collaboration while making decisions under risk, with the end goal of minimising the risk of ostracism. The strategy that has been suggested is founded on theories of organisational and human resource management (HRM), and it is contextualised for construction by means of a knowledge of systems theory. The technique that has been proposed offers a potential modelling of a medium-sized construction company that is organised in accordance with Mintzberg's organisational model through the use of game theory. An approach to the probabilistic processing of the model is described, which involves the utilisation of the bounded Pareto distribution. Additionally, the potential for predicting the probability of adopting a favourable cooperational decision is validated. At the end of the paper, a reference is made to the further steps that are necessary for the validation of the approach and for further research and development.

Arulampalam et al. (2022) This article provides a concise assessment of the various attempts that have been made in the academic literature to apply game theory to the modelling of decision-making scenarios that are pertinent to defence applications. Within the realm of describing the decision-making processes of intelligent beings, entities, and players, game theory has been demonstrated to be an extremely useful and effective tool. Modelling scenarios from a wide variety of domains, including economics, evolutionary biology, and computer science, has been accomplished with its participation. Modelling and predicting the behaviours of hostile actors and players who attempt to dodge or outsmart each other is a type of modelling and prediction that is frequently required in defence applications. One of the most important aspects of game theory is the modelling of how the actions of competitive players influence the decision making between each other. There have been a number of studies conducted over the course of the last few decades that have utilised various subfields of game theory in order to model a variety of defense-related scenarios. The purpose of this work is to present a structured overview of such attempts and provide a classification of the current literature according to the sort of warfare that was modelled, the types of games that were utilised, and the players who were involved. Following a thorough screening process, a total of 29 papers that are directly relevant are discussed and given a classification. In terms of the types of warfare that are modelled, we acknowledge that the majority of papers that apply game theory in defence settings are concerned with Command and Control Warfare. These papers can be further classified into papers that deal with (i) Resource Allocation Warfare, (ii) Information Warfare, (iii) Weapons Control Warfare, and (iv) Adversary Monitoring Warfare. In addition, we have seen that the majority of the publications that were examined were concerned with sensing, tracking, and massive sensor networks. Furthermore, the difficulties that were investigated have parallels in the analysis of sensor networks in the civilian sector. Regarding the games that were utilised, we categorise the papers that were examined into the following categories: papers that utilise non-cooperative or cooperative games, simultaneous or sequential games, discrete or continuous games, and games that are either non-zero-sum or zero-sum. In a similar manner, papers can be divided into many categories, such as two-player, three-player, or multi-player game-based papers. In addition to this, we investigate the type of participants involved in each scenario as well as the creation of payout functions. Last but not least, we also identify gaps in the existing literature where game theory could be successfully applied to situations that have not been investigated using game theory up until this point. In the study that has been offered, a succinct assessment of the current state of the art with regard to the application of game theory in defensive applications is provided. Additionally, the advantages and disadvantages of game theory in the scenarios that have been addressed are highlighted.

Wang et al. (2022) The emergence of renewable energy sources is one factor that has contributed to their widespread adoption in the energy sector. In the beginning, it was feasible to speculate that civilizations would be so enthusiastic about the benefits of these energy sources that they would deploy them in the infrastructure of energy systems, even before conducting in-depth research on the potential drawbacks of these alternative energy sources. Regrettably, the management of these sources has grown difficult as a result of the uncertainty that is connected with environmental conditions, which can cause problems on a social, economic, and technical level. New technologies that are still in the process of being developed, such as electric vehicles (EVs), have been of great assistance in lowering the levels of air pollution and, as a result, have had a favourable impact on human life. Nevertheless, we are all aware that advanced technology has the potential to make the issue structure even more intricate. An innovative management approach for risk-based optimal bidding strategies of energy aggregators in the energy market that takes into consideration green sources is proposed in this article. In addition to this, it suggests a new method for the bidding offer technique that green energy aggregators that participate in the spot electricity market should implement. An novel bi-level optimisation strategy is designed for the purpose of maximising the profit of non-participatory enterprises while taking into consideration all of the limits that include both technical and social constraints. When using this method, the equilibrium market places are determined by applying the Nash equilibrium rule to the calculation. According to this concept, all manufacturers and consumers are considered to be market actors, which allows them to propose the behaviour of electric vehicles and, as a consequence, creates an atmosphere that is more competitive. The results make it abundantly evident that the model that was provided for energy management in a social and economic context that is environmentally friendly performs exceptionally well.

DISTINCT METHODS FOR HANDLING RISKS

The human activity of risk management combines risk identification, risk assessment, risk management strategy development, and risk reduction with managerial resources. In this section, we will elucidate many possible risk treatments and strategic risk preferences.

1. Possible remedies for risk

All risk management strategies fit into one or more of these main categories after risks have been recognised and evaluated:

- **Preventing risks**

One way to use this strategy is to avoid engaging in potentially dangerous activities. An illustration would be to avoid purchasing a business or piece of real estate in order to avoid the associated liability. While avoiding risks may seem like the best course of action, doing so also means forfeiting any potential gains that could have come from embracing (or holding onto) the risk. Refusing to start a business in order to reduce the chance of losing money also eliminates the chance of making money.

- **Mitigation of risks**

This strategy uses techniques to lessen the impact of the loss. Sprinklers intended to put out a fire to lessen the danger of loss from fire are one example. This approach might not be appropriate since it could result in a larger loss due to water damage.

Through progressive development and delivery of software, modern software development approaches mitigate risk. Because early techniques only produced software at the end stages of development, any issues found in earlier stages generally required expensive rework and jeopardised the project as a whole. Software projects can reduce effort waste to a single iteration by developing in batches.

- **Retention of risk**

This method entails embracing the loss as it happens. That's when true self-insurance comes in. For minor risks, when the cost of insurance against the risk would eventually exceed the total losses incurred, risk retention is a workable approach. By default, any risks that are not transferred or avoided remain in place. This covers hazards that are either too big or too catastrophic to be insured against, or for which the premiums would be too expensive. War serves as an example because most risks and property are not covered by insurance against war, meaning that the insured bears the loss caused by the conflict.

- **Transfer of risk**

By adopting this strategy, you can force another party to take on the risk—usually through a contract or hedging. One sort of risk transfer that makes use of contracts is insurance. At other instances, it might have to do with clauses in contracts that assign risk to a third party without requiring payment of an insurance premium. This is a common approach for contractors, whether building or otherwise, to transfer liability. On the other hand, businesses usually utilise hedging to control risk financially by taking positions in derivatives that are offset.

One other instance of risk transfer is outsourcing. In this instance, businesses only outsource a portion of their internal requirements. For instance, a corporation may handle business management internally and merely contract out its software development, hard goods manufacturing, or customer service requirements to outside parties. As a result, the firm will be able to focus more on business development rather than managing the development team, the manufacturing process, or the location of the call centre.

OUR PERSPECTIVE

A risk control model is going to be presented in this study with the purpose of assisting managers in selecting amongst several strategic risk preferences. The ability to select suitable risk preferences is essential for managers in a variety of market situations.

Organisations are required to have a mechanism for risk control. It is possible to extend the concepts of the dominant strategy, the Nash equilibrium, and the Pareto-efficiency that are found in traditional game theory by taking into consideration the risk preference of the agent. An innovative risk management system will be discussed in the following parts.

OUR PROPOSAL

When it comes to an organization's corporate memory, the primary repository of its historical data is referred to as a data warehouse. A decision support system for management is comprised of the raw material contained inside it. An essential component that contributes to the utilisation of a data warehouse is the capability of a data analyst to execute intricate queries and analyses, such as data mining, on the information without causing the operational systems to become sluggish. For example, a data warehouse may be used to determine which day of the week a company sold the most widgets in May 1992, or how the number of sick days taken by employees in California and New York changed during the week leading up to the winter break between the years 2001 and 2005. According to our model, managers are required to be aware of the expected payoff, the lowest payoff, and the greatest payoff associated with each technique. Utilising a data warehouse makes it easier and more accurate for managers to obtain these data. The data warehouse provides managers with the ability to find solutions to a variety of problems. Data mining on the transactions of the organisation can also assist them in identifying hazards, in addition to this.

A MODEL FOR THE CONTROL OF RISKS

Whenever there is a high level of risk involved in a game of uncertainty, a rational agent would not always choose to play the strategy that results in the biggest expected payout. The approach that involves the least amount of risk is the one that has the greatest degree of dominance for a risk-averse actor. The approach that has the potential to deliver the biggest return is the one that has the most dominance for a risk-seeking agent, regardless of the risk and the projected payoff the strategy may give. For a risk-neutral agent, the strategy that provides the highest expected payout is the one that is considered to be the dominant strategy. According to the risk model, a strategy combination is considered to be in Nash equilibrium if any agent experiences a decrease in dominance as a result of deviating from the strategy combination individually.

Consider, for instance, the uncertain game matrix that is depicted in Figure 1. The degree of uncertainty presented by a natural move is reflected in the probability that is associated with each payout. Each entry in the game matrix that starts with X/Y represents a reward that has a chance of Y.

P / Q	C	D
A	0/0.5,20/0.5 10/0.8,20/0.2	10/0.5,20/0.5 0/0.3,10/0.7
B	15/0.4,20/0.6 0/0.3,15/0.7	15/0.4,20/0.6 0/0.7,10/0.3

Figure 1. An uncertain matrix game

P / Q	C	D
A	10 12	15 7
B	18 10	18 3

Figure 2. Expected playoff.

A simplified version of the game matrix can be created in the form of an expected reward, as shown in Figure 2. If Q does not have a preference for risk, then the uncertainty inherent in Q's decision is a risk that cannot be avoided for P. If, on the other hand, Q is determined to take risks, it will employ strategy A in order to achieve the greatest possible payout, as shown in the game matrix in Figure 3. On the other hand, if Q is risk-averse, it will employ strategy B in order to lessen the risk by reasoning on the game matrix in the risk form shown in Figure 4. Therefore, if each agent were to be aware of the risk preferences of other agents, they would be able to determine which approach has the largest dominance that other agents possess. Nevertheless, there is still a difficulty, and that is the question of how agents might arrive at a certain conclusion that includes both the Pareto-efficient and Nash equilibrium. A procedure is required in order to coordinate the agents in order to get a steady outcome.

Q \ P	C	D
A	20 20	20 10
B	20 15	20 10

Figure 3. Highest playoff

Q \ P	C	D
A	10 2	5 7
B	3 10	3 3

Figure 4. Risk matrix

Each and every combination of strategies has the potential to be a one-of-a-kind Pareto-efficient and Nash equilibrium point, albeit this is contingent upon the various combinations of risk preferences held by both agents. Because of this, the rational agent has the ability to control the eventual state that they will arrive at. There is a possibility that the end state will meet the various risk preferences of each actor. On the other hand, it is not impossible for the anticipated payout to be influenced by each interaction with agents who have a different risk preference than the risk-neutral alternative.

RISK CONTROL PROTOCOL

It is the goal of organisations to achieve equilibrium. In order to accomplish this goal, they should employ techniques that do not infringe upon the objectives maintained by other organisations. Our protocol makes the assumption that each method will have both a negative and a positive payout.

First, construct the three game matrices, which are the highest payoff, the risk, and the expected payoff.

- If the game has a Pareto-efficient and Nash equilibrium that is unique to it, then you should play the game.

- In any other case, notwithstanding the fact that there is no special Pareto-efficient and Nash equilibrium

A proposition should be made that makes use of both positive and negative payoffs, taking into account the preferences and rational assumptions of other agents.

Make use of the game.

Let's have a look at the unstable game matrix shown in Figure 1.In Figure 2, 3, and 4, the payoffs and dangers that are highlighted show the situations that are most desirable in the game matrix that corresponds to those figures. Figure 2 does not have a Nash equilibrium, however Figures 3 and 4 do indeed contain equilibriums. Therefore, in order to arrive at a solution that is stable, it is essential for rational actors to communicate with one another.

If P and Q are both risk-averse, then Q will pay -8 to play strategy A, and P will pay 7 to play strategy C. Both of these outcomes are possible. Figure 5 depicts the new expected payoff game matrix that was produced as a result of this. It is possible to demonstrate that the combination of strategies (B, C) is both Pareto-efficient and maintains the Nash equilibrium.

P Q	C	D
A	17 -3	15 -1
B	25 3	18 3

Figure 5. Resulting game matrix

CONCLUSION

A protocol was presented in this work with the purpose of assisting managers in the process of problem solving, strategic decision making, and risk management in the context of an uncertain market environment. A steady outcome should be achieved by competitive organisations, as stated in our protocol, and this should be accomplished through the implementation of certain techniques. Through the use of both positive and negative payoffs, we were able to locate the Nash equilibrium for games about uncertainty. Organisations are urged to adopt methods that will lead them all to a stable outcome through the use of this mechanism.

In recent years, researchers in the field of business have presented the 3C's concept. It is suggested by this model that a strategist should concentrate on three essential aspects in order to achieve success. The Collaborators, the Customer, and the Competitors are the three primary actors that need to be taken into consideration while developing a business strategy. A sustainable competitive advantage can only be achieved by incorporating the three C's—the collaborator, the customer, and the competitors—into a strategic triangle. Sharing certain important functions with other businesses within the organisation or even with other businesses can be one way to improve cost-effectiveness, for instance. A single organisation has the potential to serve as our customer, our collaborator, and our rival all at the same time. Within the framework of our protocol, we envisioned the competition between organisations as a rivalry between agents. In a similar fashion, we are able to simulate the communication that takes place between an organisation and its business partners and customers in the context of an uncertain game. However, we will not be addressing these transactions in any of our future initiatives.

Agents are able to incorporate risk control into decision making, which can help lessen the risk that is associated with the uncertainty of a nature move. This is made possible by the separation of risk from payout, as well as the redefinition of dominance in terms of distinct risk preferences.

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