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A GAME-BASED CONFLICT RESOLUTION METHOD BY MAPPING PRISONER'S DILEMMA INTO A TEAMWORK ENVIRONMENT IN SOFTWARE PROJECTS

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ABSTRACT

Generally, software projects demand high-level interactions among different agents. Based on a specific perspective, typical examples of agents can be stakeholders, customers, and working teams. Although these agents are cooperating toward specific goals, e.g., timely completing the project, their adopted approaches may bring them into conflict with each other. Such conflicts should be resolved since they can have serious ramifications like the project's tardiness. Apart from psychological and managerial methods, conflict resolution is obtainable through using a game theoretic-based approach and its justification. Herein, this practice is conducted under a software project associated with a video banking software application. The present study shows how teamwork behavior can be mapped into the classical prisoner's dilemma problem. By doing so, the teammates will tangibly understand the importance of their way of thinking in the project's success or failure. Coupling such a setting with a common rule of thumb psychological and managerial implications performs well in bouncing back teamwork progress when there are certain technical conflicts among teammates.

KEYWORDS: Game theory, Conflict resolution, Software development, Teamwork cooperation, Prisoners' dilemma

1. INTRODUCTION

One prominent feature of software projects is the necessity of involving diverse teams to create a unified product with various functionalities. In addition to technical challenges, a common crisis in these projects arises from conflicts in perspectives and a lack of cooperation among team members. In other words, conflict arises when services developed by two or more teams need to be integrated, but due to certain deficiencies in each service, the desired output is not achieved. In such situations, when project stakeholders inquire about the reasons for delays in delivering the final product, each team tends to analyze the problem from their perspective and perceives the shortcomings of the opposing team as a justification for their issues. Such a mindset, when present in projects with intertwined responsibilities assigned to different teams, results in irreparable damage in terms of cost and time for delivering the final product. Notably, the issue of conflicting interests and its analysis

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is not solely related to psychological aspects and communication skills. It also ties into the fundamental concept of "Prisoner's Dilemma" in game theory (Sun et al. 2023; Ho et al. 2023).

There are several papers in the literature that have provided insights into conflict resolution in teamwork and individual behavior using the Prisoners' Dilemma (Caserta et al. 2023; Bekius and Gomes, 2023). Levy (1985) discusses the importance of the cooperation threshold in moving toward a cooperative resolution. Rasmusen (1989) explores the effectiveness of ostracism in promoting cooperation in repeated prisoner Dilemma games. Flook (1970) provides an overview of the Prisoners' Dilemma and its paradoxical nature. Hristova et al. (2013) considered four types of human relations studied in their research, including communal sharing, authority ranking, equality matching, and market pricing. In their proposed Prisoner's Dilemma game, players were assigned to those relations. Specifically, players were assigned roles of teammates, chief and subordinate, partners, and opponents, respectively. The study found that the market-pricing condition, which corresponded to the opponent role in the Prisoner's Dilemma game, was characterized by considerably lower individual and cooperation, higher mutual defection, and lower payoff in comparison to the conditions impersonating the remaining three relational types. In comparison, the conditions reflecting the remaining three relational models were characterized by higher levels of individual cooperation and payoff plus a lower defection rate. Tsai and Chi (2015) considered conditions leading to win-win outcomes for the involved parties using different settings under the umbrella of game theory. In that respect, one of their certain findings pertained to the lack of trust between parties, like prisoners in the corresponding classical game, that prevents the individuals from reaching their desired outcomes.

Kagel (2018) focuses on the role of communication in fostering cooperation in finitely repeated Prisoner's dilemma games. The purpose of content analysis on communication between opponents in that study was to better understand the basis for the increase in cooperation rates achieved through unrestricted communication. They analyzed the discussions between opponents to identify the motivations for cooperation and the factors that contributed to it. The analysis was based on pre-specified categories suggested by the economics literature on possible motivations for cooperation, as well as the researcher's reading sample of the transcripts to identify unforeseen motivations/beliefs. The authors also looked at team discussions to better understand the factors motivating team play. Bruno et al. (2018) examined the use of the Prisoner's Dilemma Game in higher education to develop conflict management skills. The study found that the Prisoner's Dilemma Game is perceived as a valuable tool in students' learning experience, allowing for new insights into conflict and emphasizing its defensive, automatic, and interpersonal aspects. The article contributed to understanding PDG as a means of enhancing conflict management competencies, although its limited generalizability was acknowledged. Şeremet et al. (2021) utilized the Prisoner's Dilemma game as a tool to activate and foster collaboration practices in the target audiences. Such a methodology helped audiences to think more deeply about their choices at times of decision-making.

Cooper and Kagel (2022) examined how two-person teams and individuals behaved in repeated prisoner's dilemma games with perfect information. The paper analyzed team conversations to understand the reasons and the methods behind these decisions. The paper discovered that teams were more cooperative and quicker than individuals and that their cooperation was more consistent. The paper also discovered that the tactics used by teams were different from those found by a conventional method, and that teams often cooperated by themselves to persuade their rivals to cooperate. They ended by saying that team discussions offered useful information into the decision-making of players in repeated games.

Overall, these papers highlight various strategies and factors that can influence conflict resolution in the context of the prisoner' Dilemma. In the rest of the paper, we will first discuss the Prisoner's Dilemma issue and then provide a real-life example of the crisis that occurred during the implementation of a video banking project. Finally, based on the mentioned fundamental issue, we will draw necessary conclusions regarding the decision-making consequences of project stakeholders in the video banking project.

2. PROBLEM SETTING

This problem setting is composed of two parts. First, the classical prisoner's dilemma is introduced. Second, the software development instance associated with a video banking application is described. In this instance, the underlying conflict between working teams is described.

2.1. Prisoner's dilemma

Two individuals are detained on suspicion of involvement in a crime. The police have no concrete evidence against either of them or decide to interrogate them separately. Each suspect is asked to testify against their partner and confess to their involvement in the crime. Each individual has two possible responses: to betray their partner and confess to the crime, or to remain silent. If both remain silent, they will be sentenced to one year in prison. If one remains silent while the other confesses, the one who confesses will be released with an 8-year prison sentence, while the one who remains silent will face 8 years in prison due to insufficient evidence against them. If both individuals testify against each other, they will each be sentenced to three years in prison. Assuming that the individuals are unaware of their partner's decision but are aware of the sentencing rules in various scenarios, the question here is, what is the best decision for each individual?

If each individual seeks the best decision based on their self-interest, they can decide by analyzing their partner's strategy to minimize their punishment. Specifically, if one partner decides to remain silent, the other should betray to secure their freedom, resulting in an 8-year prison sentence for the silent partner. Therefore, the rational decision in this case is to betray. Now, if both partners intend to betray, the targeted individual will be sentenced to 3 years in prison regardless of their own decision. Thus, in any case, the dominant strategy for the targeted individual is to betray their partner. On the other hand, the partner will also make a similar rational decision based on this logical conclusion, and the outcome will be mutual betrayal, resulting in a 3-year prison sentence for both parties. However, is there a better and significantly less costly decision to be made? If both individuals remain silent and consider collective interests in resolving their conflicting interests, they can reduce their sentence to one year in prison. In fact, by learning from the Prisoner's Dilemma and applying it to real-world business environments, we can avoid crises and costly policies. Herein, we will examine a corresponding instance related to a software project.

2.2. Video banking application

The video banking project is a unique capability developed for the first time at Dotin Company, allowing customers to establish live video communication with Pasargad Bank experts online, regardless of their geographical location. Notably, Dotin Co. is a software provider in the Middle East, focusing particularly on financial solutions that handle the required services of millions of users. This project also enables virtual video identity verification. No doubt realizing a project with such features requires comprehensive cooperation among various specialized teams, including the development team, messenger teams, online broadcasting infrastructure, and artificial intelligence (Fig. 1). The close relationships between the output of the activities of these teams and, naturally, the presence of flaws in the performance of each of them, significantly affected the evolutionary process of project implementation and the final product's coherence over a considerable period. In fact, despite the efforts of auxiliary teams, issues such as communication breakdown when making multiple simultaneous calls and limitations in updating the messenger SDK led to a lack of trust in the performance of the necessary services by the main development team.

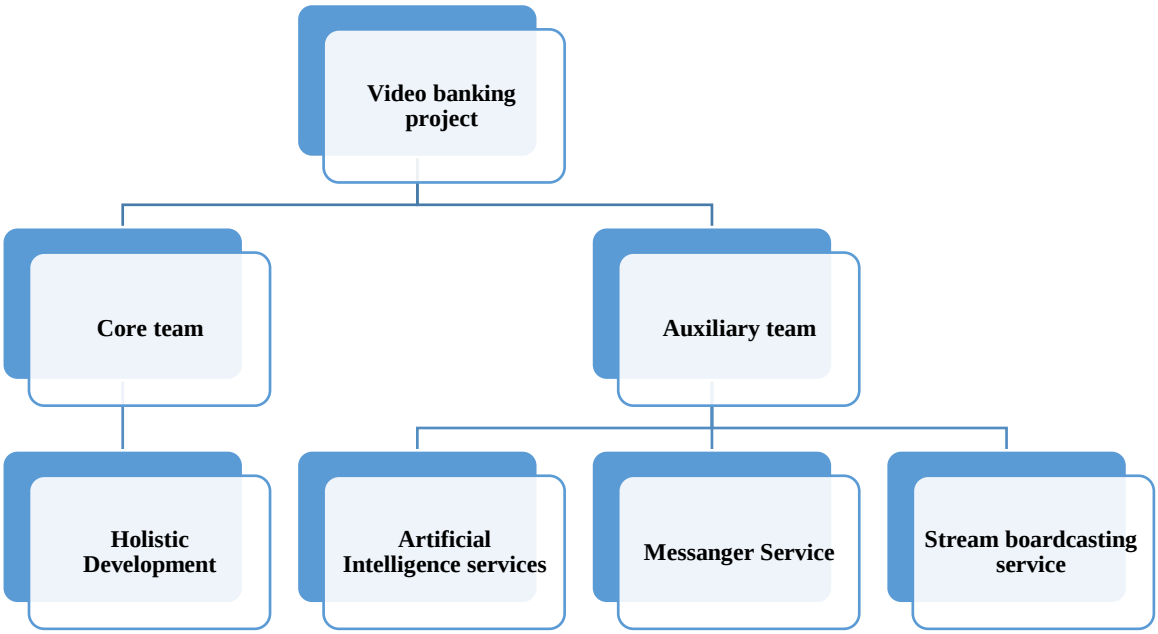

Fig. 1. Cooperation of core and auxiliary teams in the video banking project

Suggestions to create all the functionalities from scratch by the main development team were proposed. Meanwhile, the opposing team believed that the main team, due to insufficient knowledge of how to work with the mentioned services, could not achieve the necessary benefits for the final product's integration. In reality, efforts to find flaws in the opposing team and blame the other party did not yield results, and tests related to examining the performance of the video banking system failed. This prolonged conflict and the continuation of labeling each other as unprepared for the service and the functions of the involved parties in the project led to a crisis of stakeholder dissatisfaction due to delays in deliverables and team members' disillusionment regarding the project's eventual success. In this context, it is clear that the principles of team-based perspective, as demonstrated in the Prisoner's Dilemma, can provide valuable insights for resolving conflicts in teamwork scenarios, ultimately leading to more efficient and successful project outcomes.

3. Solution Methodology

A combinatorial solution related to psychological and managerial practices on one hand and using game theoretic-based justification has been used to remove underlying conflict. Precisely, after analyzing the problem, it was concluded that to resolve it, the focus should be on establishing trust and empathy among different team members, which would be more effective than improving existing technical and operational solutions. To address this, a provision was made for face-to-face communication and holding joint in-person meetings among project stakeholders, which was a shift from the previous reliance on message exchanges in the project communication channel. Additionally, envisioning and outlining the project's prospects upon successful completion were carried out. In this regard, the project's objectives and its unique position in the Middle East were reviewed. Team members were reminded that success in this project could lead to bright career prospects within the organization and international business opportunities. Alongside these motivational actions, decision-making for the key players in the video banking project was explained by mapping it to the Prisoner's Dilemma, providing stakeholders with the necessary insight into the consequences of their decisions and strategies.

From a broader perspective and in line with the aforementioned conflicts among active collaborators in the video banking project, the involved actors can be divided into two groups: the core development team and the auxiliary teams. Each group envisions two hypothetical policies in the course of performing interrelated project tasks: one favoring a label of unpreparedness toward the opposing side, and the other promoting empathy. "Unpreparedness" in this context refers to having a negative attitude towards the performance/service of the

opposing group, where each group seeks to justify the other's shortcomings and, consequently, the unacceptable progress of the project by relying on specific evidence and documents. On the other hand, "empathy" refers to having a positive attitude toward the performance/service of the opposing group. In this case, despite the shortcomings, each collaborator tries to cover their colleagues' deficiencies with enthusiasm and contribute to the advancement of the project. Additionally, Team policies, as described in the paper, refer to the hypothetical approaches or strategies that different groups of collaborators may adopt in the course of performing interrelated project tasks. These policies are categorized into two main types: "labeling," where a negative attitude is maintained towards the opposing group, and "empathy," where a positive attitude is fostered despite identified deficiencies. The concept of team policies is crucial in the application of the Prisoner's Dilemma framework to analyze decision-making scenarios among collaborators and their impact on the progress of the software development project. Furthermore, the consequences of adopting different policies by the actors can be interpreted based on the Prisoner's Dilemma framework and are categorized into four scenarios, as shown in Fig. 2.

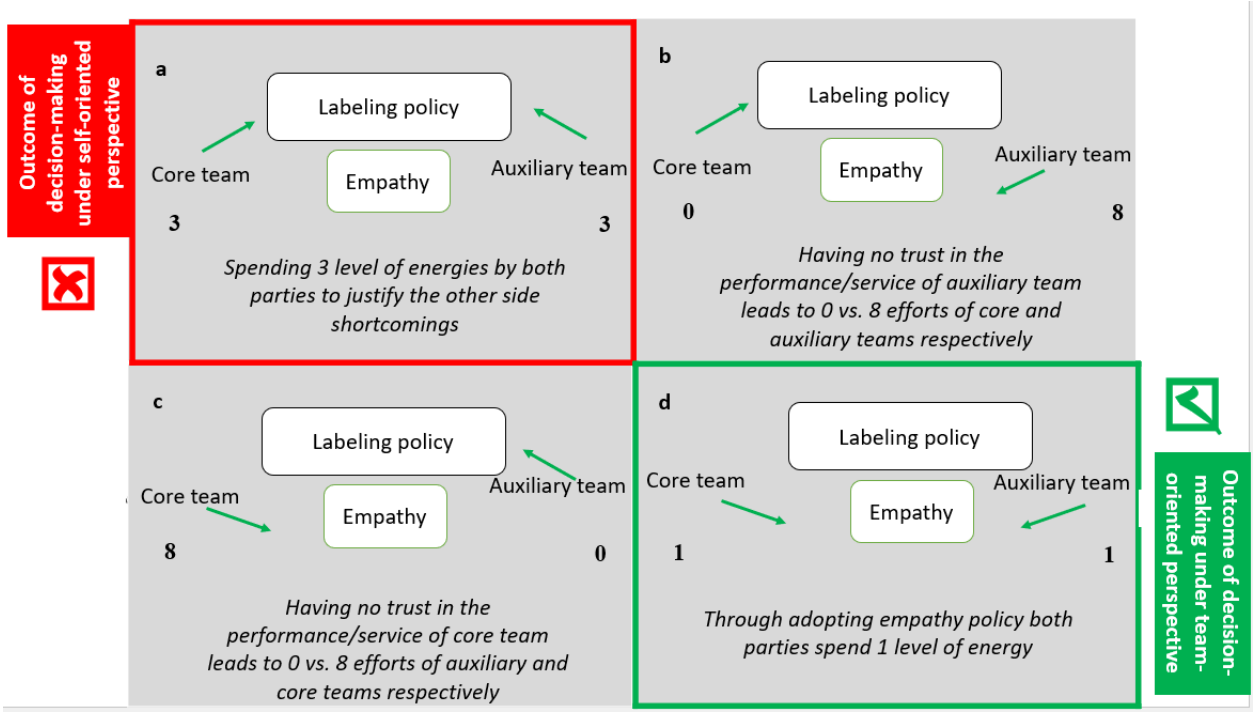

Fig 2. Mapping different teamwork policies into prisoners' dilemma pattern

In cases where both players adopt the "labeling" policy (Scenario A), both parties need to spend three units of energy (time) at the end of each round to document each other's performance/service shortcomings and justify the unacceptable project progress for management. Moreover, when both groups insist on separate policies, i.e., one advocating empathy and the other sticking to labeling (Scenarios B and C), the supportive group and the labeling group respectively require eight and zero units of energy to perform their tasks. In other words, since the supportive player has no trust in the performance/service of the opposing party and has not significantly contributed to the project's success, the supportive player must put in twice the effort to advance the project. Ultimately, if both players choose the empathy policy (Scenario D), they each contribute one unit of energy to the project's progress.

Therefore, following the rationality of individual interests, in these conditions, each player decides to focus on the labeling policy because if the opposing group adheres to it, they will have to expend significantly more energy (eight units compared to three units) when justifying their progress shortcomings. Thus, the dominant strategy for each player in this situation is to choose labeling. What is meant by more energy is that for example if the main team decided for any reason to implement the requirement related to the messenger SDK themselves

from scratch, this would require a considerable amount of time (for example, a period of eight months). On the other hand, the opposing group also adopts a similar rational conclusion and chooses the labeling policy, resulting in both parties receiving a punishment of three years in terms of energy expenditure. In summary, individuals and teams involved in business projects, armed with the necessary insight into the Prisoner's Dilemma and mapping it to business challenges, can refrain from choosing the less desirable strategies and prevent crises from occurring.

4. CONCLUSION

In this paper, we have explored a game-based conflict resolution method that leverages the principles of the Prisoner's Dilemma to address conflicts within software development teams working on complex projects. Software projects often involve multiple teams with interdependent responsibilities, and conflicts among these teams can lead to project delays and dissatisfaction among stakeholders. Drawing upon insights from game theory and prior research on conflict resolution in the context of the Prisoner's Dilemma, we have demonstrated the applicability of this approach in real-life scenarios, specifically in the context of a video banking software project. The Prisoner's Dilemma provides a framework for understanding how individual self-interest can sometimes lead to suboptimal outcomes when collective interests are not considered. Our solution methodology involves a combination of psychological and managerial practices aimed at fostering trust and empathy among team members. We emphasize the importance of face-to-face communication and joint meetings to facilitate understanding and cooperation. Additionally, we highlight the significance of mapping decision-making processes within the project to the Prisoner's Dilemma, enabling stakeholders to gain insight into the consequences of their choices.

By categorizing team policies into scenarios based on the Prisoner's Dilemma framework, we have illustrated the potential outcomes of different approaches. We have shown that adopting an empathetic approach, where teams support each other despite shortcomings, can lead to more efficient project progress. In contrast, a labeling approach, where teams focus on justifying each other's deficiencies, can result in increased time and energy expenditure. In conclusion, our research demonstrates the effectiveness of using game-based conflict resolution, inspired by the Prisoner's Dilemma, to enhance teamwork and cooperation in software development projects. This is done by mapping teamwork behaviors onto the principles of the Prisoner's Dilemma. We provide a theoretical foundation that facilitates a nuanced understanding of conflicting interests among team members. The integration of psychological and managerial practices within the proposed methodology ensures a holistic approach to conflict resolution. By promoting empathy and collaborative decision-making, teams can mitigate conflicts and improve project outcomes. However, it is important to acknowledge that the success of this approach depends on the willingness of team members to prioritize collective interests over individual concerns.

While our study has provided valuable insights into game-based conflict resolution in software development teams, several avenues for future research can further enhance our understanding and application of this approach. Conducting empirical studies to validate the effectiveness of the game-based conflict resolution method in real-world software projects is one of them. This would involve implementing the approach in different project contexts and measuring its impact on project outcomes, team satisfaction, and stakeholder relations. Next, developing decision support tools or software applications that can assist project managers and team leaders in implementing the game-based conflict resolution approach is highly worthy. These tools could guide mapping project decisions to the Prisoner's Dilemma and offer recommendations for fostering cooperation. Additionally, one can investigate the long-term effects of adopting game-based conflict resolution on team dynamics and organizational culture.

Exploring how cultural differences may influence the application of the Prisoner's Dilemma framework in conflict resolution can be also targeted. In that area, examining whether the effectiveness of this approach varies across different cultural contexts may be the main research question. The integration of game-based conflict resolution with agile development methodologies is another potential research opportunity. Scrutinizing how this approach can complement agile principles and contribute to iterative project success is a typical practice. In terms of measurement metrics, standardized metrics for evaluating the success of conflict resolution methods

within software projects should be defined. These metrics could assess factors such as project timeline adherence, stakeholder satisfaction, and team cohesion. Least but not last, creating educational programs and training materials to familiarize software development teams with the principles of the prisoner's dilemma and game-based conflict resolution can be studied. Evaluating the impact of such training on conflict management skills is no mean feat. Incorporating these future research recommendations can further advance the field of conflict resolution in software development and provide practical tools for improving teamwork and project outcomes in this dynamic and challenging domain.

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