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THE ROLE OF GAME THEORY IN ECONOMICS FOR FUTURE CORPORATE PURPOSE: AN OVERVIEW

Niklas Parlindungan Simorangkir
Swiss German University, Tangerang, Indonesia

Ivan Kurniawan
Swiss German University, Tangerang, Indonesia

ABSTRACT

This research aims to determine the role of game theory in economics, specifically in the area of understanding the future corporate purpose. Game theory is a discipline with numerous applications and is used to create a theoretical framework or strategy to help solve decision-making situations. A general overview of game theory will be discussed along with its important aspects. The method that will be utilized is extracting information from published papers from multiple sources, conducted through several stages. By determining the relationship of corporate purpose to economics, the use of game theory in economics will be discussed in more detail through two relevant applications: economic games and voting theory. The results are that both economic games and voting theory are theoretically feasible for future corporate purpose application, with indirect support from practical applications already conducted. This research will help guide corporations in developing strategies to have a meaningful corporate purpose.

Keywords: Game Theory, Corporate Purpose, Economics, Economic Games, Voting Theory

INTRODUCTION

Game theory, in a traditional sense, is about studying mathematical models on the interaction between rational players in a strategic manner, obtaining the best results possible. It is an evolving discipline that is adapted to different fields of study, however diverse they may be. One such area is economics. Economics, as is commonly known, is a main social science and it consists of a broad range of disciplines. Having a strong influence in corporation, it may have the potential to help develop the corporate purpose, with the help of the game theory approach.

In corporations, there are various factors that affect their success, which can be mixed with quantitative and qualitative aspects. Quantitative modelling can be used to minimize costs in a corporation's workings. But qualitative aspects are slightly more complex. These can be explained through prosocial behaviors. Prosocial behaviors may be considered as charitable, as they are one's actions on helping others regardless of the possibility

of one being affected by the personal cost (Thielmann et al., 2020). Naturally, corporations cannot entirely be prosocial, as they have to earn some profits one way or another. Therefore, trade-offs have to be made through strong considerations of the factors involved, by considering costs (in whichever form) along with the social perspectives of corporate actions involved. Two economics areas are identified for this: economic games and voting theory.

Previous research did not specifically address the role of game theory in future corporate purpose, but there are publications that discussed game theory, corporate purpose, and economics separately. There are five most important ones. The first paper is written by Toh, where game theory is utilized in the economics of decision-making. This is important because it can be applied to determining the corporate purpose of a company. A paper by Sadik-Zada et al. discusses the applications of game theory (amongst others) in development economics, which cements further understanding on the direction of such a corporate purpose. Meir wrote a paper on strategic voting, where game theory is used to determine the rational behavior of voters on certain mechanisms. This is applicable in determining the future corporate purpose because votes have to be given when deciding on the company's purpose. Thielmann et al. wrote a paper on personality and prosocial behavior, which focuses more on the qualitative aspects. This is important to look at because there needs to be a basic qualitative viewpoint when discussing the future corporate purpose. The fifth paper is by Fisch et al., where corporate purpose is heavily discussed. The defining aspect of corporate purpose stated in said paper will serve as an important guide.

The rest of this paper will be divided into three sections: literature review, methodology, applications of game theory in economics for future corporate purpose, real-life analyses' examples for corporate purpose realizations, and conclusions. The state of the art will provide an overview of game theory as well as corporate purpose. The next section is on the methodology of the research, which will focus on the mechanisms of obtaining the necessary literature for the applications of game theory in economics. The applications of game theory in economics for future corporate purpose section will discuss about the area of economics that can affect future corporate purpose, and subsequently explain game-theoretic approaches in economic games and voting theory. Real-life analyses' examples for corporate purpose realizations consist of two papers that provide detailed information that may help begin realizing today's corporate purposes to confront today's challenges. As for the conclusions, a summary of the applications of game theory in economics for future corporate purpose will be discussed.

LITERATURE REVIEW

Game Theory

Modern game theory was introduced by Gerolamo Cordano, especially through his treatise titled *Book of Games of Chance* (Sadik-Zada et al., 2024). The structure of game models and reasonings (along with the calculus of chances) as foundation for game theory was given by Blaise Pascal and Christiaan Huygens. Game theory still retained a presence in the 18th century and its development was notable in the 1920s with the contributions of Emile Borel and John von Neumann. This field of knowledge was exacerbated further with the publication of two books: *On the Theory of Games of Strategy* by John von Neumann in 1928 and *Theory of games and economic behavior* by John von Neumann and Oskar Morgenstern in 1944. It was eventually applied to various fields such as psychology and biology. In modern times, game theory is widely used, whether in its traditional form or in its variants.

Game theory is composed of three aspects, which are actions, preferences and payoff functions, and the theory of rational choice. With these three aspects, game theory can then be applied to a situation known as a strategic game. A strategic game consists of three components: a set of players, a set of actions, for each of the players involved, preferences for each of the actions that each player conducted (Osborne, 2004).

A strategic game can consist of two or more players. An example of a two-player game is Ruth and Charlie. It is a game in the normal form, where it consists of a set of strategies along with two payoff functions (a loose definition, in which its formal mathematics one can be found in (Kolokoltsov & Malafeyev, 2020)). This falls in line with the three components of a strategic game mentioned previously (a set of players, a set of actions, a set of preferences for said actions).

There are two types of strategic games: strictly competitive and symmetric. Strictly competitive games are "the games where the gain of one player always equals the lose of another one, i.e. $\Pi_R(s_R, s_C) = -\Pi_C(s_R, s_C)$ for all strategies of *R* and *C*" (Kolokoltsov & Malafeyev, 2020). This equation states that the payoffs' summation from both will equal to 0, leading to strictly competitive games classified also as zero-sum games. In the other hand, symmetric games are "games where each player has the same set of strategies *S* (i.e. the sets S_R and S_C coincide) and the payoff depends on the pair of strategies only, and not on the name of player that uses them" (Kolokoltsov, V.N. & Malafeyev, O.A., 2020). Other examples of a strategic game are the Prisoner's Dilemma, Bach or Stravinsky?, Matching Pennies, and the Stag Hunt.

For any of the strategic games, alternative theories can be set in place as to how to win the games. One of the most famous theories is the Nash equilibrium. A Nash equilibrium is essentially when a player can do no better by deviating from their strategy *as long as* the other players do not deviate from their strategies as well (Kolokoltsov, V.N. & Malafeyev, O.A., 2020). But there are some limitations with the use of Nash equilibrium in a strategic game. The first limitation is that Nash equilibrium can only be used in a strategic game that corresponds to actions that are steady state in nature. The second limitation is that Nash equilibrium does not give an exact solution; it can only give an approximate one. To ensure that this approximate solution is optimal, there are two ways that it can be verified: statistical data sets or comparison analysis with alternative theories. Other such theories that are closely related to game theory include social choice theory, artificial intelligence, geometry, agent systems, Sperner theory, etc.

For practical applications, the specialized discipline of game theory that is preferably used is evolutionary game theory (EGT). There is a stark difference between the traditional game theory and EGT. Traditional game theory believes that humans are completely rational in the choices that they make, whereas EGT believes that information conditions are unimportant, and the rationality of the players involved in the game is limited (Wang et al., 2022), making this game theory variant to be more realistic. It was first applied to analyze the conflicts and cooperations between plants and animals, but throughout time, it was also applied in other areas, including economics.

Adhering to its policy of limited human rationalities, EGT utilizes selective mechanisms. These mechanisms will impose learning and strategy adjustments on different kinds of players, as the rationalities and learning capacities are different for each of them. A famous selective mechanism known as the replicator dynamic equation works by adjusting the strategy in a repetitive game, but with large groups being randomly paired (Wang et al., 2022).

A survey was conducted by (Sandholm, n.d.) on the games' evolution. There are six games/models identified: normal form games (commonly studied models of strategic interaction), static notions of evolutionary stability (utilization of an evolutionarily stable strategy in a normal form state), population games (general models with large populations to observe strategic interactions), revision protocols (individual-level behaviors being used to define population-level processes), deterministic dynamics (using deterministic differential equations in the context of game dynamics), and stochastic dynamics (deterministic and stochastic models in the context of local interactions).

Corporate Purpose

Corporate purpose originated in England, in the 16th to 17th centuries. It is defined in corporate charters, which also define the rules and regulations surrounding such purpose. It then moved to the United States of America, where its functions are limited commercially, so it is usually set in public goods, such as charities (Carey et al., 2021). But with the advent of the industrial revolution, these legal constraints were eroded.

Nowadays, corporate purpose is geared more and more towards confronting societal challenges. This is shown in the "Statement on the Purpose of a Corporation" issued by the Business Roundtable (an organization consisting of chief executive officers of America's leading companies) in August 2019. The statement, in short, discusses value deliverance to customers, investment in employees, fair and ethical interactions with suppliers, supporting communities, and giving long-term value for shareholders (Rock, 2020). This charitable expression, however, is also directly related to the threats presented in society. Most of them are outside the scope of this paper, but there are two that are of utmost importance: climate change and its impact on business and societies and public health. Corporate purpose is then directed on improving such situations, through two ways: strategy and governance.

Governance will not be discussed in this paper as it is not within the scope, but the way of strategy will be discussed due to its significant relationship with game theory. There are two types of strategies: bad strategy and good strategy. Bad strategy is when there is a confusing group of conflicting demands and interests whereas a good strategy is when the energy and resources owned are focused into one or (a few) more objectives that will produce beneficial results (Devinney & Schwalbach, 2021). Focusing on a key area utilizing the available resources is imperative for a modern corporate purpose, and developing the concepts and strategies to achieve this can be conducted using game theory.

METHODOLOGY

The research of this paper focuses on the applications of game theory in economics that can further the corporate purpose. As such, there has been a significant number of papers for the individual topics alone, but not of them combined into a single overarching topic. To rectify this drawback, three phases are utilized for this methodology: keyword search, screening and analysis, and extraction. This method is relevant to my research due to its characteristic of extracting the necessary information for the research and how said information can support each other.

The first phase is to search for papers/publications using important keywords. The initial keywords to start the search are as follows: "game theory", "economic games", "corporate purpose", "game theory in economics", "economics in corporate purpose". Based on the publications received from the searches of these keywords, the subsequent searches for more papers/publications will be more specific in accordance with the areas of research that needed to be investigated. The time period of the papers is 2020 – 2024, with one exception. The exception is if the paper/publication discusses the basic theories involved.

The second phase is the screening and analysis, where the papers and other publications received are inspected firstly by reading the abstract, and if the abstract shows promising information, then the papers will be read thoroughly. While being analyzed, important information will be highlighted. This then brings on to the third phase.

The third phase is the extraction process. After the paper's analysis is completed, the important information will then be organized in folders, in which the important information can be referred to during the investigation and/or when writing the first draft of the paper. These references can also be used when revising the drafts of the paper.

Figure 1 shows the flowchart of the methodology for this paper's research.

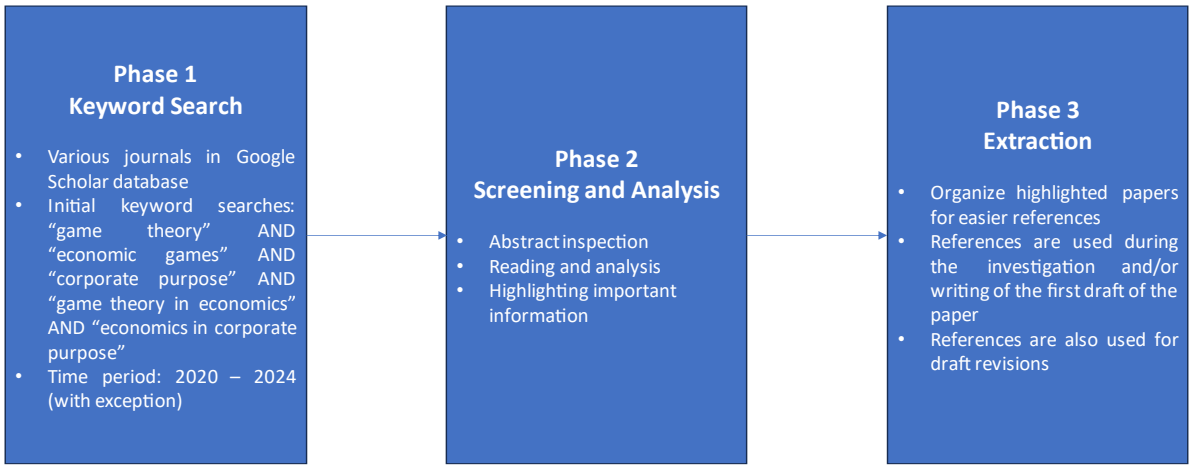

Figure 1: Methodology Flowchart

Source: author's work

APPLICATIONS OF GAME THEORY IN ECONOMICS FOR CORPORATE PURPOSE

With the literature review for both game theory and corporate purpose explored, the applications of game theory will be discussed regarding their role in the future of corporate purpose through the economic lens. Corporate purpose, as of the present time, is mainly directed to solving the societal challenges facing the world, such as climate change. To confront this issue, it is imperative that the areas of economics to be used are ones that are both quantitative and qualitative. In that regard, there are two areas of economic applications: economic games and voting theory. For each of these economics' areas, the game theory approach will be used as its approach.

Economic Games

Economic games may also be seen as experimental games, where players have a finite set of strategies. When all of them are considered and combined, the outcome of each of the players will be determined (Van Dijk & De Dreu, 2020). Economic games tend to have types of theories involved: game theory and interdependence theory. Interdependence theory is qualitative rather than quantitative, transforming a certain situation into one that is perceived to be subjective (Thielmann et al., 2021). Interdependence theory will not be explained in-depth in this paper (it is not within the scope); only game theory will be focused on.

These economic games are deeply affected by the concept of behavioral economics (a field that contributes to behavioral science and policy, where it can be used to "develop interventions that advance policy goals without using mandates or significant changes in economic incentives" (Bryan et al., 2022)). In behavioral economics, game theory is usually applied to either explain the economic actions or the indirect effect of such actions in a certain situation. Behavioral economics consist of several aspects, including anchoring, the contrast effect, the endowment progress effect, hedonic treadmill, loss aversion, reciprocal altruism, and sunk cost fallacy (Toh, 2021).

Table 1 shows an overview of the economic concepts and decision-making in a behavior.

Table 1: Economic Concepts and Decision-Making

Economic concepts	Definition
Return on investment and gratifications	Decisions are made on maximizing utility over time.
Sunk gain/cost and risk/loss aversion	Decisions are made and actions planned to avert losses from sunk cost/gain
Scarcity of resources	Decisions are made and actions taken to conserve resources.
Cost-benefit analysis	Decisions are made by evaluating gains and losses involved in available options.
Emotions and economic decision-making	Decisions are made using prior experience (e.g., emotions and bias) under time-constrained conditions with limited information.

Source: Toh (2021)

These economic concepts can also be used in creating a new kind of working behavior, where collective action coordinated by companies' purpose is conducted as a value creation source, which will act as a starting point of a moral contract between the corporations and the society (Mayer, 2020). This "contract" falls under the umbrella concept of mixed-motive decision-making, in which some examples are N-person public good, contest game (e.g., Tullock's contest (Fallucchi et al., 2021)), ultimate bargaining, and trust game. Figure 2 provides an overview of some economic games (not all are included).

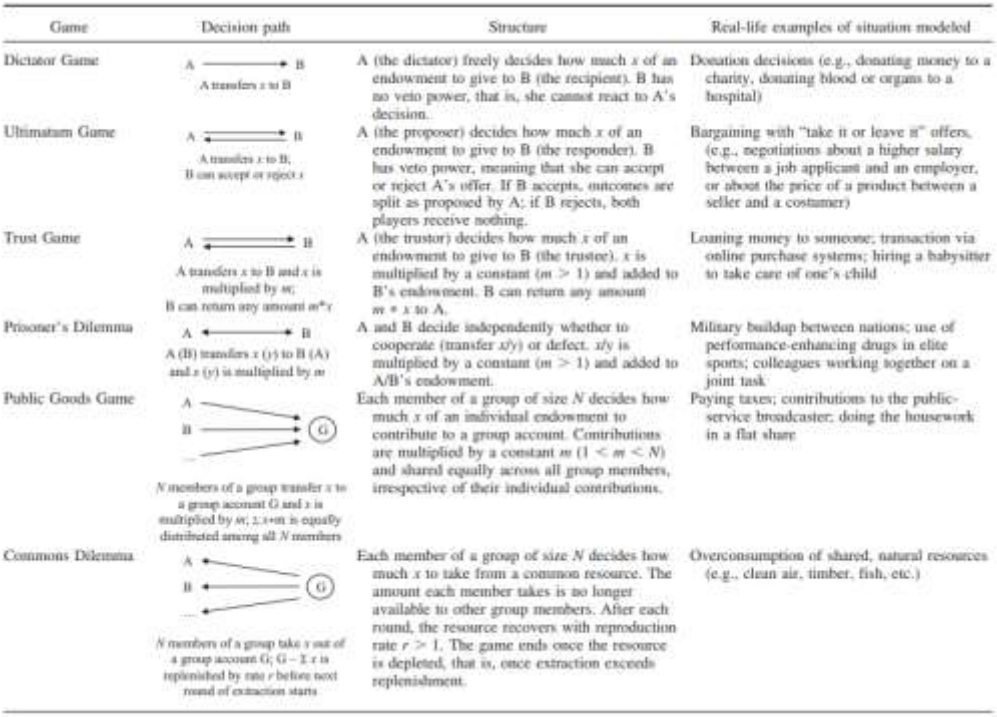

Figure 2: Overview of Economic Games

Source: Thielmann et al. (2021)

Economic games contain components of game theory and interdependence theory; this paper will focus on the ones that are strongly game-theoretic and also for future corporate purpose matters. There are three games that are most relevant: public goods game, ultimatum bargaining game, and trust game.

Public Goods Game

A public goods game is simply about the contribution that needs to be made from each member of a group and then shared equally amongst the members. The following excerpt is taken directly from (Murase & Baek, 2021):

"Let us consider the n-person public goods (PG) game, in which a player may choose either cooperation (c), by contributing a token to a public pool, or defection (d), by refusing it. Let the number of cooperators be denoted as n_c. The n_c tokens in the public pool are multiplied by a factor of ρ, where $1 < \rho < n$, and then equally redistributed to the n players. We assume that the tokens are infinitely divisible. A player's payoff is thus given as

$$\begin{cases} \frac{\rho n_c}{n} \text{ when the player chooses } c. \\ 1 + \frac{\rho n_c}{n} \text{ when the player chooses } d. \end{cases} \quad (1)$$ "

Public goods game has a strong influence on future corporate purpose because it allows mechanisms for corporations to contribute more to public services. Future corporate purpose is now bent on confronting societal challenges that are usually concerned with the public's welfare; therefore, an essential method to do this is for corporations to contribute to the public more and more. Ensuring that corporations can still retain their mercantile activities means that payoffs have to be determined on what to lose and gain; public goods game is a good platform for such an application.

Ultimatum Bargaining Game

In the ultimatum bargaining game, its main component is negotiation. A negotiation is a decision-making process in which two opposing parties attempt to reach an agreement on resolving a specific issue (Schauer et al., 2023). Real-life situations regarding the role of game theory in negotiations are related to political, social, and economic processes. And negotiations cannot be defined merely quantitatively; qualitative measures are also needed when conducting negotiations. The intricacies of negotiations are beyond the scope of this paper, but the qualitative aspects that game theory may consider when negotiating or bargaining can be referred to in the paper by (Brañas-Garza et al., 2023).

Negotiating and bargaining are important for future corporate purposes. As future corporate purposes try to solve societal challenges, making trade-offs is inevitable, and so ensuring that corporations are not in the 'losing' situation, a process of agreement is needed, which is through negotiating. The ultimatum bargaining game can do this because it explains the relationship quite well through the use of quantitative and/or qualitative modelling.

Trust Game

In the trust game, it concerns itself with the interactions between parties involved that consist of 'trust' qualities. Trust, in this context, is the willingness to be dictated by the other players' actions pertaining to the belief that the other player can be trusted (Mehrotra et al., 2021). There are several real-life situations of a trust game. One can be seen in a paper written by Mehrotra et al. (2021), where an investigation is conducted on increased interactions between clients and bankers, and how they influence the trust that clients have on the bankers.

The trust game strongly influences corporate purpose because it involves the public putting their trust on the corporations. Future corporate purpose is geared towards contributing more to the public, and the public needs to trust that the corporations can do this. Modelling this requires an understanding of the trust game, which may help corporations in forming their corporate purpose(s).

Voting Theory

Economic games showcase the possibility of the corporate purpose being developed through such means. Another way is voting theory. Game theory has a strong presence in the area of voting theory, known as strategic voting. In this application, game theory is used to develop models and predictions on behavior based on rational means and social interactions. Additionally (and perhaps most importantly), it allows me the ability to analyze the strategic decisions of voters.

Theorems can be used to explain voting behavior, such as the Gibbard-Satterthwaite (G-S) theorem. The paper by Meir (2020) suggested the use of the G-S theorem to make a statement that there will always be some voters that misreport their voting preferences, for whichever reason (the G-S theorem is used in social choice theory and mechanism design, in which it has been mathematically proven through combinatorial, analytic, and algebraic topology techniques (Baryshnikov & Root, 2024). Two lines of research are produced here, where the first will still be continuing the development of a truthful voting system by being more flexible with some of the assumptions set out, and the other line is on disregarding the truthful votes and instead focusing on the strategic interactions of voters in the voting mechanisms through the applications of game theory and equilibrium analysis (Meir, 2020).

The voting system can also be seen as a simple game as it showcases a single alternative against the status quo. This type of game can also be seen in the form of an influence game, a type of cooperative in which the game is won by having a sufficient number of players participate in a task, in which said players are convinced by a team or coalition of players (Molinero & Riquelme, 2021).

An application of game theory in strategic voting can be seen in proxy voting, which is an important component in corporate governance. It is present in proxy advisory firms, where they give recommendations regarding the voting mechanism as well as conduct research and provide such reports to the shareholders (Malenko et al., 2021). These recommendations are made public, but their research reports are only available for the subscribers. Proxy voting harkens to game theory through setting up a model, which will then be continuously worked on after considering the factors involved in the situation at hand.

Voting theory is then a strong factor in determining a corporate purpose. Corporate purpose is supported by corporate policies, and corporate policies require voting by all of the parties involved. Besides the objectivity of the costs being used, conflicts of interest are also present (an example would be the familial issue, where families' funds are being used to further family interests which may not be considered appropriate for the individual funds' fiduciary duties within a corporation (Michaely et al., 2021)).

REAL-LIFE ANALYSES' EXAMPLES FOR CORPORATE PURPOSE REALIZATIONS

Game Theory Applications to Socio-Environmental Studies, Development Economics, and Sustainability Research (Sadik-Zada et al., 2024)

This study showcases that environmental regulations are also affected by the workings of game theory. Game theory can also act as a methodological framework to analyze climate-related issues. Its analytical capabilities can also balance the sustainable use of natural resources, environmental quality, resilience policy and solutions, and the societal anthropogenic impact (Sadik-Zada et al., 2024). These aspects are what modern corporate purpose faces in dealing with societal challenges, and game theory presents itself as a tool to realize it. Moreover, applications of game theory are also available in the economics of natural resources, such as on the patterns of monopolistic and oligopolistic interactions (Sadik-Zada et al., 2024).

Evolutionary game theory modelling to represent the behavioural dynamics of economic shutdowns and shield immunity in the COVID-19 pandemic (Kabir & Tanimoto, 2020)

A paper by Kabir & Tanimoto (2020) utilizes a game-theoretic model to show how the cost of policy actions in the COVID-19 pandemic affects the effectiveness of said actions. This model will give a deeper insight into how the individual economic costs of the public health measures and infection risk affect the spread of the epidemic.

The modelling for the paper by Kabir & Tanimoto (2020) is quantitative in nature. There are various models that encompass this study, but for this paper, the behavioral model will be explained to showcase the application of game theory in such a situation.

As previously mentioned, in game theory, there are three components: actions, preferences and payoff functions, and the theory of rational choice. There are two payoff functions within this behavioral model, namely compliance payoff and non-compliance payoff (seen in Equations 2 – 3).

$$[-C_Q \cdot Q(t)] \quad (2)$$

$$[-C_i \cdot I^{tot}(t)] \quad (3)$$

where "C_Q is the economic cost of stay-at-home, C_i is the cost of infection, $Q(t)$ is the perceived fraction of quarantined and non-infected individuals over time t and $I^{tot}(t)$ is the total number of infected individuals ($I^{tot}(t) = I^S + I^A(t)$, which is the sum of symptomatic I^S and asymptomatic I^A infected at time t)" (Kabir & Tanimoto, 2020).

CONCLUSION

Through the investigation conducted by this paper, game theory is a concept that can be applied for modern corporate purpose through economic lenses (economic games and voting theory). The economic games provide mechanisms that can be used by corporations to develop strategies on contributing to the public and solving societal challenges. Voting theory also allows corporations to achieve their corporate purpose by creating priorities, including the methods of each priority. Economic games and voting theory are certainly feasible theoretically, and they are also supported by the real-life analyses of the two papers provided in the previous chapter.

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ABOUT THE AUTHORS

Niklas Parlindungan Simorangkir, email: niklas.simorangkir@sgu.ac.id

Niklas Parlindungan Simorangkir obtained his bachelor's degrees from Swiss German University and South Westphalia University of Applied Sciences, both with a major in industrial engineering. He is currently working as a teaching assistant in the industrial engineering department at Swiss German University.

Ivan Kurniawan obtained his bachelor's degrees from Swiss German University and South Westphalia University of Applied Sciences, both with a major in industrial engineering. After finishing his undergraduate studies, he continued his education and attained his master's degrees from University of Indonesia and National Taiwan University of Science and Technology (MT in the former and MBA in the latter). He is currently working as a lecturer in the industrial engineering department at Swiss German University.