Applying game theory application to assess construction site work

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ABSTRACT

Game theory usually analyses decision-making processes in various fields. There are different methods of solving decision related problems. Game theory focuses on problem solution from one player's point of view, while game theory emphasizes its analysis in the interaction among many players. Much of game theory is concerned with finite, discrete games, which have a finite number of players, moves, events, outcomes, etc. Many researchers in different research fields' work applied the game theory in: construction engineering, management area. This research shows that the applications to construction site working to identify the activities that are responsible for the delays in a project and divide the cost among them.

KEYWORDS: Game theory, Decision- making, delays, cost.

I. INTRODUCTION

Decision making is a process involving activities that starts with recognition of a decision problem and ends with recommendation for a decision. The quality of the decision depends on the sequence and quality of the activities that are carried out. Two major approaches for the organization of activities can be distinguished:

a) Alternative-focused. The alternative-focused approach starts with the development of alternative options, proceeds with the specification of values and criteria and then ends with the evaluation and recommendation of an option.

b) Value-focused. The value-focused approach applied to decision problems, can be much more effective. However, if the decision problem starts with a choice of options, the alternative-focused approach seems more relevant. For the solution of alternative-focused problems different methods are known. Decision theory usually analyses decision-making processes from one player's point of view, while game theory emphasizes its analysis in the interaction among many players. Because game theory focuses on situations in which interactions and interdependence play a role, it can be seen as an extension of decision theory.

II. GAME THEORY

Game theory was first developed in the 1950s by scientists such as John Nash and Johnvan Neumann. Game theory is the study of mathematical modelling techniques, used across many fields where some degree of strategy is needed. It can be used in construction as an

efficient framework for decision-making and dispute resolution.

SUCCESS CRITERIA OF A CONSTRUCTION SITE SELECTION:

Success of a construction site selection is an abstract concept, and determining whether a project is a success or a failure is highly. Actually, owners, designers, architects, consultants, as well as contractors and each project team or individual has a definition of selection success. Success of construction site selection should be viewed from different perspectives. However, the client may have different views on own selection of a construction site objectives and criteria for measuring success. Moreover, even the same person's perception of success changes from project to project.

Construction project scheduling:

When it comes to construction management, maintaining a construction project schedule is one of the most important parts of a project. A well-planned schedule helps minimize downtime and ensures that all parts of the project are completed on-time and on-budget.

III. SCOPE AND OBJECTIVE

The objective of this paper is to study the different literatures about game theory applications and identify the suitable site selection, time and concreting work.

The scope of paper includes,

- ❖ To study the Game theory, methodology and its applications
- ❖ To identify the defeat site by using Game theory, time to completion of construction work and concreting work can be completed by machine or manual can be identified.

IV. LITERATURE REVIEW

The main purpose of literature survey is given an idea about the work conducted world over in the field of the project work. Several studies have been conducted in the area of the project selection, project scheduling and concreting. The following are some of the studies which describe the application of Game theory. Literature pertaining to occupational diseases and their prevailing has been presented here.

1)"Game theory based multi criteria decision making problem under uncertainty: a case study on Indian tea industry" Animesh Debnath, Abhirup Bandyopadhyay, Jagannath Roy and Samarjit Kar (2017)

In this paper the imprecision on the impact of the strategies are modelled as fuzzy numbers whereas the market volatility is taken into account as white noise. Hence the MCDM problem for Indian Tea Industry is modelled as a hybrid evolutionary game. The probabilities of strategies are obtained by solving hybrid evolutionary game and could be represented as a Dempster-Shafer belief structure facilitate the Decision Makers to choose the strategies (decisions) under different type of uncertainty.

2.Game theory based negotiation method for dispute resolution of construction projects",Jorde, T.M (2013)

Construction projects which mainly consist of project-based activities, have complex and dynamic nature due to involvement of multi-parties, different disciplines and tasks in it. Participants of professionals with different level of knowledge, experiences, and expectations in the multidisciplinary structure of the project may cause disputes during complex working process.

3. "Game theory- final project, the price of anarchy in network creation",Itzik malkiel (2011)

The game is very simple, there are N companies, we can call them players (later vertices), each player want to be connected to the whole world - all the other players. every player is selfish-there is no way that two (or more) players cooperate. building a connection to another players has a predefined cost, α. the player who build the connection is the one who pay for it. A connection, or as we call it in the rest of the paper, an edge can be created unilaterally, there is no need of an agreement or any help from the target player.

4."A simple game-theoretic framework for studying r&d expenditure r&d cooperation",Ulrich Kaiser (2001)

This paper derives a three stage Cournot duopoly game for research collaboration, research expenditures and product market competition. The amount of knowledge firms can absorb is made dependent on their own research efforts, e.g. firms' absorptive capacity is treated as an endogenous variable. It is shown that cooperating firms invest more in R&D than non–cooperating firms if spillovers are sufficiently large. The degree of market competition is a key determinant of the

effects of research cooperation on research efforts, implying that existing models which assume perfect competition might be too restrictive.

5. "The principal-agent theory and the role of project managers in construction: guidelines for future research",Anita cerich (2009)

This paper will present recent research into the relationship between the project owner's and contractor's project managers along the lines of the principal-agent theory. The Delphi method was employed for further exploration of the issues involved. It has been shown that the two managers play key roles in the construction phase even though they are both agents not related by contracts. The paper addresses the opportunities for further research in this area, which offers a challenge to the principal-agent theory in the field of construction. They focus on communication risks caused by asymmetric information, which are of central importance to the principal-agent theory.

6."Applying game theory and real options to competitiveness in construction businesses", Martha Garcia-Saenz (2004)

Net Present Value (NPV) has been the tool used to decide about the future of many projects for a long time. Refinements in calculations are necessary on a daily basis because of global business competition. Two theories: a Real Options Valuation, imported from the stock market, and Game Theory, imported from the industrial organization, can analyze and explain the competitive reaction to the strategic investment. This paper shows the advantages and disadvantages in decision making when NPV value is applied, and when the Real Option valuation and game theory are used to help understand a competitive environment.

7. "Game theory for security: a real world-challenge problem for multi agent systems and beyond", MilindTambe,BoAn (2001)

Security is a critical concern around the world that arises in protecting our ports, airports, transportation or other critical national infrastructure from adversaries, in protecting our wildlife and forests from poachers and smugglers, and in curtailing the illegal flow of weapons, drugs and money. Our goal is not only to introduce the problem, but also to provide exemplars of initial successes of deployed systems in this challenge problem areas.

8. "An application of computational game theory for the security of the ports of the united states",EricShieh,BoAn,RongYang,MilindTamb

(2012)

This paper presents PROTECT, a game theoretic system deployed by the United States Coast Guard (USCG) in the port of Boston for scheduling their patrols. The first real-world deployment of the QR model. Second, to improve PROTECT efficiency. This paper provides real world data: (i)comparison of human-generated vs PROTECT security schedules, and (ii) results from an Adversarial Perspective Team's (human mock attackers) analysis.

9."Game theory based approach for energy routing in a smart grid network", JuneS.Hong,MihuiKim (2015)

Small power plants and buildings with renewable power generation capability have recently been added to traditional central power plants. To evaluate the effect of the proposed decision strategies, we simulated our mechanism, and the result proved that our mechanism yields results pursued by each strategy. Our proposed strategies will contribute to spreading a smart micro grid for enhancing the utilization of micro grids.

10."Game theory and water resources",Kaveh Madani (2009)Conflicts also arise from social and political aspects of the design, operation and management of water projects. This study review applicability of game theory to water resources management and conflict resolution through a series of non-cooperative water resource game. The paper illustrates the dynamic structure of water resources problems and the importance of considering the game's evolution path while studying such problems. Game theory can predict if the optimal resolution are reachable and explain the decision makers behaviour under specific conditions.

11."Anapplication of game theory: cost allocation", Jean Lemaire(2011)

Cost allocation is one of the toughest problems of accounting. It occurs whenever cooperation between several departments of a company produces economies of scale: the benefits of cooperation have to be allocated to the participating departments. Next it is proved that a cost allocation problem is identical to the determination of the value of a cooperative game

with transferable utilities, and 4 new accounting methods that originate from game theory are proposed.

12."Exploring game theory as a tool for mapping strategic interactions in common pool resource scenarios",Vanessa Perez (2001)

The objective of this paper is to introduce game theory as an analytical tool for understanding and mapping strategic interactions amongst individuals and institutions in the management of common pool resources. This section intends to contribute towards this broad question by introducing game theory as a useful analytical tool that helps us understand how decision-making processes are made in the management of common pool resources. The review explains how strategic decision making processes can be mapped in a game theoretic fashion so that variables that are key for arriving at socially optimal solutions can be identified.

13. "Analysis of the evolution game of construction and demolition waste recycling behaviour based on prospect theory under environmental regulation",Hong Shen, Ying Peng and Chunxiang Guo(2018)

With the development of the construction industry, increasing concern over construction and demolition waste (CDW) has initiated a wave of environmental regulation by the government in order to reduce the environmental impact and ensure sustainable development. This paper aims to study the behavioral decision-making of stakeholders in CDW recycling under environmental regulation. The results indicate that, only when the perceived benefits of one or both stakeholders for participation under the environmental regulation exceed those for non-participation, can the CDW recycling system eventually evolve to a stable state in which both stakeholders choose to participate.

14."Game-theoretic approach for non-cooperative planning",Jaume Jordan and Eva Onaindia (2015)

In this paper, we present a game-theoretic approach to non-cooperative planning that helps predict before execution what plan schedules agents will adopt so that the set of strategies so fall agents constitute a Nash equilibrium. We perform some experiments and discuss the solutions obtained with our game-theoretical approach,

analyzing how the conflicts between the plans determine the strategic behavior of the agents.

15."The usefulness of game theory as a method for policy evaluation", Leon M. Hermans, Scott W. Cunningham and Jill H. Slinger (2012)

This paper explores the usefulness of game theory as a method for evaluations in a networked society, based on an evaluation of coastal policy implementation in the Netherlands. This paper is not a call for the application of game theory everywhere. However, it is a call for a conscious choice of analytical lenses and theoretical concepts. When interactions among multiple actors are an imported part of the policy or program that is to be evaluated, neglecting lenses that help explain such interactions would be a bad choice.

16."Game theory based construction effective topology in wireless sensor networks",M.J.Abbasi, Muhammad Shafie Bin Abd Latiff, HassanChizari and N.Fisal (2014)

In this paper, we present a minimum spanning tree-(MST)based algorithm, called non-cooperative minimum spanning tree (NMST), for topology control in wireless multi-hop networks. Wireless sensor networks (WSNs) are composed of smart nodes, that is, tiny devices equipped with communication component, data computation, and sensing capability.

17 "A game theory approach for multiple design tasks schedule",Guohai Zhang, Guanghui Zhouand Xuequn Su (2010)

This paper presents a new kind of scheduling solution for multiple design tasks in networked developing environments. In this paper, we make several contributions to the research literature with respect to multiple design tasks scheduling based on game theory in the networked manufacturing environment. We study the scheduling model for both design tasks and design sites based on game theory. From the computational results we concluded that the presented tasks scheduling game performed well.

18."Modeling collaboration formation with a game theory approach",Jbid Arsenyan, Gülçin Büyüközkan, Orhan Feyzioğlu (2011)

Game Theory attempts to model and analyse strategic situations, including various types of games suitable for different settings. A

mathematical model is proposed for Collaborative Product Development and a Nash Bargaining solution is proposed in a numerical analysis.

19. "The principal-agent theory and the role of project managers in construction: guidelines for future research", Anita Ceric (2007)

The principal-agent theory has been successfully applied to the research of management of construction projects. An exploratory survey was used at the first stage of research. After the exploratory survey, the Delphi method was employed for further exploration of the issues involved. They focus on communication risks caused by asymmetric information, which are of central importance to the principal-agent theory.

20. "An analysis using game theory on the investment incentive of ppp (public private partnership) project" Shiau-Jing Hoab and Sheng-Lung Linac and Hui-Ping Tsernga (2017)

The purpose of the study is to assist the government and the tenders in judging whether the different types of PPP royalty reserve price has the incentive for investment.

V. CONCLUSION

Game theory provides a way to think about the collective decision-making processes. In first phase carried above, it is concluded that application of game theory is used for solving construction site work. In the second phase, the mathematical model (zero sum theory) used to solve the construction site work site. Work type and range will be given to choose the construction site. The time required for completion of projects has calculated and delay sources are found and solved by game theory.

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