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Game Theory as a Tool of Project Management

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Abstract

The primary purpose of the article is defining game theory as one of the creative methods of successful managing of communication risks at educational projects of different types and sizes, with respect to economic and management specifics of post-crisis Czech Republic. We will use critical analysis of literature and information sources, qualitative analysis by structured interviews and by questionnaires, the analysis of available and validated results within the research on features of project managers and their competencies, which are available and described in more detail within the annual report of the KEGA project No. 003/DTI-4/2014. Finally we use synthesis of the above mentioned findings and facts to answer the research question and to confirm the Bilton and Cumming's hypothesis. From the examples mentioned in presented paper will be clear, that game theory has its place in project management.

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Introduction

Without realising it, we experience many conflicts in our every-day lives. It does not only need to be a married couple argument or a political crisis. It can also be very common incidents, like shopping in a local groceries store or playing cards, as well as specialised events, like explaining evolution biology or trading on stock markets. All these conflicts are connected by game theory, a mathematic field of expertise which can be used by the participants to their benefit.

The primary purpose of the article is to try to identify such aspects of game theory, which can fill a gap of the game theory application in project management, because an idea to analyse game theory as a tool of project

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management is relatively new and relevant, and there is no many research and application works trying to fill this gap.

The **research question** is: “*Is it possible to consider the game theory as one of the creative methods of successful managing of communication risks at educational projects of different types and sizes, with respect to economic and management specifics of post-crisis Czech Republic?*”

To fulfil the high cited purpose and to answer the research question we will use these methods:

- Critical analysis of literature and information sources.
- The analysis of available and validated results within the research on features of project managers and their competencies, which are available and described in more detail within the annual report of the KEGA project No. 003/DTI-4/2014 (qualitative analysis by structured interviews and quantitative analysis by questionnaires sent to project managers about application of specific approaches and methods to risk management and communication in educational projects).
- Application of game theory in current economic situation in the Czech Republic, with the aim to find a specific example of application of the prisoner’s dilemma and its correlation with a specific situation and subsequent transformation of the findings into its use by project managers for elimination of communication risks at educational projects.
- Synthesis of the above mentioned findings and facts to confirm the Bilton and Cumming’s hypothesis (2014) that **the use of game theory makes it possible to understand the needs and interests of the involved persons in a better way and to finalize the project successfully.**

From the examples mentioned in presented paper will be clear, that game theory has its place in project management and is for it quite utilizable. Besides, a well-defined communication strategy built on the principles of game theory may reduce or eliminate the probability of risk (problem) creation.

The theoretical contribution of presented paper consist in defining game theory, describing the specifics of game theory in post-crisis Czech Republic and formulating of a game theory application in project management.

The practical implication of found results is:

- confirmation of Bilton and Cumming’s hypothesis published in (Bilton, Cummins, 2014) stating that using game theory helps understand the needs and interests of the involved participants in the project and eliminate eventual communication risks, hindering the successful completion of the project,
- identifying of game theory aspects applicable in successful managing of communication risks at educational projects.

1. The Game Theory

The game theory as a mathematical field was founded by Hungarian mathematician John von Neumann, the author of the article named *On Game Theory* (1928), in which he proved basic sentences of matrix games. Together with Oskar Morgenstern they published the book of *Game Theory and Economic Behavior* in 1944 (Hykšová, 2004). Game theory was able to find most applications in economy. Many mathematicians were awarded the Nobel Prize for Economy for research on this field.

The game theory is one of less known areas of exact mathematics, mingling with humanist sciences, with focus on the psychological aspect of the individual. Therefore, it is not only a useful tool in the hands of scientists, but also on fields that are more attractive to the lay public. However, it would be wrong to think that game theory is able to find a way to win at every conflict. When you are a part of the game and decide on the next steps, you need to take the choice of the others into account. However, when you think about their choices, it is necessary to count with that that they are thinking the same way. In the moment of coming up with own strategy reflecting the ideas of the other “players”, you need to know they are doing the same. And this goes on and on, as stated by Godin (2012). Simply said, according to Sawyer (2012), “*the content of game theory is analysis of a very wide spectrum of decision influencing situations*”.

The “prisoner’s dilemma” is a classic example of game theory (Godin, 2012). We rank it to the non-zero-sum games. The dominant strategy is non-cooperation, meaning that no matter what strategy the other player chooses, non-cooperation always results in better result for the player than cooperation (FAJRONT©2005). Below, we

describe an example of application of game theory, used to analyse a price war situation.

In economic recession, we can observe a specific competition war between two strong companies, creating a duopoly. These companies usually operate on a part of the market, being a monopoly there. During a crisis, these parts of market usually merge, creating an all-state market with for the product. The question is, whether it is better for the companies to accept the new power distribution or to try push the competition out and keep the previous monopoly position.

The answer? AC^0 is the value of average costs of one company, AC' being the value of average costs of two companies. If AC' is higher than AC^0 , the total costs would be significantly lower if the market of the product was monopolistic. Therefore, from the point of view of the companies, a fusion might seem to be a very attractive option. However, such a step would probably have to be investigated by the Anti-Monopoly Office. And let us not forget that many companies do not co-operate because of strong rivalry.

Another option is creation of competitive prices. A price war starts with declaration of one of the producers about significant price decrease with the aim to push out the competitor of the market. It is obvious that thanks to lower prices, the profits will not be maximised. However, the producer attacking first will acquire a significant portion of the competitor's customers. The competitor has no other choice but decrease his prices, as well. But the price cannot drop under the cost limit, although the producer may sell his products with no margin.

During price war, both companies lose money. And at the end, one of them - usually the smaller, younger, less known one or the one with less significant backing - leaves the market. The company which stays, reclaims its monopolistic position, but with high losses the company might not recover from. The company which declared the price war counts with restoring the prices and heal its profit wounds, as soon as it reclaims the monopolistic position. In general, the longer the war takes, the higher the losses are and the higher the long-term profit must be. If the market as a whole develops well and healthy, it is usually better for the companies on it not to provoke a price war. It is clear that nobody wins in a price war – one of the companies has to leave the market and the other one is weakened and its war expenses have to be paid by the previously satisfied customers.

2. The Game Theory and its application in post-crisis Czech Republic

An interesting and by media often shown example of price war is the long-term fight between the bus transport companies of Asiana, owned by Alexej Litvin, and Student Agency, owned by Radim Jančura, in the Czech Republic. Their conflict started in 2007 at the line from Praha to Karlovy Vary. Student Agency reduced the ticket price to 120 CZK, some of the tickets even cost only 50 CZK. Asiana was not able to decrease the prices under 140 CZK, therefore, it was forced to leave the line on August 2007.

On 01.10.2007, the price war shifted to the most lucrative line in the Czech Republic - from Brno to Praha. Whereas Student Agency was operating thirty buses per day from and to these cities, Asiana started with only eight. After the introduction of a system of discounts and higher service, Asiana lost this battle two months after. The next battle took place already in 2009.

After Student Agency introduced some tickets for a symbolic price of 1 CZK, Asiana was not able to cover the losses and left the market to the benefit of Radim Jančura. The CEO of Student Agency and former entrepreneur of the year has now only less significant competition of regional bus transport operators, he frequently co-operates with. And he has to deal with some lawsuits with the owner of Asiana.

This example seems to deny what we just established in the beginning of this chapter – the victorious Student Agency walked out of the fight stronger than before and Asiana did not terminate its business activities. The reason of this is a less known fact that bus transport is only less significant part of the business activities of both of these competitors (to be exact, only 23%). The bus transport conflict only became an arena and relatively cheap form of marketing, funded by profits from very lucrative flight tickets and accommodation sale and other additional services. Despite the expensive war price and the impact of economic crisis, both these companies might have reached a y/y profit growth this year.

As indicated, a price war is almost always unfavourable for all participants. However, it is not to be avoided time to time. We have established that the participant who provokes it, anticipates higher market share for the price of lower profit. Thanks to retaliatory actions of the competitors, there is often significant profit drop in the whole

segment. Therefore, let us find a strategy that would bring the participant profit or at least minimise his losses. When does it make sense to conduct price war?

- If the company is economically strong enough. Nokia, the Finnish producer of mobile phones, with the profit of 9.8 billion EUR in Q3 2009 (source: Reuters), will certainly have bigger fighting chance than the local competitor of Emgeton.
- If the company operates a bigger market. A producer with customers in several countries can pay his war losses by higher prices of exported goods.
- The price war can be used for marketing purposes. The participants will suffer profit losses, but can rely on unpaid advertising in the media. In this way, they demonstrate their power and economic activities to the competitor.
- The company may reach profit, if it offers significantly better services than the competitor. What counts is the quality of the service, warranty period and fast delivery.
- The monopolistic position can be reached, if the competitor is a very unstable company with low profits. Such a counterpart will not survive more losses and will be forced to leave the market.

What to do when price decrease is not an option? The research of Hong Kong scientists Chun-Hung Chia, Tsan-Ming Choia and Duan Lia (Zyga, 2009) is not very known in the Czech Republic, but it comes with an unusual solution called *reverse price war*. It works with the premises that by decreasing the prices, the more successful competitor claims more market share. However, part of the customers stays with the other company. The reasons are similar as in our recommendations – better service, tradition of the brand or higher quality. The more customers switch to the competitor, the worse for him. His profits will keep dropping, and losses adding up. Therefore, the more reasonable strategy for the attacked competitor is not lowering the prices (and provoke a vicious circle of discounts leading to a bankruptcy), but slightly increasing them. By this solution, the company compensates the losses it suffered from loss of customers and after some time, can profit more than the cheaper competitor.

Although it is hard to find successful application of such strategy, we can find indications of *reverse price war* also on the domestic market. Let us mention the behaviour of Český Telecom (today Telefonica O2), which reacted to the competition of mobile phone operators by increasing its services in 2006.

It is natural that most managers will be sceptical towards such a strategy. However, it can be anticipated that it might be very successful thanks to its unusualness, especially when fighting a less experienced competitor. The scientists also suggested a less radical strategy of *no-action strategy*. Applying it, the attacked company stays absolutely passive. By not reacting to the competitor's price attacks, the company will suffer losses, but will not have to face the above mentioned results of an active price war.

3. As it applies to project management

Game theory was first developed to predict situations where one player does better at another's expense. „*Today, game theory has expanded to treat a wide range of situations and interactions, including human as well as non-human players (computers, for example). As such, game theory is an excellent tool for project management*“ (BRIGHTTHUBPM©2012).

Project managers manage the links between related projects, decide on resource priorities and report progress of the project to the appropriate people. This authority, responsibility and accountability is an important and demanding role. This mostly involves dealing with people; negotiating with them and arriving at a solution that keeps the project moving forward. It is in these negotiations that game theory can be an essential tool for project management, because **game theory is a mathematical method for analyzing calculated circumstances, such as in games, where a person's success is based upon the choices of others**. More formally, it is “*the study of mathematical models of conflict and cooperation between intelligent rational decision-makers.*” (WIKIPEDIA©2015)

To bring it into perspective for a project professional, Game Theory is about establishing and planning your project to be a ‘game’ that allows you to maximize gains and minimize losses, but it is based on applying decision making not only in terms of your own knowledge and strategies but more importantly also those of others in the

‘game’ or project in order to ensure success. Applying this concept to every stakeholder in your project will help to see things in a radically new way, as it is described in (Toppenberg, 2011).

Project managers manage many different areas including the links between related projects; we decide on resource priorities and report progress of the project to the appropriate people. The authority, responsibility and accountability in this role make for an important and demanding role. As we know the activities we perform mostly involves dealing with people; negotiating with them and arriving at a solution that keeps the project moving forward. **It is in these negotiations that game theory can be an essential tool for project management.**

While playing the games can teach us much about how players interact in a specific setting, applying those rules and observations in real-life examples can be even more rewarding. For project professionals this can be helpful in many ways, says Bloch (2015).

There is no many research and application works trying to describe the game theory application in project management, especially its application to avoid communication risks at educational projects of different types and sizes, with respect to economic and management specifics of post-crisis Czech Republic.

Some details we can read mostly in internet sources, like (BRIGHTTHUBPM©2012) and (Hatfield, 2015) or (Toppenberg, 2011). For more information on Game Theory and to dig deeper into the application of game theory in business, “*The Art of Strategy*” by Avinash Dixit and Barry Nalebuf is an excellent start. Very interesting paper by Gil Junqueira is retrieved from <http://www.projectsart.co.uk/cutting-edge-project-management-what-game-theory-and-poker-can-teach-us.php>. With the specifics of game theory application in solving the construction projects conflicts deals the paper published on the 6th International Strategic Management Conference in 2012 in Spain, that is retrieved from http://www.academia.edu/1857937/Application_of_Game_Theory_Approach_in_Solving_the_Construction_Project_Conflicts.

Conclusion

As seen above, it is possible to use game theory as a project management framework. On a day-to-day basis, project managers need to solve problems to keep projects on track and ensure that all those involved are motivated. As mentioned, this often involves negotiation. Here are some things that project managers need to think about in any negotiation process:

- What is the issue you are trying to solve?
- Who are the players?
- Which players will have an impact on the success of your decision?

To use game theory for project management, draw a list of players keeping the above questions in mind. For each player then answer the following questions:

- Are there any time issues? Who is in a hurry and who can afford to delay? Will players make decisions independently or wait for other players make decisions?
- What players can make a commitment to help you and the project? Prioritize these players.
- Have you got an angle to negotiate? Mutual gain is possible if players have different preferences, priorities or capacities. Where mutual gain is likely, a negotiated outcome is possible.
- What are the players’ goals? Put yourself in each player’s shoes and assume their goals and actions will be rational from their point of view, even though you may not agree.

It is helpful to put these questions and players in a simple table to clearly show different choices, or tree diagrams that follow steps of an interaction. By looking at the possible outcomes and working backward, project managers can choose the strategy most likely to give the best results.

Using game theory in the above manner helps you understand how people act and interact – an essential skill needed to successfully manage projects and to avoid the communication risks in educational project.

The principles of game theory and the games that emerge as a result of the principles are very interesting and can help us think of different ways of interacting with the people around us, especially those in professional settings. The fact that the principles centers around playing games helps us to tease out the most fundamental actions and behaviors in a human being, since playing games is what comes natural to us. The fact is that we play games every

day whether we know it's a game or not. With this in mind we can explore how we might utilize this information as a framework:

- As negotiation and communication are primary tasks of project managers, let's root the framework in this, and since game theory is as much about own our strategy as well as knowing the strategy of those around us.
- As we prepare for and approach a situation of negotiation consider the following questions:
 - What does the person stand to gain or lose? Are they under a time constraint?
 - If cooperative, would it be in our best interest to share details prior to the negotiation, and is it to the mutual benefit to determine if we will negotiate simultaneous or sequential.
 - What are the mutual and achievable goals for cooperative, and for non-cooperative, what are the goals of the person we are negotiating with?
 - Is the person able to make commitments on behalf of only themselves or others?
 - Evaluating the other persons strategies, what are some potential risk areas of our strategy or approach? How can they use what they know about us to their advantage?

Just we would act as we play a game of poker with our friends, we must now decide how we approach any stakeholder on our project, decide for each person as we engage them what their strategy is and what they desire to achieve.

The game theory application goes through the teamwork as well. As project managers we thrive on working as parts of cross-functional and diverse teams, undertaking planning and management responsibilities towards and stated set of success criteria. While much of what we spend our time on is following a prescribed set of tasks, managing our teams through obstacles and removing road-blocks in the way, the ultimate success of our efforts is how well we know our teams and our resources at hand.

From the above mentioned examples, it is clear that game theory has its place in project management and is for it quite utilizable. Besides, a well-defined communication strategy built on the principles of game theory may reduce or eliminate the probability of risk (problem) creation. Here are a few areas that applying the principles and learning of game theory can be beneficial:

- Contract negotiations with vendors.
- Resource negotiations with stakeholders and resource managers.
- Task Assignments.
- Team management.

The research question was answered. The Bilton and Cumming's hypothesis was confirmed.

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