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Using Game Theory to Determine the Optimal Strategy for the Transportation Sector in Iraq

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Abstract

In this paper, game theory was used and applied to the transport sector in Iraq, as this sector includes two axes, the public transport axis and the second axis the private transport axis, as each of these axes includes several types of transport, namely (sea transport, air transport, land transport, transport by rail, port transport) and the travel and tourism sector, as public transport lacks this sector, as the competitive advantage matrix for the transport sector was formed and after applying the MinMax-MaxMin principle to the matrix in all its stages, it was found that there was an equilibrium point except for the last stage where the equilibrium point was not available Therefore, the use of the linear programming method was used to solve the matrix, because the matrix was of a degree (5 * 5), so the result of the game was reached that the investment of public transport in the field of railways would achieve the highest possible profit and private transport in the field of ports to achieve the least possible loss.

Keywords: Public and private transport sector, Game theory, Max-Min, Linear

Programming

1. Introduction

Game theory is concerned with the mathematical analysis of conflict and competition situations and situations where conflict or gain prevails at the expense of the opposing party. In the development of a scientific analysis of strategic games was the scientist (Newman) and that was in 1928, but he did not address at that time the concepts of economic, administrative and military applications in these games, but focused most of his attention on expressing games with algorithms and theories that build on the mathematical and logical basis of the rules and laws of each game. In 1944, the two scientists Newman and Morgenstern made the first attempt to publish a book in this context (Game Theory in Economic Behavior), and this book was the first introduction to strategic game theories and in the economic and administrative fields. The concept of strategic games theory is summarized in the presence of a specific competitive game or game that has a specific end goal that both players strive for. What is scored by one of the competitors is the decisive factor for winning the game, and sometimes the one who wins the game is the player with the least time. In general, the game is measured by the strategies followed by one of the players and the extent of their impact on the other party, such as a chess game or a commercial, military and strategic game...etc. Here, the players must take the necessary decisions to move through the strategies, but there are cases of another kind represented in the presence of a conflict of interest between several competing parties for a specific return or benefit. To show what is the field that invests in both public and private transport sectors, which in turn achieves the highest possible profit in return for the least possible loss, so it needs a mathematical and analytical method to solve this competition between the two sectors. The paper aims to determine which of the public or private sectors maximizes the added value and capital formation in the transport activity through the results that will be reached and the conclusions that the paper will produce and build a strategy to develop the existing productive transportation institutions in the Iraqi economy, based on a solid economic basis.

2. The concept of game theory:

It was defined as a competition between two or more parties according to a predetermined rule, as each party or competitor has a set of strategies that help it obtain better results (Christian Schmidt, 2002:16).

Perhaps the best definition of it from the economic side is: analyzing the rational behavior of economic units, whether they are individuals or business establishments, in light of the adoption of certain strategies, by adopting the best of these strategies for the unit, taking into account the potential strategies of the opponents (Al-Shamrti, 2010: 378). This definition took into account the three pillars on which the game is based, namely, rational behavior, which is one of the basic assumptions of game theory, competition, which is the essence of the game, and strategies, which are the game tool through which logical or mathematical calculations are made.

The researcher embraces the procedural definition of game theory based on the previous definitions: it is a mathematical examination of conflict of interest situations with the goal of identifying the best feasible possibilities for making the best decision.

3. Elements of the game: (Bashiwa, 2010: 594)

I. **Number of competitors: If the number of competitors is (2), then the game is called a two player game, but if the number of players is more than (2), i.e. (N≥3) then the game is called a game (N) of players (N- player game).**

II. **Sum of gains and losses: If the sum of gains and losses between players (competitors) is zero, then the game is called a Zero-Sum Game, otherwise it is called a (Non-Zero sum game).**

III. **Number of Strategies (or plans) included in a game: Each player's strategy in game theory is a plan that shows the behaviour of that player against each possible behaviour of the other player. It is possible for each player to have two strategies (there are only two players) and this state of the game is denoted by the symbol (2 * 2), but if there are two players, one of whom has two strategies and the other has more than two strategies, the game is denoted in this case either (M * 2) or (2*N). If the number of strategies for the first player is (M) and the number of strategies for the second player is (N), then the game is said to have strategies (M*N) and if (N, M) is a finite number, the game is said to be finished, and if (N, M) is an infinite number and the game is said to be infinite.**

IV. **Pay off matrix: In a two-player game, payouts are arranged in the form of a matrix called the payoff matrix or the game matrix. The rows of this matrix represent the strategies of one of the players, which we will call the first player, and the columns (in the same time) strategies for the other player we will call the second player, and the matrix elements are the payoff of one of the players, the element in row (i) and column (j) which we denote $(a_{ij})$is the payoff when the first player uses strategy i and the second player uses strategy j, if $(a_{ij})$is positive, then the first player gains $(a_{ij})$from the second player, but if it is negative, the first player will lose (a_{ij})paying it to the second player, and the matrix (the payment matrix and its elements) is as follows:**

	B						
		1	2	3	j	...	n
A	1	a_{11}	a_{12}	a_{13}	a_{1j}	...	a_{1n}
	2	a_{21}	a_{22}	a_{23}	a_{2j}	...	a_{2n}
	3	a_{31}	a_{32}	a_{33}	a_{3j}	...	a_{3n}
	I	a_{i1}	a_{i2}	a_{i3}	a_{ij}	...	a_{in}
	⋮	⋮	⋮	⋮	⋮	...	⋮
	M	a_{m1}	a_{m2}	a_{m3}	a_{mj}	...	a_{mn}

4. The use of game theory in bargaining analysis

The idea of bargaining is a way to solve problems that represent cooperative games, and John Nash was a pioneer in addressing this type of games, by finding a way to maximize the benefit for both players, and the method developed by Nash was considered the best solution in cooperative games, and it was known later by (the Nash Bargaining Solution), which depended on the relative strength of bargaining between players (Thomas, 2000:3)

It is noted that the idea of bargaining is the most important achievement among all the developments that game theory has gone through, because most of the contributions that developed the theory were represented in the mathematical aspect and technical methods of solving, while the idea of bargaining is an intellectual addition not a technical addition to the theory, and the idea of bargaining is of special importance. In economics, because economics is constantly searching for balances in the sense of maximizing utility, here comes the role of the idea of bargaining in game theory, as it provides economics with a mechanism through which competitors can exit after bargaining and the benefit to both of them has been maximized.

5. Games types:

i. Two-Person Zero Sum game:

The binary games style is one of the most widespread, and includes many familiar games such as chess, checkers, or any game based on two teams, the binary games have been extensively analyzed in game theories, and the real difficulty in extending the results reached to include games with n players lies the expectation of possible interactions between different players, because in binary games all possible choices and moves as well as outcomes are predictable. But when there are three or more players, complex random possibilities of choices and opportunities arise under the circumstances to form cooperation, or Collision, or collision between players.

In game theory and economic theory, a zero sum situation is one in which one participant's profit or loss is exactly equal to the sum of the other participants' losses or gains. When the entire gains of the players are totaled up and the losses are removed, the result is zero. Because the sum of all players' advantages and losses equals the same amount of money, the zero sum can also be thought of as a fixed sum (or interest). (Hamdan, 2010: 344)

ii. Two-Person Constant Sum game:

In the beginning, all the decision problems were formulated from the point of view of one party, and this party was not necessarily an individual, but could be a company or an institution, and it is certain that the results of his decision do not depend on these decisions alone, usually another agency works, which can be called an opportunity in the sense of choosing between countries. The world resulting from events in which the actor has no control, for example (roulette wheel, price of a commodity, and the like).

In the following, the analysis of these games will be the same as zero-sum games, since subtracting the given constant from the profit of the player in the column makes it a zero-sum game, in fact, we will initially assume that the preferences of the second party are completely incompatible with the preferences of the first party, i.e. what is the best for the latter is the worst for the first and vice versa, so the sum of the gains in each outcome is zero, i.e. what one player wins, the other loses. Since the rewards will usually be given on an interval scale, where the zero point and the unit can be chosen at random, we can generalize this condition and assure that the sum of the winnings in each outcome is constant. (Proper shift of the zero point in the instrument can replace this constant with zero). Competitors will now be called players and the decision state will be called a two-person fixed amount (or lump sum).

As for the strategy, it is the plan (decision) taken by a certain party according to scientific rules that that party believes that following it leads to increasing its profits or reducing its losses. (Rapoport, 1998: 189).

iii. <u>Two-Person Non Constant Sum game:</u>

It is a one-shot game in which players compete by announcing resource distributions at the same time as they are subject to their budget constraints, each paid auction is won by the player who bids the highest in that auction, and players receive their payroll via individual full-pay auctions (Roberson, Kvasov, 2010:5). The prisoner's dilemma is one example of this game.

iv. <u>n-Person Zero Sum game:</u>

Any game in which the number of players is 3 and above ($n \geq 3$) then this game is called (n-Person) and these games become much deeper, as we can offer games that have alliances, connections and side payments, and that all these games have a point of balance between pure strategies. Nor would this equilibrium point be unique in general, nor would these games be solvable in Nash's sense. So we approach the problem from a different point of view. Our definition of solutions leads to a certain set of strategies that constitute a point of equilibrium, but these strategies are usually mixed and not pure strategies. (GALE, 1953:496)

6. Practical Sector

Here, the fields of transport for the public and private sectors will be chosen to determine the matrix of games that reach its dimensions (6 * 6), i.e. a square matrix consisting of players. The first player represents the public sector, while the second player represents the private sector and the final outcome is zero. The public transport sector categories can be divided into:

i. Maritime transport (in the private sector represented by Lorraine Company)

ii. Land transport (in the private sector represented by the Iraqi Company for Land Transport)

iii. Air transport (in the private sector represented by Nasser Aviation Wings Company)

iv. Railways (in the private sector represented by Al-Majara Company)

v.Ports (in the private sector represented by Rayanat Al Oud Company)

vi. Travel and tourism in the private sector

a. First: For the public transport sector

Each of the above-mentioned areas of transportation has an added value at fixed prices and fixed capital formation. Each company will be explained as follows:

Table 1 displays the value added and fixed capital formation at fixed prices, as well as the value added to fixed capital formation ratio of enterprises in the public transportation industry.

Value added to fixed capital creation ratio (2:1)	Capital formation (2)	Value Added (1)	Years
			Maritime transport.1
13.60	1732	23548	2016
10.50	3081	32350	2017
10.43	3208	33446	2018
11.51	Total average		
			Land Transport.2
0.49	3177	1551	2016
0.40	4786	1905	2017
0.81	2149	1739	2018
0.57	Total average		
			Air transport.3
12.40	4233	52480	2016
10.54	4006	42220	2017
5.09	6218	31630	2018
9.34	Total average		
			Railways.4
12.61	239.5	3019	2016
14.41	170.0	2450	2017
17.53	137.2	2405	2018
14.85	Total average		
			Ports.5
8.11	22719	184285	2016
8.66	36887	319313	2017
7.73	41642	322024	2018
8.17	Total average		

b. Second: The private transport sector

Table (2) shows the value contributed and fixed capital formation at fixed pricing, as well as the value added to fixed capital ratio in private transportation companies

Value added to fixed capital creation ratio (2:1)	Capital formation (2)	Value Added (1)	Years
(Lorraine Company) Maritime transport.1			
0.92	3710	3419	2016
0.66	3737	2470	2017
0.73	4137	3035	2018
0.77	Total average		
(The Iraqi Company) Land Transport.2			
10.14	344	3488	2016
6.25	249	1556	2017
7.20	327	2353	2018
7.86	Total average		
(Nasser Wings Airlines Company) Air transport.3			
0.37	7090	2637	2016
0.29	8620	2467	2017
0.15	8520	1298	2018
0.27	Total average		
(Al-Majara Company) Railways.4			
0.50	50250	25000	2016
0.41	30883	12558	2017
1.51	26222	39702	2018
0.81	Total average		
(Rayanat Al Oud Company) Ports.5			
0.28	13.52	3.809	2016
0.25	21.50	5.410	2017
0.09	16.33	1.602	2018
0.21	Total average		
Travel and tourism.6			
20.37	1042	21229	2016
11.17	1942	21685	2017
28.19	1066	30050	2018
19.91	Total average		

In light of the preceding, the game model's result grid will focus on the collection of exercises and their branches that make up the activities area as a whole, and the value of each movement is comprised of the level of significant value added to its proper capital as a standard for the focused on the period (2016-2018), as shown in Table (3) below.

Table (3) At constant prices, the percentage of value added to fixed capital creation in the public and private transportation sectors as an average for the study period.		
Private sector	**Public sector**	**Sectors / Activities**
0.77	11.51	Maritime transport
7.86	0.57	Land transport
0.27	9.34	Air transport
0.81	14.85	Railways
0.21	8.17	Ports
19.91	0	Travel and tourism

Source: Prepared by researcher based on the data in Tables (2, 1)

One of the reasons for using this ratio is to determine the profitability of each sector because it represents the value of that sector's profit on average over the studied period using one unit of fixed capital formation, and thus it includes the unit of homogeneity when determining profitability for all modes of transportation. Because the payoff matrix will be known in terms of the return (profit) for Player A, whose policies are in the rows, and Player B, whose policies are in the columns, as shown in Table (4), the competitors and their respective policies must be identified in order to formulate this matrix.

Table (4) is a matrix of payoffs for public and private transportation providers (first case)						
Private / Public	**Maritime 0.77**	**Land 7.86**	**Air 0.27**	**Railways 0.81**	**Ports 0.21**	**Travel & tourism 19.91**
Maritime 11.51	10.74	3.65	11.24	10.70	11.30	-8.40
Land 0.57	-0.20	-7.29	0.30	-0.24	0.36	-19.34
Air 9.34	8.57	1.48	9.07	8.53	9.13	-10.57
Railways 14.85	14.08	6.99	14.58	14.04	14.64	-5.06
Ports 8.17	7.4	0.31	7.9	7.36	7.96	-11.74
Travel & tourism 0	-0.77	-7.86	-0.27	-0.81	-0.21	-19.91

Source: Prepared by researcher based on the data of Table No. (3)

Table (4) shows how the matrix is created and what the explanations are for the rows and columns contained within it:

i. If the sign is positive and the sector has six strategies, the above matrix represents the profit for the public sector in each row.

ii. In the public sector, the negative symbol (-) implies a loss.

iii. The private sector owns six techniques, and each negative number reflects earnings, while the positive number represents a loss.

iv. We get the values of the array in the following way:-

$a_{11} = X_1 - Y_1 = 11.51 - 0.77 = 10.74$
$a_{21} = X_2 - Y_1 = 0.57 - 0.77 = -0.20$
$a_{31} = X_3 - Y_1 = 9.34 - 0.77 = 8.57$

v.The reason for this is that the public sector did not enter the field of travel and tourism, which was limited to the private sector, and in order of the above and to exclude the impact of transportation fields from the optimal decision of the public sector and a profit for the private sector, and in order of the above and to exclude the impact of transportation fields from the optimal decision of the public sector and a profit for the private sector, and in order of the above and to exclude the impact of transportation fields from the optimal decision of the public sector and private sector. A pay off matrix of size 6 * 5 was formed after eliminating the sixth row from the previous matrix, resulting in a matrix of public sector revenues directed toward the private sector based on the five options available to it. The private sector, on the other hand, preserved its available strategies, which are reflected in the table (5) below by the matrix columns:

The payoff matrix for public and private sector transportation enterprises is shown in Table (5). (The second case)

Private / Public	Maritime 0.77	Land 7.86	Air 0.27	Railways 0.81	Ports 0.21	Travel & tourism 19.91
Maritime 11.51	10.74	3.65	11.24	10.70	11.30	-8.40
Land 0.57	-0.20	-7.29	0.30	-0.24	0.36	-19.34
Air 9.34	8.57	1.48	9.07	8.53	9.13	-10.57
Railways 14.85	14.08	6.99	14.58	14.04	14.64	-5.06
Ports 8.17	7.4	0.31	7.9	7.36	7.96	-11.74

Source: Prepared by researcher based on the data of Table No. (4)

Table (6) shows the payoff matrix for public and private transportation businesses (the third case)

Private / Public	Maritime 0.77	Land 7.86	Air 0.27	Railways 0.81	Ports 0.21
Maritime 11.51	10.74	3.65	11.24	10.70	11.30
Land 0.57	-0.20	-7.29	0.30	-0.24	0.36
Air 9.34	8.57	1.48	9.07	8.53	9.13
Railways 14.85	14.08	6.99	14.58	14.04	14.64
Ports 8.17	7.4	0.31	7.9	7.36	7.96

Source: Prepared by researcher based on the data of Table No. (4)

Matrix no. (6) portrays competition between the public and private sectors in all forms of transportation, with the exception of tourism and travel, which are not competed in by any part. As a result, the public and private sectors compete in five activities, with the losses and profits of each represented by a negative or positive sign. In each row and column, the rows represent the public sector and the columns represent the private sector, as previously indicated.

c.Third: Transportation-related fields have a competitive edge.

Matrix A and Matrix B, which represent the comparative advantage of the fields for the public and private sectors, respectively, have been designed in order to determine matrix C, which represents the payoff matrix for the games model for the public and private sectors. Based on each of their comparative benefits, this matrix can be represented as follows:

- **matrix A:**

This matrix depicts the relative advantage of the transportation fields for the public and private sectors, as each element in the matrix represents the earnings of one unit of fixed capital formation according to the fields of transportation, which are represented by the following table (7):

Table (7) Matrix A, which shows the fields where public transportation has a comparative advantage

Public / Public	Maritime 11.51	Land 0.57	Air 9.34	Railways 14.85	Ports 8.17	Travel & tourism 0
Maritime 11.51	0	10.94	2.17	-3.34	3.34	11.51
Land 0.57	-10.94	0	-8.77	-14.28	-7.60	0.57
Air 9.34	-2.17	8.77	0	-5.51	1.17	9.34
Railways 14.85	3.34	14.28	5.51	0	6.68	14.85
Ports 8.17	-3.34	7.60	-1.17	-6.68	0	8.17
Travel & tourism 0	-11.51	-0.57	-9.34	-14.85	-8.17	0

Source: Prepared by researcher based on the data of Table No. (3) and Table No. (4)

From Table (7) it is clear that the rows of the matrix represent the profits of each field of transport in the event that it is directed to invest those other areas and leave it to its original field. (Assuming that positive numbers represent profits for the field of transport and negative numbers represent a loss for it). For example, the element (a_{12}) represents the profitability of the investor in maritime transport if he chooses land transport as a pure policy alternative to maritime transport. This profitability can be deduced according to the following equation: (11.51-0.57 =10.94)

And in order of the above result, land transport has an advantage of (10.94) relative to sea transport. Since land transport gives a return of (10.94), when the investor in maritime transport chooses to go to land transport, he loses the profit he was getting as a result of the maritime transport investment of (11.51)
The same applies to the element (a_{13}) ,which represents the profit of the investor in maritime transport in the event that he leaves the investment in maritime transport and turns towards investing in air transport, where he achieves a profit of (2.1))
And also for the element(a_{15}) , which represents the profit of the investor in the maritime transport in the event that the investment in the maritime transport is left and its tendency towards investing in the port transport, where it achieves a profit of (3.34)
As for (a_{11})it represents the comparative advantage of the maritime transport investment towards itself, as it achieves a profit of zero and as follows: 11.51-11.51=0)
In light of the foregoing, the values of the matrix elements (A) can be calculated. As for the columns, they represent the loss of the public sector in the event that insists on investing the activity represented by that column towards other activities. For example, the element (a_{21}) represents the investor's loss when he insists on investing in maritime transport. Without investment in road transport it can be concluded as follows:
0.57-11.51 = -10.94

- **matrix B:**

The matrix (B), which indicates the private sector's competitive advantage in the transportation fields, is calculated in the same method as the matrix (A) and as shown in table (8):

Matrix B, shown in Table (8), depicts the unique transport fields' competitive advantage

Private / Private	Maritime 0.77	Land 7.86	Air 0.27	Railways 0.81	Ports 0.21	Travel & 19.91 tourism
Maritime 0.77	0	-7.09	0.50	-0.04	0.56	-19.14
Land 7.86	7.09	0	7.59	7.05	7.65	-12.05
Air 0.27	-0.50	-7.59	0	-0.54	0.06	-19.64
Railways 0.81	0.04	-7.05	0.54	0	0.60	-19.10
Ports 0.21	-0.56	-7.65	-0.06	-0.60	0	-19.70
Travel & 19.91 tourism	19.14	12.05	19.64	19.10	19.70	0

Source: Prepared by researcher based on the data of Table No. (3) and Table No. (4)

- **Matrix C:**

Based on the relative advantage of the transfer fields, the matrix C reflects the profits of player (A) towards player (B), and the inverse of these values shows the profits of player (B) towards player (A).

By subtracting matrix (B) from its counterpart (A), the following equation can be used to calculate this matrix:

$$[A] - [B] = [C]$$

As shown in Table (9):

Table (9) Matrix C, which depicts player A's earnings in relation to player B based on the relative advantage of the transfer fields (case 4)

Private (B) / Public (A)	Maritime	Land	Air	Railways	Ports	Travel & tourism
Maritime	0	18.03	1.67	-3.3	2.78	30.65
Land	-18.03	0	-16.36	-21.33	-15.25	12.62
Air	-1.67	16.36	0	-4.97	1.11	28.98
Railways	3.3	21.33	4.97	0	6.08	33.95
Ports	-2.78	15.25	-1.64	-6.08	0	27.87
Travel & tourism	-30.65	-12.62	-28.98	-33.95	-27.87	0

Source: Prepared by researcher based on the data of Table No. (7) and Table No. (8)

To account for the impact of the private sector's investment in travel and tourism on the public sector, as well as the effect of zero country values in the C matrix, the matrix shown in Table ten has been designed to address the two previous cases and to provide a clear picture of the comparative advantage of the shared fields of transportation between the public and private sectors, where the diagonal values of that matrix have been. For example, the value of the element (a_{11}) (maritime transportation) in the public sector will be 11.51, whereas its value in the private sector will be 0.77, hence its value in the public sector will be 11.51.

One of the reasons for utilizing real values of the transport field instead of zero values is that it provides a clear image of the profit generated by this field, which aids in the comparison process for determining the comparative advantage of the other transport fields. For example, in matrix A, the element(a_{11}) represents the net profit that the field of maritime transport gives to itself, which reflects what was mentioned in the matrix of Table (9), where the element (a_{11}) represents the value of the comparative advantage of the field of maritime transport to itself, and this is also true for the rest of the country's elements, and Table (10). This is explained in more detail below.

Table (10) Presents the payoff matrix for transportation domains based on the public and private sectors' comparative advantages (the fifth case)

Private (B) / Public (A)	Maritime	Land	Air	Railways	Ports
Maritime	10.74	18.03	1.67	-3.3	2.78
Land	-18.03	-7.29	-16.36	-21.33	-15.25
Air	-1.67	16.36	9.07	-4.97	1.11
Railways	3.3	21.33	4.97	14.04	6.08
Ports	-2.78	15.25	-1.64	-6.08	7.96

Source: Prepared by the researcher based on the data of Table No. (7) and Table No. (8)

d. Fourth decide on the optimal plan:

The (Min Max-Max Min) criterion was used to look for pure strategies and the saddle point in (Table 4) (the first case), as shown in Table (11) below.

According to the first scenario, Table (11) shows the best policy for the Payoff matrix.

Private / Public	Maritime 0.77	Land 7.86	Air 0.27	Railways 0.81	Ports 0.21	Travel & tourism 19.91	*Min*
Maritime 11.51	10.74	3.65	11.24	10.70	11.30	-8.40	-8.40
Land 0.57	-0.20	-7.29	0.30	-0.24	0.36	-19.34	-19.34
Air 9.34	8.57	1.48	9.07	8.53	9.13	-10.57	-10.57
Railways 14.85	14.08	6.99	14.58	14.04	14.64	-5.06	-5.06
Ports 8.17	7.4	0.31	7.9	7.36	7.96	-11.74	-11.74
Travel & tourism 0	-0.77	-7.86	-0.27	-0.81	-0.21	-19.91	-19.91
Max	14.08	6.99	14.58	14.04	14.64	-5.06	

Source: Prepared by researcher based on the data of Table No. (4)

From the table (11) above, it is clear that the optimal strategy for the competitors is (a_{66}) ,which corresponds to the value of $(MinMax)$ and $(MaxMin)$. The second pure policy, which represents investment (travel and tourism) to maximize the lowest possible gain that can be obtained, taking into account the policy of player B, who will choose to invest in (travel and tourism) also, which reduces the greatest expected loss for him, and by comparing these results with the values contained in Table (3) to show us that investment in travel and tourism achieves the greatest added value for the public sector to reach (0), while travel and tourism achieve the greatest added value for the private sector relative to the rest of the transport fields, which amounts to (19.91), and thus this model is able to achieve maximizing the returns of both sectors by choosing the strategy optimal for each.

Table (12), which represents the optimal solution for the second hypothesized case, shows that the value of the game is similar to the value of the game in the first case, but the strategies are different, indicating that the optimal policy in the first case was for public and private sector investment in travel and tourism, whereas the optimal policy in the second case was(a_{46}) i.e. investment in railways for the public sector and investment in travel and tourism for the private sector, meaning that the private sector is still continuing to invest in travel and tourism, as shown in Table (12) below.

The ideal policy for the Payoff matrix in the second scenario is shown in Table (12)							
Private / Public	Maritime 0.77	Land 7.86	Air 0.27	Railways 0.81	Ports 0.21	Travel & tourism 19.91	*Min*
Maritime 11.51	10.74	3.65	11.24	10.70	11.30	-8.40	-8.40
Land 0.57	-0.20	-7.29	0.30	-0.24	0.36	-19.34	-19.34
Air 9.34	8.57	1.48	9.07	8.53	9.13	-10.57	-10.57
Railways 14.85	14.08	6.99	14.58	14.04	14.64	-5.06	-5.06
Ports 8.17	7.4	0.31	7.9	7.36	7.96	-11.74	-11.74
Max	14.08	6.99	14.58	14.04	14.64	-5.06	

Source: Prepared by researcher based on the data of Table No. (5)

According to the data in Table (13) below, the best strategy for the competitors appears to be (a_{42}), which corresponds to the values of (MaxMin) and (MinMax), although the game value was (6.99) and different in the preceding situations.

Table (13) shows the best policy for the Payoff Matrix in the third example						
Private / Public	Maritime 0.77	Land 7.86	Air 0.27	Railways 0.81	Ports 0.21	*Min*
Maritime 11.51	10.74	3.65	11.24	10.70	11.30	3.65
Land 0.57	-0.20	-7.29	0.30	-0.24	0.36	-7.29
Air 9.34	8.57	1.48	9.07	8.53	9.13	1.48
Railways 14.85	14.08	6.99	14.58	14.04	14.64	6.99
Ports 8.17	7.4	0.31	7.9	7.36	7.96	0.31
Max	14.08	6.99	14.58	14.04	14.64	

Source: Prepared by researcher based on the data of Table No. (6)

To maximize the lowest possible profit, given Player B's policy of choosing road transportation, the ideal strategy requires that player A chooses the fourth pure policy, which reflects investment in rail transportation. When these findings are compared to the added value of the various modes of transportation stated in Table (3), it is evident that rail transportation has the most added value for the public sector, whereas land transportation has the highest added value for the private sector (after excluding the value of travel and tourism).

In terms of comparative advantage, Table (14) shows that the game's value has reached zero, and therefore the best policy for both competitors is (a_{44}), which relates to the railways, which has a comparative advantage in Iraqi transportation.

Table (14) shows the best strategy for the Payoff Matrix in the fourth scenario							
Private (B) / Public (A)	Maritime	Land	Air	Railways	Ports	Travel & tourism	*Min*
Maritime	0	18.03	1.67	-3.3	2.78	30.65	-3.3
Land	-18.03	0	-16.36	-21.33	-15.25	12.62	-21.33
Air	-1.67	16.36	0	-4.97	1.11	28.98	-4.97
Railways	3.3	21.33	4.97	0	6.08	33.95	0
Ports	-2.78	15.25	-1.11	-6.08	0	27.87	-6.08
Travel & tourism	-30.65	-12.62	-28.98	-33.95	-27.87	0	-33.95
Max	3.3	21.33	4.97	0	6.08	33.95	

Source: Prepared by researcher based on the data of Table No. (9)

Because the game was stable at the equilibrium sites in all four cases, the value of ($MaxMin$) was equal to the value of ($MaxMin$) ($MinMax$). According to the fifth scenario, there is no equilibrium point, as shown in table (15) below:

Table (15) shows the Payoff Matrix's optimal policy in the fifth example						
Private (B) / Public (A)	Maritime	Land	Air	Railways	Ports	*Min*
Maritime	10.74	18.03	1.67	-3.3	2.78	-3.3
Land	-18.03	-7.29	-16.36	-21.33	-15.25	-21.33
Air	-1.67	16.36	9.07	-4.97	1.11	-4.97
Railways	3.3	21.33	4.97	14.04	6.08	3.3
Ports	-2.78	15.25	-1.11	-6.08	7.96	-6.08
Max	10.74	21.33	9.07	14.04	7.96	

Source: Prepared by researcher based on the data of Table No. (10)

The value of the game was between ($3.3 \leq v \leq 7.96$), so we will resort to solving the game using the linear programming method as follows:

Player (A) Linear Programming Model (Public Transport)

$$Min\ Z = R_1 + R_2 + R_3 + R_4 + R_5$$

$Min\ Z = X_1 + X_2 + X_3 + X_4 + X_5$

S.T.

$10.74X_1 - 18.03X_2 - 1.67X_3 + 3.3X_4 - 2.78X_5 \geq 1$

$18.03X_1 - 7.29X_2 + 16.36X_3 + 21.33X_4 + 15.25X_5 \geq 1$

$1.67X_1 - 16.36X_2 + 9.07X_3 + 4.97X_4 - 1.11X_5 \geq 1$

$-3.3X_1 - 21.33X_2 - 4.97X_3 + 14.04X_4 - 6.08X_5 \geq 1$

$2.78X_1 - 15.25X_2 + 1.11X_3 + 6.08X_4 + 7.96X_5 \geq 1$

$X_1, X_2, X_3, X_4, X_5 \geq 0$

Player (B) Linear Programming Model (Private Transfer)

$Max\ W = Y_1 + Y_2 + Y_3 + Y_4 + Y_5$

S.T.

$10.74Y_1 + 18.03Y_2 + 1.67Y_3 - 3.3Y_4 + 2.78Y_5 \leq 1$

$-18.03Y_1 - 7.29Y_2 - 16.36Y_3 - 21.33Y_4 - 15.25Y_5 \leq 1$

$-1.67Y_1 + 16.36Y_2 + 9.07Y_3 - 4.97Y_4 + 1.11Y_5 \leq 1$

$3.3Y_1 + 21.33Y_2 + 4.97Y_3 + 14.04Y_4 + 6.08Y_5 \leq 1$

$-2.78Y_1 + 15.25Y_2 - 1.11Y_3 - 6.08Y_4 + 7.96Y_5 \leq 1$

$Y_1, Y_2, Y_3, Y_4, Y_5 \geq 0$

We will choose the player model (B) (private transport) and solve it by linear programming based on the (QM) program, as we get the following results:

Game Theory Results

sohad solution

	Maritime	Land	Air	Railways	Ports	Row Mix
Maritime	10.74	18.03	1.67	-3.3	2.78	.26
Land	-18.03	-7.29	-16.36	-21.33	-15.25	0
Air	-1.67	16.36	9.07	-4.97	1.11	.12
Railways	3.3	21.33	4.97	14.04	6.08	.62
Ports	-2.78	15.25	-1.11	-6.08	7.96	0
Column Mix--->	.31	0	.55	0	.14	
Value of game (to row)	4.62					

In order to optimize the lowest possible profit while taking into account the policy of player B, who opts for port transportation, the optimum strategy indicates that player A chooses the fourth pure policy, which requires railway investment. When these findings are compared to the added value of the various modes of transportation listed in Table (3), it is clear that the railways field provides the most added value to the public sector, while transport via ports provides the most added value to the private sector after travel and tourism are removed.

7. Conclusions:

The results above show that competition exists between the two sectors, so in the fifth case, the two parties did not agree on the strategy that achieved the value of the game, so another method was used, which was the linear programming method to resolve the conflict between the two parties. Possible profit, unlike the private sector, whose investment is directed towards the ports to achieve the least possible loss than the rest of the fields.

Refrences:

1.Bakhit, Abdul-Jabbar Khader and Al-Nuaimi, Saad Ahmed and Batikh, Abbas Hussein, “Operations Research: Fundamental Pillars and Scientific Decisions”, Baghdad, Iraq, Books and Documentation House, 1, 2015.

2.Bashiwa, Lahsan Abdullah, "Operations Research", Amman, Jordan, Al-Yazuri Scientific Publishing and Distribution House, 2010.

3.GALE, DAVID, " A THEORY OF N-PERSON GAMES WITH PERFECT INFORMATION", MATHEMATICS, Vol. 39, 1953

4.Hamdan, Fathi Khalil, “Operations Research with Computer Applications”, Amman, Jordan, Wael House for Publishing and Distribution, 1st Edition, 2010.

5.Murthy, P. Rama, "Operation Research", 2nd edition, New Delhi , 2007.

6.Rapoport, Anatol, " Decision Theory and Decision Behavior", 2nd edition, Toronto, Canada, 1998

7.Thomas S. Ferguson, Games theory, Academic Press, London,2000, p3

8.Turocy, Theodore L. and Stengel, Bernhard von," Game Theory", CDAM Research Report LSE-CDAM,2001.

استعمال نظرية الالعاب في تحديد الاستراتيجية المثلى لقطاع النقل في العراق

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مستخلص البحث

في هذا البحث تم استعمال نظرية الألعاب وتطبيقها على قطاع النقل في العراق اذ يشمل هذا القطاع محورين هما محور النقل العام والمحور الثاني محور النقل الخاص اذ يشتمل كل محور من هذه المحاور على عدة أنواع للنقل وهي (النقل البحري، النقل الجوي، النقل البري، النقل عن طريق السكك، النقل عن طريق الموانئ) وقطاع السفر والسياحة اذ يفتقر النقل العام لهذا القطاع ، اذ تم تكوين مصفوفة الميزة التنافسية الخاصة بقطاع النقل وبعد تطبيق مبدأ MinMax-MaxMin على المصفوفة بكل مراحلها تبين وجود نقطة توازن باستثناء المرحلة الأخيرة اذ لا تتوفر نقطة التوازن لذا تم اللجوء الى استعمال اسلوب البرمجة الخطية لحل المصفوفة وذلك لان المصفوفة كانت من درجة (5*5) لذا تم التوصل الى نتيجة المباراة بان يكون استثمار النقل العام في المجال السكك ليحقق اعلى ربح ممكن والنقل الخاص في مجال الموانئ ليحقق اقل خسارة ممكنة.

المصطلحات الرئيسة للبحث: قطاع النقل العام، قطاع النقل الخاص، نظرية الألعاب، نقطة التوازن، البرمجة الخطية