Game Theory approach for pharmaceutical industry players

Game theory is the theory of independent and interdependent decision making. It is concerned with decision making in organizations, where the result depends on the decision of two or more unknown players, where the players do not have control on the outcomes. Games as chess or bridge fall in the category of game theory, and so does the stable marriage allocation problem as in social situations. Game theory is particularly concerned with optimal strategic behaviour, equilibrium situations, stable outcomes, bargaining, coalition formation, equitable allocations, and similar concepts related to solve conflicts. Game theory extends to areas in economics, political science, operations research and military planning, and it is the study of mathematical models and co-operation between intelligent rational decision makers. The model approach here is applicable to the pharmaceutical industry. The pay-off matrix is explained in the note. The competitive advantage is achieved through the capability of an organization to create a perspective of value for the customers. The advantage is created through lower costs from competitors or unique services against competitors' products and services. The pharmaceutical industry has many competitive advantages, and the emphasis is on their effectiveness along with their customers. The top five of the most effective sections as anti-bacterial, anti neo plastic, cardio-vascular, neurotic and respiratory drugs are used to develop the pay-off models.

PO: pay-off

i: players (i=1, 2, 3)

k: strategy behavior of players (k=1,2,…r)

p: competitive advantage (p=1, 2, …, q)

j: h1 player strategic behavior (j=1, 2, …, m)

g: h2 player strategic behavior (g=1, 2, …, n)

c: h3 player strategic behavior (c=1, 2, …, z)

ehik: the effectiveness of strategic behavior for player hi (based on percentage of market share)
yhik: hi player performance in selected strategic behavior (based on percentage of market share)
$mhik,hi'k$: hi player market share adjustment rate if select kth strategy and hi′(i′≠ i) player select kth strategy (based on percentage; $-1<mhik,hi'k<1$)
Ii: the importance of competitive advantage for player hi in pharmaceutical industry
Whip: hi player relative ability in pth competitive advantage
[Xj,,]: pay-off value for hi player when h1 selected jth strategic behavior, h2 selected gth strategic behavior and h3 selected kth strategic behaviour!

The numerical validation for model validation is elaborated in the note. The assumptions are-

Considering three players (i=3).

- Number of competitive advantages is four including quality, cost, deliver time, innovation (p=4).
- Among the most effective sections of therapeutic, focused on cardio vascular drugs.

The tables below elaborate the framework for the players against various competitive advantages.

	I	II	III
Quality	0.261	0.616	0.106
Cost	0.429	0.143	0.429
Deliver Time	0.634	0.106	0.261
Innovation	0.261	0.106	0.634

Table 1- hi th player relative ability in p th competitive advantage

Drug sections vs. p	**Cardio-Vascular**	**Anti-Neoplastic**	**Anti-Bacterial**	**Respiratory**	**Neurotic**
Quality	0.365	0.295	0.166	0.273	0.157
Cost	0.172	0.163	0.499	0.410	0.231
Deliver Time	0.099	0.303	0.242	0.169	0.073
Innovation	0.365	0.240	0.119	0.096	0.583

Table 2- The importance of competitive advantage for player hi

Strategic behaviours in the pharmaceutical industry	Strategic Behaviour Code
ISO9001, ISo14001	Quality-1
Good Manufacturing Practice (GMP)	Quality-2
Healthy Safety Environment	Quality-3
Maintenance	Cost-1
Risk Based and Reliability Maintenance (RBM, RCM)	Cost-2
Reorder Point Modelling	Delivery Time- 1
Supply Chain Maintenance	Delivery Time- 2
Transport Management	Delivery Time- 3
Portfolio Planning	Innovation- 1
Generic Production	Innovation- 2
Branding	Innovation- 3

Table 3- Strategic Behaviour in the pharmaceutical industry

Strategic Behaviours	I	II	III
Quality- 1	0.70	0.65	0.60
Quality- 2	0.50	0.42	0.30
Quality- 3	0.65	0.54	0.65
Cost- 1	0.50	0.50	0.50
Cost- 2	0.35	0.45	0.22
Delivery Time- 1	0.65	0.66	0.55
Delivery Time- 2	0.53	0.50	0.55
Delivery Time- 3	0.66	0.68	0.71
Innovation -1	0.63	0.70	0.50
Innovation- 2	0.30	0.31	0.18
Innovation- 3	0.35	0.40	0.21

Table 4- hi th player performance in selected strategic behaviour

Quality		h2		
		I	II	III
h1	I	0.2	0.3	0.3
	II	-0.2	0.2	0.2
	III	-0.3	-0.2	0.2
Quality		**h3**		
		I	II	III
h1	I	0.2	0.4	0.4
	II	-0.2	0.2	0.2
	III	-0.4	0	0.2
Quality		**h3**		
		I	II	III
h2	I	0.2	0.3	0.3
	II	-0.2	0	0
	III	0.3	0	0

Table 5.1- kth strategy (quality) and hi th player

Cost		h2	
		I	II
h1	I	0.2	0
	II	0.2	0
Cost		h2	
		I	II
h1	I	0.2	0
	II	0.2	0.2
Cost		h3	
		I	II
h2	I	0.2	0
	II	0.3	0

Table 5.2- kth strategy (Cost) and hi th player

Pay-off matrix can be concluded as shown-
x_{h11}=(0.365×0.261)×0.7(1+0.2×0.65*+0.2×0.60*)=0.08 (*- Taking values from other tables)
By considering a coefficient (1000) for simplification of calculation 0.08 ×1000=80, we get the pay-off matrix. Using this approach, the whole table is filled.

Quality		h2 (h3 selected I)		
		I	II	III
h1	I	(80, 126, 20)	(69, 125, 17)	(83, 116, 20)
	II	(68, 124, 19)	(63, 102, 16)	(68, 124, 19)
	III	(54, 165, 23)	(54, 130, 20)	(70, 127, 23)
Quality		h2 (h3 selected II)		
		I	II	III
h1	I	(71, 128, 18)	(57, 113, 12)	(71,113, 15)
	II	(60, 133, 9)	(50, 110, 9)	(60, 111, 15)
	III	(28, 156, 15)	(49, 113, 19)	(64, 113, 16)
Quality		h2 (h3 selected III)		
		I	II	III
h1	I	(83, 126, 18)	(68, 123, 15)	(83, 126, 18)
	II	(67, 124, 17)	(14, 100, 14)	(67, 80, 18)
	III	(61, 165, 18)	(61, 128, 16)	(77, 127, 18)

Table 6- The Pay-off matrix for quality

The analysis of competitive advantages of the pharmaceutical industry behaviour by providing a new pay-off model has produced 2 Nash equilibrium points as marked. Proceeding on the same lines will yield the pay-off matrix for the whole pharmaceutical industry. The optimal answer is marked in case of highest benefits to the players for quality is elaborated. Similarly, the pay-off matrix can be drawn for innovation, delivery time & cost. Going further, modelling can be considered for resources, scheduling & affordability.

