Supporting The Profitability Of Social Network Analysis In Telecommunication Sector Using Discrete Event Simulation

Ramiz Assaf

Abstract: In recent years Social Network Analysis gained a lot of attention from the research community. Discrete Event Simulation was among some of the tools used in analyzing these social Networks. In this work, Discrete Event Simulation is adopted for evaluating the profitability of using Social Network Analysis in telecommunication area. The experiment compared profitability between two scenarios either using or not using Social Network Analysis in marketing efforts. After applying Discrete Event Simulation using Matlab software, results show that using Social Network Analysis significantly improves the Return on Investment performance measure.

Index Terms: Social Networks, Simulation, Profitability, Matlab, Experiment, marketing

1 INTRODUCTION

The current world is a complex network of connection between people. The Internet and the widespread of new technologies made this connection online. This is called Social Media. Data and Analysis can be collected over these networks in what is called Social Network Analysis (SNA). More formally, SNA is a social structures investigation strategy by applying theories of network and graph. SNA uses relational information among people in order to predict interests and patterns while in the same time identifying influencers among the network. [1] In contemporary social communities (that are complex), people influence each other, their acquaintances, relatives, colleagues and coworkers. Ideas, tastes and even political inclines evolve in these networks. Individuals are also influenced by choices of others; the introduction of social media proved the power of the "word-of-mouth" in communities. [2] Social Network Analysis uses the interaction patterns found in telecommunication, banks, government institutions and other industries. These interactions of customer networks identify groups of comparable persons. Group features influence the behavior observed by the individuals within the group. [3] From another side, little has been done in the area of proofing the value of SNA from a profitability point of view. Different types of simulation were used in different levels of Social Network Analysis using simulation [4]. This work tries to present a case in which results of SNA can be utilized in a Discrete Event Simulation (DES) Model to evaluate and quantify benefits.

2 THE SOCIAL NETWORK ANALYSIS

Although this paper only builds on the result of SNA, A brief process will be explained. More can be found in [5]. Figure 1. Explains the steps of performing Data mining that leads to SNA. The steps including reading data from the data warehouse, preprocessing the data and eliminating outliers, problems with some data points.

The next steps include transforming the data into a representative subset then mining the data and extracting relevant information that leads after analysis to knowledge. [6] Wellman and Marin [7] explained that SNA is a very powerful tool as it is different from traditional social scientific studies. Their work shows that the latter focuses on the traits of every single individual whereas SNA focuses on relationships and ties among members within social networks. Social networks study can be defined as several nodes (a set) which is comprised of members where nodes are connected by links. Links could have different types of relationships among the members in the network. SNA study all connections as the building block of the social communities. [7]. Some of the applied methodologies of data analysis consider individual’s attributes from all observations to analyze the related information. For example asking questions about: The mean characteristic from a population of companies” Especially in telecom companies, it is quite usual to analyze data of individuals to understand the behaviors of the customers. Examples include the average billing amount, payment means, or the amount of usage...[8] Moreover SNA considers all relational information among the network members. Actually, within a social network the inter relational information is more important than the attributes of the individuals. Relational information among the network say more about members than the attributes of each one individually which highlights the differences between SNA and data analysis. What "you are" is not as important as "how you behave and connect with others". [8]

3 SIMULATION AND SOCIAL NETWORKS

This paper will use Discrete Event Simulation (DES) to the study the profitability of adopting SNA marketing approach in telecommunication. This paper is among many other papers which used some type of simulation. Some of the papers

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adopt an Agent based Simulation (ABS) in their study of the Social Network such as [9]. Others similar to this paper use DES, examples include [10], [11] and [12]. For example, Chan et al. worked presented an introduction of using ABS in Social context. One of the examples the work presented was the famous Game of Life. Their work provided a tutorial on how Agent Based Simulation (ABS) should be implemented and how they provide deductive reasoning and results. [9] Alt and Lieberman presented a model and an implementation for a social network which was dynamic and applied discrete event simulation in a social context. Their work focused on a conceptual model for the value of homophily and the relationships among individuals and among different population groups. [10].

4. METHODOLOGY

The study follows the methodology of a discrete event simulation study. The model was defined in earlier sections. Assumptions of the model are based on the relationships among the members of the groups (see Assaf 2019, Abu Rezek 2017 for more details). Since the problem under consideration in static, Matlab will be used to model the profitability of each of the adopted marketing approaches in Telecommunication networks. The code that was used in these experiments is attached in the appendix section. After performing the analysis, t-test will be used to compare between the results. A proper hypothesis will be proposed and statistically evaluated. More details regarding the hypothesis will be presented in the following section as well.

5. RESULTS AND DISCUSSION

According to the analysis presented in [5,13], the average group size of selected network samples is between 2 – 42 members in each group. To evaluate the profitability, the work assumes that these group members daily revenues is uniformly between from $0.3 to $2. It should be noted that companies tend to sustain its customers the longest period they can through serving them better and satisfying their needs. In theory this attract a positive word of mouth. It is also assumed that this action will help company grow in market size through the feedback of its current customers. The result is that more customer satisfaction is obtained. Furthermore, the more customer tenure is expected and the more revenue this company can obtain. According to both Vodafone (Egypt) and Jawwal (Palestine) benchmarks [13], the trend of revenue uplift in the most of given offer is uniformly distributed between 15% and 25% on individual level. However, applying the mentality of SNA, group level profitability should be considered instead. Those network leaders have power of influence over others. They can affect the decision to buy a company’s product, i.e. to subscribe for an new offer or to stay contracted to the same service provider of these leaders. The percent of accepting offers given by telecom operators (i.e. the opt in ration) is assumed to be uniformly distributed between 7% to 12% [13]. When applying SNA by employing influencers, this opt in ration approaches 30% [13]. The Opt in ratio and revenue uplift are not enough alone, a company should consider all costs paid. For example, cost of promotion, system running cost, payrolls, tools … etc. The Return On Investment (ROI) can summarize all the costs and the incomes into one metric. Traditionally, the cost of targeting a group of five members individually is about five times the cost of targeting one member. SNA approach is different as it tries targeting one member and let him/her influencing others. So costs are only paid once.

5.1 Hypothesis of the Study

This subsection includes using Monte Carlo Simulation to prove how companies will save or stretch its current subscribers base of revenues when applying SNA following the below hypothesis:

\[ H_0: \mu_1 = \mu_2 \]
\[ H_1: \mu_1 \neq \mu_2 \]

where 
\[ \mu_1 = \text{the mean of Return on Investment without applying Social Network Analysis}, \]
\[ \mu_2 = \text{the mean of Return on Investment when applying Social Network Analysis}. \]

Null hypothesis assumes that there is no differences in mean ROI of the group when applying SNA vs not applying SNA. The simulation of the two cases was performed using MATLAB taking into considerations the following parameters and for 10,000 replications.

| Table 1: Simulation Model Parameters used in offers targeting |
| From | To |
| Size of group | 2 | 42 |
| Revenues per day | $0.30 | $2.00 |
| Cost per offer: Time, System & Communication | $0.05 | $0.10 |
| Active Days | 1 | 12 |

Table 2: Assumptions used to compare ROI when incorporating SNA vs not

| With Vs Without SNA | With SNA | Without SNA |
| Offer Acceptance Ratio | 30% | 10% |
| # of Offers | 2 | # of members per group |
| Revenue Uplift | 15% - 25% |

Table 2 states the main model assumptions. In the case of SNA only one offer will be sent to the leader and the disseminator. While the rest of the group may or may not feel tempted to join the offer. When SNA is not applied the offer will be sent to all subscribers. Therefore, it was assumed that the leader would have a higher effect on the opt-in rate of his followers.

5.2 Independent Samples T-test: Compare Two Means

The results of the independent sample T-test, for ROI with/without 10,000 replications for each case is shown in Table 3 and Table 4.

| Table 3: Group Statistics |
| With SNA | N | Mean | Std. Dev. | Std. Error Mean |
| No | 10000 | 94.676 | 241.644 | 2.416 |
| Yes | 10000 | 4749.084 | 5929.574 | 59.2950 |
Table 4: Independent Samples Test

<table>
<thead>
<tr>
<th>R</th>
<th>T</th>
<th>DF</th>
<th>P-value</th>
<th>Mean Difference</th>
<th>Std. Error Difference</th>
<th>95% Confidence Interval of the Difference</th>
<th>Lower 95%</th>
<th>Upper 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROI</td>
<td>78.4</td>
<td>10032</td>
<td>0.00</td>
<td>-4654.4</td>
<td>59.34</td>
<td>4770.73</td>
<td>-4538.0</td>
<td>8</td>
</tr>
</tbody>
</table>

Equal variances not assumed

Table 4, concludes that since the p-value is less than 0.05, then the groups’ means are significantly different. Thus hypothesis $H_0$ is rejected in favor of $H_1$. This means that ROI applying SNA is significantly larger than ROI without applying SNA. Using SNA may result to increase ROI of about 50 times, below are the histograms from both scenarios.

5.3 Verification of Variables and Validations of Results

All the numbers that are reported in the simulation study were obtained of a series of meeting with key personnel at the telecommunication company under study. The meetings confirmed the validity the model inputs (revenues, uplift, tenure, costs...). Moreover, the calculated ROIs are very close to ROI obtained from similar offers (applying the traditional approach). For the results obtained by applying SNA, top management at the company agrees that results will be very useful for performance improvement in future offers.

6 CONCLUSION AND FUTURE WORK

This work presented a DES approach to evaluating the use of SNA in the profitability analysis of Telecommunication Sector. The analysis showed using SNA is far more superior than traditional approaches of offering offers to subscribers. Future Work should be directed on adopting SNA methods and obtain feedback on their performance. Such study will validate the use of SNA analysis in multiple industrial and service sectors. Another area of research is to adopt a more dynamic simulation language in studying such models namely ARENA.

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REFERENCES


2010.


APPENDIX

Matlab Script to apply Monte-Carlo Simulation

%% Without SNA analysis
Replications = 10000
for i = 1: Replications
% number of members
groupSize = randi(41,1,1)+1 ; % group size from 2 to 42
daily_revenue = (randi(18,1, groupSize) + 2 ) ./ 10 ; % daily revenue from $0.3 to $2.0
d_v = (rand(1, groupSize)) ; % dummy variable that has the same size the number of group members
offer_cost = (d_v <= 0.3) .* 0.05 + 0.05 ; % offer cost is 0.05 with a probability 70% or and 0.1 with probability of 30%
acceptOffer = rand(1, groupSize) <= 0.1 ; % percentage of taking the offer
revenue_uplift = acceptOffer.* ((randi(11,1, groupSize)+14).*0.01).*daily_revenue.*(randi(10,1,1)+0) ;
% the equation takes into account if a customer took the offer then it calculate how much the company profited from the offer ranges between 15 to 25%
total_uplift = sum(revenue_uplift) ; % to calculate the total ROI for the group we need to sum the revenue_uplift values
total_cost = sum(offer_cost);  % we also calculate the cost, then we use the ROI formula
ROI_PERCENT(:,i)=(total_uplift-total_cost)./total_cost *100;
end
hist(ROI_PERCENT)
meanROI_w_SNA=mean(ROI_PERCENT)
stdROI_w_S NA=std(ROI_PERCENT)

%% with SNA analysis
Replications = 10000
for i = 1: Replications
% number of members
groupSize = randi(41,1,1)+1 ; % group size from 2 to 42
daily_revenue = (randi(18,1, groupSize)+2 ) ./ 10 ; % daily revenue from $0.3 to $2.0
d_v = (rand(1, groupSize)) ; % dummy variable that has the same size the number of group members
offer_cost = (d_v <= 0.3) .* 0.05 + 0.05 ; % offer cost is 0.05 with a probability 70% or and 0.1 with probability of 30%
offer_cost(1,[3:end])=0; % No cost is assigned for most of the group members
acceptOffer = rand(1,2) < 0.3 ;
for j = 3: groupSize
if acceptOffer(1,1) == 1 || acceptOffer(1,2)==1
acceptOffer(1,j) = rand(1,1)<0.3;
else acceptOffer(1,j) = rand(1,1)<0.1 ;
end
end
% if the one of the group leaders (the highest authority or dissemination score) opted in, the remaining of the group would opt in, otherwise, the probability of opting in is as without SNA which is 7%
revenue_uplift = acceptOffer.* ((randi(11,1, groupSize)+14).*0.01).*daily_revenue.*(randi(10,1,1)+0) ;
% the equation takes into account if a customer took the offer then it calculate how much the company profited from the offer ranges between 15 to 25%
total_uplift = sum(revenue_uplift) ; % to calculate the total ROI for the group we need to sum the revenue_uplift values
total_cost = sum(offer_cost);  % we also calculate the cost, then we use the ROI formula
ROI_PERCENT(:,i)=(total_uplift-total_cost)./total_cost *100;
end
hist(ROI_PERCENT)
meanROI_w_SNA=mean(ROI_PERCENT)
stdROI_w_S NA=std(ROI_PERCENT)