

CHAPTER 4

INFORMATION DIFFUSION AND PROPAGATION

4.1 Introduction

Online Social media has shifted the way in which information is produced, transferred and consumed. This phenomenon has become an important aspect of the marketing mix, changing the conventional way, companies interact with customers. With the popularity of online social networks like Facebook [19] and Twitter [20], the propagation of information pattern has become very visible and traceable. The studies of the diffusion of information in various fields, lead to the theories built on direct observation in small networks, and survey response from large samples. With the development of communication technologies, there has been an increase in online human activities lowering the cost. This improved the understanding and tracking of how people share the information and what kind of information is spread. People are connected to predefined online interactions forming a network. These networks share messages with the connected contact and propagate information through links already formed and create cascades. Viral marketing exploits existing social networks, by

encouraging customers to share product information with their friends. Structure of a social network can favour or impede the diffusion of information.

4.2 Social media and brand promotion

Every business always wants to have their customers and prospective customers to engage with their brand. The aim is to make the engaging customer believe in, purchase and support the brand, both individually and among their contacts. In social media, this is strongly related to the friends or acquaintances or just idle participants. The business firm tries to engage in some way with the brand. This demonstrates the brand's popularity or the marketer's friends to the rest of the world. However, with a greater portion of branding activity being shifted to the internet, marketers realize that social media was made for people, not for brands [86]. It is argued that "popularity" in terms of brand engagement, has thus taken centre stage for most marketers, rather than how social media can or might influence consumers to favour their brands or buy their products [87].

In the conventional Word Of Mouth (WOM), being engaged with the brand meant the engaged had tried the brand, convinced with it to become a loyal buyer and, if they were outgoing and effusive enough, were willing to mention the brand to friends, neighbours, and others [88]. This type of advocacy or brand promotion has been found in interpersonal communication research for years, the rise of social media has provided a

new dimension to the existing scenario. The difference today is that marketers and academicians have re-created shared engagement, in a new format. Viral marketing can be thought of as a diffusion of information about the product, and its adoption over the network [88].

Brand promotion is a continuous process. Reaching people, standing by the brand and promoting the brand, should be done regularly. Channels are important while reaching out to people. People use a number of communication channels thus making it difficult and costly for companies to reach them through different media. Social media brand promotion has gained upper hand in all other digital media as masses are available on this platform, and you can reach them and engage them effectively. Social media like FB has become a key item in a marketer's tool box in this digital age. Brands and businesses are coming up with creative and unique ways to leverage the Facebook platform. Small business groups and organizations have started to acknowledge that, Social Media is a powerful medium to reach existing and potential customers. They use Social Media to post contents and have people from varied walks of life like them and drive traffic to their site.

4.2.1 Facebook as Social Media Platform

Facebook is a relation based online social networking site, which has 800 million active users [89]. It allows the users to create their personal profile and get connected with their friends. A Facebook user has 130 friends on an average [94]. A user's profile has a wall where their interactions are

archived and visible to friends. Friends interact by posting the information on their wall or other's wall. These interactions can be 'commented' or 'like'ed by other users, which is conformity of reach. These interactions of the user and their friends are pushed to the user's page by the user's newsfeed. These feeds give a snapshot of what is going on within their social network. Facebook focuses on building and reflecting, the social networking and relationships among the community, sharing similar interest. Facebook has become an integral part of human digital lifestyle. The changes evolved as emails replacing the traditional snail mails, giving way to wall posts. With the development of communication technologies, there has been an increase in online human activities lowering the cost. It has opened a new vista of personal profiling for self-expression and describing who you are, your interests, keeping in touch with friends, sharing photos, and videos and similar. Social Network sites like Facebook, Twitter, etc. are highly valued for their collected detailed user profile and network data and also their retention capability. This is extremely helpful in the case of targeted advertising. Realising the potential and seeing the success, small business also has joined by building relationships with new demographics. The social media can be effectively used to engage people.

4.3 Brand Awareness

Brand awareness is a measure of how recognizable the brand is, to the target audience. Advertising has a significant effect in promoting brand awareness. Social media is a dynamic network and study of diffusion of information

helps in strategizing advertisements. The correlation between the number of people engaging in spreading information and probability of adopting information, as an important feature of information diffusion has already been examined. The studies of the diffusion of information in various fields, lead to the theories built on direct observation in small networks and survey response from large samples. This idea is important in the marketing mix, to improve the relations with customers. People are connected to predefined online interactions forming a network. These networks share messages, with the connected contact and propagate information through links already formed and creating cascades. By encouraging the customers to share product information, with their friends via social media, viral marketing is promoted. Structure of a social network can favour or impede the diffusion of information. The intended outcome of the social media campaign is to strengthen the awareness of the brand. To achieve the objective, social media metrics are aligned with the company parameters. In the traditional marketing effort, it is difficult to evaluate due to complications of determining the link, between campaigning and brand awareness. The online social media like Facebook gives the right opportunity to study social interactions, starting from the spread of information to influence patterns and thereby decision making process. This decision and experience good or bad, influence many others also in the process. L.E.K. media consumer survey reported by Smith & Rourke [96] reveals that tech-savvy consumers are found, sixteen times more influential in the purchase decision of family and friends. From the organization perspective, this highly interactive nature

of social media provides valuable data regarding customer preferences and behaviour from the direct and immediate feedback. This direct engagement increases brand loyalty and credibility. The case studied examined here details the characteristics of this social interaction.

4.4 Modelling Diffusion of Information

Diffusion of information occurs in a social network due to the spreading of items through word of mouth (WOM) and other factors. There has been many studies of the diffusion process at both macro and micro levels. Macro model focus on the number of adopters in the diffusion process whereas micro models determine the individual adopting pattern. In the conventional real-world scenario, there is no 100 % awareness of products. Marketing firms have been trying many methods to do brand promotion.

Bass Diffusion Model [93] which is the standard diffusion model, describes the process of how new products get adopted in a social network. This model describes the process by which new products are adopted as an interaction between users and potential users. Bass's model assumes that the traditional S shape of the adoption curve comes from the mixture of internal and external influences. Internal influences include the interactions within the social system including word of mouth. External influence comes from agents, outside the social system. Combination of these two effects describes the adoption path for a new product. The model displays a cumulative S curve of adopters when the number of users of a new product

is plotted against time, adoption proceeds slowly at first and accelerates as it spread throughout the potential adopting population. Then slows down as the relevant population becomes saturated. In this chapter, we are experimenting with three datasets and establishing a general probabilistic framework, used to derive a macro level diffusion model which confirms the well-known Bass Model (BM). Using the case study approach, this checks whether social media is more effective than the traditional media on a brand management perspective and is in conformity with Bass Model and finds the implementation challenges that make it a two face phenomenon.

4.5 Research Methodology

The influence of social media is growing day by day. It has become the most successful medium of communication among the people. Social media has become the largest marketplace, where you can reach the potential customers instantly through right marketing; correct social media strategy can lure the customers. A strong social media marketing analytics can throw light on the customers, their buying habits, purchasing power, and the latest trend and so on. These details will further help to develop a better customer friendly product. Understanding this, and realizing that Return on Investment (ROI) of this medium is better than other traditional Media, many firms are adding the Social Media in marketing. This has taken the online marketing to a new level, where the companies are using social networking sites as a key variable for their brand promotions. It is a fast and highly influential way of promoting brands and products. Here Facebook

data is the only social media considered.

There has been a growth in brand engagement with the availability of many analytic tools, inbuilt tools with the social media, as well as third-party tools. The brand engagement construct has fuzzy boundaries beyond recommending to others. As a first step, we define what engagement is, how it works, and what it means. Following this, the brand engagement is measured within a social media context. This measurement problem is challenging in the social media space since, for all its expected benefits, few businesses understand its impact on consumer and brand engagement. With all these constraints in mind, we address the available tool too.

In this chapter we model designing a marketing campaign, to create awareness and adoption of a new product among consumers linked by social media. We consider Facebook as the social media. Consumers learn about the product either by receiving a direct advertisement or through word-of-mouth from their social contacts. When the network is modelled as a random graph, product awareness grows over time. It is also considered that in this process, some consumers can fail to learn about the product in the long run because they are not aware of the contacts to spread the word. We use social analytic tools to characterize the optimal marketing mix when the monopolist can invest in both direct advertising and in —virall content designed to stimulate word-of-mouth.

Brands take advantage of the new promotion, through Facebook pages with the following.

1. **Improving Participation:** Promotions launched directly on the brand page significantly increase success rates, as people are more likely to participate and add more “like”s.
2. **Extend Reach and Engagement:** Page posts about promotions will be displayed prominently, in the News Feeds of those who like the page, broadening the audience reach, and overall post engagement. The frequency of promotion is also important.
3. **Posting in Timeline:** Implementing promotions through a brand page via Timeline is a much faster and effective way for better reach, as they can be spontaneous, whether it's designated weekly giveaways or seasonal-type promotions, brands can implement as they see fit.
4. **Increasing the number of Fans:** Depending on the promotion value, brands allow fans to have some advantage of giving the ability to participate in some promos, which increases your fan base and prompt non-fans to enter to win and become a fan.

4.6 Measuring the impact of Facebook promotion

Facebook has analytic tools like Page Insights [94] that provide information about Page's performance, demographic data about the audience, and see how people are discovering and responding to the posts. Page Insights regularly give the trends which help, in developing better performing content. It helps us to understand who responds to the messages. This also gives the parameters gender, age and location of the people who are the

most engaged with your business which helps in continuing to engage them through targeted ads and promoted posts. Facebook will automatically optimise your campaign so that more of your budget goes to the advertisement that performs the best.

4.7 Diffusion Model

Diffusion models have entered the marketing discipline, with the publication of the first mathematical model of new product diffusion by Bass, who realized that it is possible to use diffusion theory, to mimic the S-shaped growth pattern. Bass Model is one of the most used diffusion models to describe the process of how new products, get adopted in a social network. Here we are experimenting with three datasets and establishing a general probabilistic framework to derive the macro level diffusion models which confirms the well-known Bass Model.

There are two types of diffusion effects Innovation and Imitation. Innovation is the awareness of the brand by advertising and promotions and Imitation is the awareness of brand caused by word-of-mouth recommendations and reputation. Prior to Bass, diffusion models were either pure innovative (assume diffusion only caused by external forces) or pure imitative (assume diffusion only caused by imitation /word of mouth).

The Bass model combines innovative and imitative behaviour into one model.

The model presents a rationale of how current adopters and potential

adopters of a new product interact. The mathematical expression for Bass Model principle is

$$\frac{f(t)}{1 - F(t)} = p + qF(t)^{[1]}$$

Where:

f(t) – the rate of change of the installed base fraction

F(t) – the installed base fraction

p - Influence parameter for innovation

q - Influence parameter for imitation

This expression can be rewritten for additional intuitive understanding using the equivalent representation. There are two special cases of the Bass diffusion model. The first special case occurs when $q=0$, when the model reduces to the Exponential distribution. The second special case reduces to the logistic distribution when $p=0$. The Bass model is a special case of the Gamma/shifted Gompertz distribution (G/SG)

4.8 Case Studies

For the purpose of the study, descriptive research is undertaken. The data used in this study has been collected from an authorized marketing agency, involved in social media promotion. The researcher was familiarized with the domain and the problem or concept to be studied. There are three case

studies considered in this chapter. The different metrics examining the growing significance of social media as a tool, in achieving the marketing communication objectives of organisations in the emerging economies and effectiveness of this kind of promotion was earlier studied and presented. The data is taken for a period for a different duration for different case studies.

A firm introduces a new brand into a population of consumers connected by a random network. The consumer is made aware of this brand through direct advertisement or through social contact. Brand promotion is a continuous process. Reaching people, standing by the brand and promoting the brand is done regularly. The brand awareness and product adoption move together over time. The model is dynamic.

4.8.1 Case: 1 Brand Promotion of XYZ Hypermarket

As a case study, we are analysing data from Facebook for the Brand awareness promotion of a global chain of supermarket in the local market of Cochin. For the case of anonymity, the brand is called XYZ Hypermarket which had already established around 100 outlets in another part of the world.

A descriptive research is undertaken. The growing tendency of social media as a marketing tool in a confined geographical location is considered. The objective of the study is

- a) To understand the concept of Social Media Communication.

- b) To explore the tools used in social media communication that help brand promotion
- c) To study the effectiveness of campaigns using social media in emerging markets.

Facebook tracks the total number of fans for your brand page. Apart from this, it reviews the number of friends from those it become fans during a specific period of time or during the promotion or those who commented or liked your post to identify the potential monthly reach. Facebook insights provide values. Measuring engagements show how many people actually cared enough about what you had to say to result in some kind of action. Facebook determines how many times your link was “clicked”, messages were “liked” or “commented” on. This can be broken down to see how many people created this activity. Wall posts and private messages if linked to the activity that is directly tied to a specific social media campaign can also be tracked.

In Facebook, the number of fans for the page, the number of friends that each user have, became fans during the month, commented on the post during the month, liked the post during the month are all recorded. This helps to understand the reach, engagement and influence through this channel which calculates the impact that can then be applied as a model to other social network.

The data is analysed for one year period between April 2011 and March

2012.

#Likes for a period from Jun 2011 and Mar 2012		
<i>Month</i>	<i>New Likes</i>	<i>Total Likes</i>
Jun ^a	2328	2328
Jul	6682	9010
Aug	4083	13093
Sep	7266	20359
Oct	9359	29718
Nov	6623	36341
Dec	8001	44342
Jan	3508	47850
Feb	9238	57088
Mar	9065	66158

Table 4.1 No. of “likes” in FB page between Apr 2011 - Mar 2012

The analysis is done only from June 2011 to March 2012 as we see very little activity for the period Mar 2011 to May 2011. The ‘likes’ steadily increased from June, which showed that our purpose of increasing the reach has achieved. Likes provide very little information. The results and response of Facebook activity namely - Number of posts, Number of people actively engaging through comments, likes are measured using FB insights.

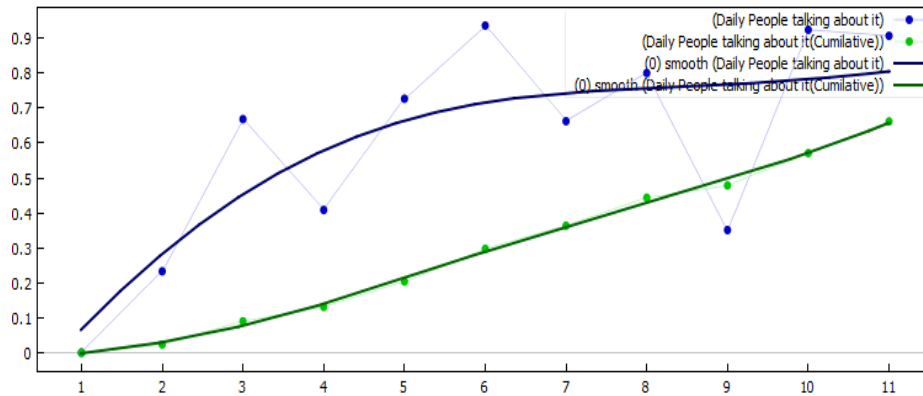


Fig 4.1 Increase in the number of Adopters over a period of one year with months in X-axis and No. of adopters in 1000 in Y-axis

4.8.2 Case 2: Brand promotion of a new Cinema Multiplex

In this case, we analyse the problem of brand promotion using Social Media with Facebook as a media of a new multiplex near Cochin. For the case of anonymity, the brand is termed XYZ cinemas. Data has been collected from an authorized marketing agency deployed by the company. This helped the researcher to familiarize with the problem or concept to be studied. This study examined the growing significance of social media, as a tool in achieving the marketing communication objectives of organizations in the emerging economies in particular confined to a geographical location. This data is only for a month.

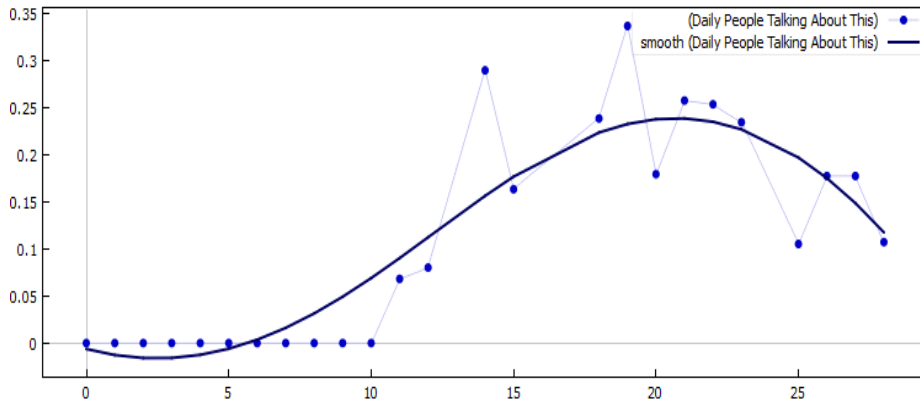


Fig 4.2 Increase in the Number of Adopters (in a short span of one month) with days in X-axis and No. of adopters in 1000 in Y-axis

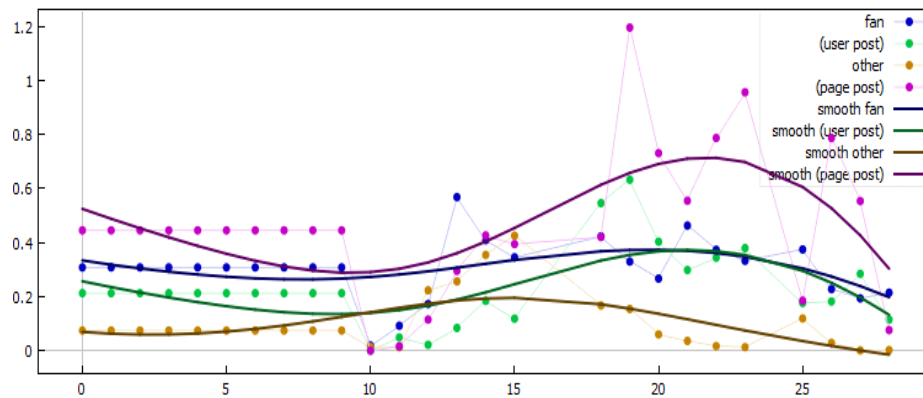


Fig 4.3 Daily viral reach of the Page by story type (Unique Users) with days in X-axis and No. of adopters in 1000 in Y-axis

4.8.3 Case study 3 Brand promotion of a Movie

This is a case study of promoting the movie in Cochin. For the case of anonymity, the name is XYZ. Data has been collected from an authorized

marketing agency deployed. This helped the researcher to familiarize in movie industry creating viral alternate reality campaigns in social networks to build awareness, leveraging social media to connect with fans and promoting its products. Figure 4.4 below shows the ways that social media is having an impact on movie marketing and promotion.

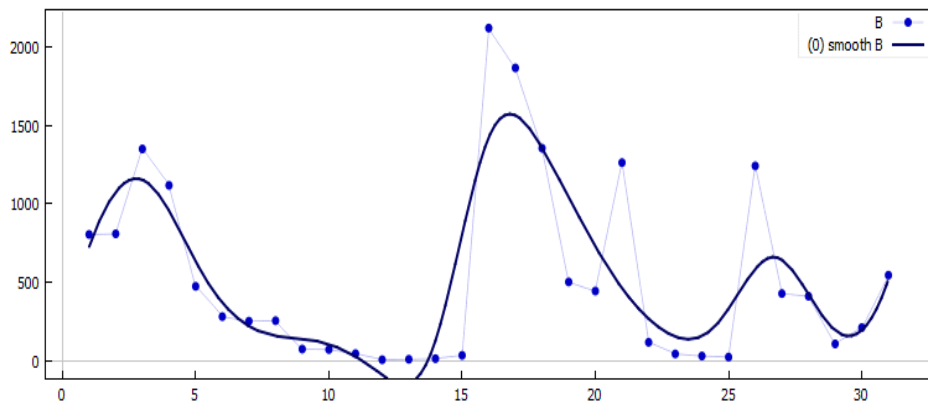


Fig 4.4 Daily viral reach of the Page by story type. (Unique Users) for the first month with days in X-axis and No. of adopters in 1000 in Y-axis

Dataset:

The dataset used for the experiment is shared with an understanding of keeping the anonymity. The real data for brand promotion is used for methodological, theoretical studies.

4.9 Discussion:

In the above three cases studied, the first two follow a similar pattern, whereas the third case gives a totally different picture. The first two almost

fits the Bass Diffusion model, whereas the third case study is slightly different. It is concluded that domain is also important. In this analysis, we have not considered domicile, gender or age factors. There may be visible changes in the diffusion pattern if these parameters are considered.

FB insight tools [94] give the metrics that makes or helps the study of the patterns. The 'likes' are steadily increased, which shows our purpose of increasing the reach, has been achieved. Likes alone provide very little information. FB insights give the measurement of Number of posts, and the Number of people actively engaging through comments or likes

- Weekly People Talking About This – is a measure of unique users sharing stories about the page? These stories include liking your Page, posting to your Page's Wall, liking, commenting on or sharing one of your Page posts, answering a Question you posted, RSVP'ing to one of your events, mentioning your Page, photo tagging your Page or checking in at your Place. The number is counted only once no matter how many times they interact with your page as we consider unique users.
- Weekly Total Reach - is a measure of the number of people, who have seen any content associated with your Page. An important observation here is that there is a time related variation here. You need to engage the fans to attract more people.
- Virality - is the measure of the number of unique people who have

created a story from your Page Post, as a percentage of the number of unique people who have seen it.

This answers the first research question. Facebook focus on the user experience and the integrity of its website. With the increasing amount of members spending online, social media advertising is the wave of the future. Facebook seems to have a handle on this new method of advertising that appeals directly to the Internet generation. Facebook advertising and ads like sponsored like stories play a very important role in the fan increase.

4.10 Findings

The performance in terms of influence and spread is demonstrated through the three real life network experiments. In all the three cases, marketers leveraged content allowing full implementation of social media initiatives for short-term promotion modes or sales promotion techniques. Though the work is preliminary, it gives significant insights and implications for diffusion research and marketing practice. The acceptability of a new product before investing significant resources in them is predicted. This is compared with the traditional advertising models. Hence Bass model [93] is treated as a good starting point for forecasting the long-term branding.

The important findings are summarised as

1. The different measures of likes, reach, engagement, demographics helps in understanding the growth of users and how the content is resonating with audience.

2. Facebook Insights provide data which can be analysed to get meaningful information. This data can be used to track the performance of finding emerging patterns in information diffusion
3. It takes some time for the content to start and reach many people. This is very helpful to plan promotions and also time sensitive initiatives.
4. The count of unique visitors in terms of organic searches, paid and viral gives the effectiveness of how much of the content is actually reaching the potential customer.

This describes the second research question of path of information diffusion. From the preceding discussion, it is clear that social media has vast opportunities to develop brand engagement. The data points measured like engagement, reach, demographics through likes, comments and repost gave an insight into how the content is resonating with the audience, how the page view is growing and how the trend is likely to be.

Facebook helped to create a brand for many businesses. Collecting social media data is a challenge for researchers. Automated data collection is not permitted by Facebook. Hence the scope is restricted to modelling and observing the user network that the content has generated during a limited time period. The effect of the content, people and network dimensions and different socially affecting factors are analysed. Certainly, the vast majority

of social media efforts have not been successful and many seem to be merely sales promotion activities directed to customers already involved with the brand. Yet, as with nearly all innovations, ways of thinking, and marketing paradigms, social media practitioners and academics need to find better ways to use these forms of social interaction. Since academic contribution is less in this area, successful social media campaigns will create more insightful outputs for marketers.

The findings are structured as follows. The preliminary definitions, social metrics and details concerning data collection are provided. A data driven percolation model is mapped.

The word-of-mouth campaign has a crucial role in influencing consumer decisions. But the conventional methods were highly inefficient to measure the impact. The social media campaign is treated as electronic word of mouth. A gradual growth and decay around an event was observed. Abrupt spikes were also found. Viral patterns driving content diffusion can be monitored. The experiment provided an insight into the marketing strategies to be followed considering the dynamic nature of social network. The third research question is addressed here.

.4.11 Conclusion and Future Directions

Many of the earlier research on the flow of information and influence through the networks is done in the context of epidemiology and the spread of diseases. Thus diffusion process were modelled as SIR

(susceptible/ infected/ recovered) and SIS (susceptible/ infected/ (recovered)/ susceptible) models. There are numerous other models of influence spread in social networks. One of the first and most influential diffusion models was proposed by Bass [93]. The model describes an S-shaped curve, where adoption is slow at first, takes off exponentially, and flattens at the end. It can effectively model word-of-mouth product diffusion at the aggregate level but not at the level of an individual person, which is one of the topics we explore in this article. Diffusion models that try to model the process of adoption of an idea or a product are divided into threshold model or cascade model.

Many studies are conducted on information cascades. The simple cascades of resharing are studied extensively, but the cascading behaviours on social media are less explored. Large scale analysis of cascades on Facebook over a long period is studied by Cheng et al.[127]. The size of information cascades are predicted by feature based methods and point process based methods. Feature based methods first extract an exhaustive list of potentially relevant features, including content features, original poster features, network structural features, and temporal features. Then learning algorithms are applied. Cheng et al.[127] formulated social virality prediction as a sequence of binary classification problems, while a cascade is tracked over time. Matsubara et al. [128] studied the rise and fall patterns of information diffusion and found that it follows power-law pattern and periodicities are inherent in such data. Matsubara et al. [128] introduced the time series fitting model to describe the temporal pattern of a viral event

with a diffusion mechanism and periodicity. Zhao et al. [129] proposed the self-exciting model for information cascades (SEISMIC) using the theory of exciting point processes where no feature engineering is required. SEISMIC employs a double stochastic process, one accounting for infectiousness and the other one for the arrival time of events.

People in social networks build up relationships and share ideas and information with their friends, family members, casual acquaintances, and so on. Social media has penetrated into our everyday life and has made the information spread faster and easier. The community is one of the most significant structural properties of networks. Community detection is of great importance and has a variety of applications. The ability to identify a community of customers in a consumer network helps in understanding/knowing similar interests and purchase behaviours. This helps in an effective recommender systems. The issue of identifying communities in the context of social networks is not easy as it needs to be with respect to the context of the application.

From the literature up to date, we see that game theories have been used to solve community detection problems. The evolution of clusters is a bottom up natural evolution in real-world networks. The game theorists model the interactions among individuals in social networks as game, in which the decision of one player can influence the decision-making of other players.

The community detection problem is addressed by Chen et al.[122] as a non-cooperative game theory-based framework. The community formation

is the result of individual agents' rational behaviours and a community structure as an equilibrium of a game. This framework could identify the overlapping communities. The major drawback here was that hierarchies between communities were hidden.

The community detection problem was addressed by Hajibagheri et al. [123] using a framework based on an information diffusion model and the Shapley Value concept. In this framework, each vertex of the underlying graph is attributed to a rational agent aiming to maximize its Shapley value in the form of information it receives, and the Nash equilibrium of the game corresponds to the community structure of the graph. Zhou et al. [124] proposed a coalitional game framework and is able to detect overlapping communities but it needs tuning of parameter values. Bu et al. [125] proposed a method named GLEAM to identify communities based on game optimization. Cosine similarity is used to weigh each edge including intra-edge and inter-edge. The temporal dynamics of networks is not considered. In evolving networks, the time decaying strategy for edge weights should be designed to determine the influence of historical relationships. A game theory-based framework and a corresponding deterministic method are proposed in [126] to model the Materialised View Selection (MVS) problem as a non-cooperative game. The MVS problem is modeled as a repetitive game. The game has two players, which are equivalent to the query processing cost and view maintenance cost. The data characterizing a profile is used in the information search process to provide relevant results for its query.

Mobile social networks are getting increasing attention from both academia and industry. With the expanding scale of mobile networks and the population of mobile users, delivery of mobile content has increasing demand. This content delivery in MSNs unlike conventional networks is huge in quantity and is based on social ties. Xu et al. [130] found that smartphones are popular where information can be easily disseminated and used by all mobile users through peer-to-peer links. An analytical model to mimic information dissemination among mobile social users was developed by Z. Su et al.[131]. The two pre-immunity and immunity elements was introduced in the proposed model to show the change of mobile nodes' interests during information dissemination efficiently. The information dissemination mechanism showing the dynamic diffusion of information flow in the social network is studied by Z. Wei et al.[132]. PAC-K-Means algorithm is adopted for building a comprehensive assessment system of information development and to find a relationship between the information spread and public opinion.

Social networks have become an important part of everyone's life. Many research on the analysis of the propagation of information, influence, innovations, infections through networks etc., are being explored from different angles. The cascade of information flow over the network is one of the most important phenomenon observed over these networks. We have reviewed some of the recent developments in information diffusion analysis in social networks and its applications. Here we have demonstrated with practical examples of promoting a company page on Facebook in three

different scenarios. From the literature, we conclude that this basic study on information diffusion gives an insight into the current issues of information diffusion and a pointer to future research directions.

.....&&.....