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TweetSight: Enhancing Financial Analysts' Social Media Use

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ABSTRACT

Financial analysts utilize information from heterogeneous sources (e.g. corporate filings, economic indicators, news, and tweets) to generate unique trade ideas through a sensemaking process. In this paper, we seek to understand the role of social media in this process. We conducted a semi-structured interview and identified essential benefits and barriers for the primary social media platform used by the analysts - Twitter. Analysts use Twitter as a query exploration tool, as a bellwether to understand sentiment, and to gauge knock-on effects. Drawing from our findings, we developed four scenarios to guide the design of TweetSight. Finally, we evaluated the design of TweetSight by walking analysts through the prototype. Analysts responded positively to anchoring contextual tweets in news articles to facilitate discovery and exploration of Twitter. Our findings and design implications can be applied more broadly to leverage social media for sensemaking, benefiting various business communities.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**; *Wireframes*;

KEYWORDS

Financial analysts; Prototyping; Twitter; Human centered design; Sensemaking

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1 INTRODUCTION

In the current age of extensive digital connectivity, social media has become an important medium of communication. As such, use of social media in the enterprise has been studied to various degrees [22, 24, 32]. Researchers have observed that employees use social media for various work related activities, such as keeping updated with peers, finding solutions to work problems, and discussing work-related information with their community [11].

Financial analysts represent an interesting case of social media use in the enterprise. Financial analysts are responsible for generating financial reports and providing stock recommendations for buying and selling various financial instruments [6]. A primary output and revenue generator of these reports are the unique trade ideas. In generating these ideas, analysts depend heavily on external information from various sources e.g, corporate filings, company fundamentals, news from traditional media, and opinions on social media [5]. However, there has been very little research on how these financial analysts make use of social media to accomplish their work. Therefore, we present the following research question:

RQ-1: How do financial analysts leverage social media in sensemaking to generate trade ideas and research reports?

To gain insight into this question, we performed semi-structured interviews with financial analysts to understand their perceptions and usage patterns of social media. Financial analysts are particularly of interest in this aspect because their work is extremely time sensitive and high stakes. They need to generate unique and relevant trade ideas at an extremely fast pace, as these ideas lose value over a period of time [28]. They work in a high stakes environment where their earnings are directly tied to their trade ideas and research reports [26].

In this investigation we uncovered some of the problems analysts experience using Twitter as an information source. We derived four scenarios from these problems, which were built to further probe and check these problems around past financial events. These scenarios were then used to design TweetSight - a prototype which allows financial analysts to explore important and contextual tweets while reading a news article.

RQ-2: How can we support the practices of financial analysts in leveraging social media (Twitter) for sensemaking?

We conducted design analysis interviews with the analysts to validate the effectiveness of TweetSight. Our study can help researchers and designers understand how social media is used in sensemaking by organization professionals whose work is time critical and involves high-stakes knowledge creation.

2 RELATED WORK

In this section we present prior work related to our main contributions: How financial analysts use social media; how to support sensemaking practices with social media.

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2.1 The work of a Financial Analyst

Financial analysts are an important part of the financial market ecosystem as they collect, study, explicate, and disseminate information to various market participants [6]. They are remunerated in direct proportion with the performance of their recommendations. Therefore they keep abreast by gathering information from various inputs, making sense of key trends from news and interacting with management [7, 9, 23]. They seek to be responsive to their clients and gain their approval [6]. There is extensive research on financial analysts from finance and accounting perspective [6, 7, 26].

On the other hand, research in the field of Human Computer Interaction has largely focused on stock market movement. Studies have leveraged information (e.g, social media) to predict market movements using data mining techniques [8, 20, 29]. Particularly as breaking insights on these platforms have a significant effect on stock prices [13]. We seek to fill this gap in the literature by examining how financial analysts leverage social media to provide accurate forecasts.

2.2 Sensemaking research in specialized fields.

Sensemaking is often defined as people "making sense of their worlds" [19]. In other words, it is how an individual processes information in order to come to a deeper understanding [19]. Even though sensemaking has been used in various research areas related to information [10] and organizational studies [27], it was brought to the field of Human Computer Interaction (HCI) by Russell et al. [21]. Russell et al. framed sensemaking as the process of forming meaningful representations and using them to facilitate insights and actions.

The most established sensemaking model is Pirolli and Card's [18]. In Pirolli and Cards' model the overall process is divided into two loops - Foraging and Sensemaking [17, 21]. The foraging loop involves activities such as seeking, filtration, and extraction of information, and the sensemaking loop involves the development of representational schemas used to draw conclusions and form hypotheses. One active research direction in sensemaking is how to support creating, organizing, and shaping such external representations of knowledge [16].

A lot of work has been done around sensmaking processes and systems for various specialized domains. For instance: Citesense is a tool which assists academics in making sense of vast amounts of literature [31]; Wahlstrom et al. examined sensemaking in safety critical decisions in car racing [25]; and various other areas such as web searching [1, 3, 16], intelligence, business analysis [17, 18], and education [2, 30]. Our study provides new insights into how financial analysts leverage social media in sensemaking and proposes a social media tool to support these practices.

2.3 Social Media in the Enterprise

With the rise of social media in recent years, research into how it is used in the enterprise has increased. Researchers have found that social media provides opportunities for colleagues to form better relationships in the organization [32]. One difference between work and personal use of Twitter, is that work tweets are often limited to knowledge sharing [24]. Similarly, updates on Facebook's wall updates are used extensively for connecting with employees on a personal level [22]. On explicitly professional social networks, e.g, LinkedIn, users are interested more in the current professional lives of their social network.

However, there are comparatively fewer studies which have investigated how social media facilitates more primary work processes. One example is Mena et al., who found that Twitter is used by many e-retail platforms to engage and solve customer problems [4]. Facebook and Twitter is also used in the academic domain to recruit participants [12]. Most relevant to this study, are studies into the growing use of social media by the financial domain [5, 28]. We seek to add to this growing body of literature, through investigating how social media is directly used by financial analysts in their work.

3 STUDY-1: SEMI-STRUCTURED INTERVIEW OF FINANCIAL ANALYSTS

To investigate financial analysts' existing practices with social media, we conducted semi-structured interviews with six participants. Our research partner belongs to a large, privately-held financial corporation, helped us to select and schedule participants. Our partner reached out to candidates with extensive experience in the financial domain and specific knowledge into how social media is used. In our pool of participants we had three application specialists experts and three product managers. Participants had a minimum of 10 years (mean 16 years) of experience in the financial field. The interviewees spent an average of nine hours in their work environment per day.

3.1 Procedure

We conducted the interviews over the telephone and they lasted anywhere from 45-60 minutes. We provided interviewees with a brief introduction about what we were doing and how it might benefit their organization. Our interview prompts were purposefully high-level, open-ended questions, such as: "What is your typical work session like?", and "What are your deliverables?" We then transitioned to more specific questions: "How do you use social media in your deliverables?" Since the interviews were semi-structured, the questions were only used to guide the conversation. All the interviews were audio recorded after obtaining permission from the participants and later transcribed. We used open coding to analyze the material with a particular focus on our various exploratory goals: (1) Understanding the common deliverables and practices of financial analysts; (2) Usage of social media in their analysis. We present our findings in the next section.

3.2 Overview - What does a financial analyst do?

As per our interview analysis, the job of a financial analyst (also known as an equity, research, or rating analyst) is to generate trade ideas that create value for their clients' financial portfolios. These trade ideas aim to minimize risk and generate revenue. Financial analysts are futher divided into two main categories, sell-side and buy-side. Sell-side analysts perform regular, in-depth research reports about specific companies to give recommendations to buy-side analysts. In addition to these reports, buy-side analysts conduct their own research to generate unique ideas and recommendations

to sell to their investors, referred to as 'trade ideas'. These trade ideas aim at:

> [...] understanding what business is doing, what it is capable of doing and also understanding where the street is positioned around the story. As an analyst, your job is to pitch the story and the trade idea. - I2

According to I3 and I5, irrespective of the category they belong to, they start as junior analysts, covering one or two companies in their portfolio within a sector. As their experience increases, they start covering more companies (as many as twenty) and sectors. The set of companies that an analyst covers are referred to as their 'target list'.

As financial analysts' end goal is to recommend whether or not to buy or sell shares of a company, a company is the single most important entity for them. Naturally, their research and deliverables revolve around particular companies in their target list. As such, the analysts day-to-day activities involve reading news, opinions, and other information about the companies in their target list. We found that the information that the analysis gather can be broadly classified into two types: *Events* and *Themes*. In events based research the analysts are interested in how a specific event impacts a particular company. An example event provided by I5 was when Tesla announced the release of Model 3; a new budget electric car which could revolutionize inexpensive and eco-friendly car production. In contrast to events, themes are more broad, and refer to a particular phenomena that may involve multiple events. Themes also contrast with events in that they are an indicator for a particular sector (such as automotive), instead of a particular company. For instance, in 2016 there were multple competing announcements of affordable electric cars from Tesla, Chevrolet, Audi, and Ford. In this example, similar events occurred across various companies which represents a theme across the automotive sector. Based on our interviews there are a few salient characteristics of the work which financial analysts perform.

3.2.1 High stakes job. Interviewees mentioned that analysts earn most of their income from sales commissions on their trade ideas and research reports. Therefore their income is directly linked to the quality and the frequency of their ideas. Analysts need to predict the price at which a company's stock will trade as accurately as possible. This constant pressure to frequently generate high quality, accurate ideas makes for a high stakes job.

3.2.2 Time constraint. Financial market prices move fast and unpredictably. As such, trade ideas must be generated with a similar speed. As time passes, these ideas quickly lose their uniqueness and ability to generate income. Therefore, analysts have to capitalize on their unique ideas before other analysts catch up (I2 called this the *crowding affect*).

3.2.3 Unique trade ideas. Lastly, according to I1, it is not enough for analysts to just generate ideas. If everyone has the same idea at the same time as the analyst, the ideas are not useful. Therefore, they need to present unique ideas through a deeper understanding of the market. Analysts gain this insight through meeting with the management of the companies they are covering, attending important conferences in the sector, and reading news and breakthrough insights.

> [...]So he starts to develop kind of pieces in his head. Pieces in his head come from all sort of sources but a lot of them come from walking down the street, attending conferences, meeting management and also reading news articles. - I4

3.3 How are unique trade ideas generated?

The unique nature of financial analysts' work means that they must be on constant lookout for new information from various information sources. This information is used as input into their models, allowing them to predict trade-prices and build various trade-ideas for their research and recommendations.

3.3.1 Locating new information (Input). We found that the basis of any trade idea lies in understanding the current events or themes which impact a company or sector respectively. For example, release of information in a quarterly earnings report by Microsoft can impact the company's stock price. To gauge the impact of such an event or theme, the analyst is always on the lookout for information.

Irrespective of specialization, analysts are constantly scouring for information to understand events and themes that impact their target list. Common sources include financial metrics released by the company (such as price-to-earning ratio), official press releases, news (e.g, Wall Street Journal), and social media (e.g, Twitter, Facebook, and blogs). We understood that the information gathered plays a critical role in the analyst's job.

News often contains information that can impact their research model and feed into unique, profitable trade ideas. As I2 points out: "News is the precursor to either unlock value or create an investable idea. News drives the market." Analysts start each day reviewing news articles. They look at the companies in their target list which have undergone price changes and prioritize those companies when reading the news. If the analyst finds that a company's stock has moved 20%, they would then read news on what is causing the price fluctuation. Based on this understanding, the analyst can then go and update the portfolio security details or come up with a buying or selling rationale.

> When I would start with the beginning of the day, I would come in and look my portfolio and I see which news is associated with each stock. I would focus firstly on stock price changes. So something was up and down a lot, I would focus on that news first. - I3

To facilitate these practices, many analyst use financial tools like Terminal (by Bloomberg) and Platform (by S&P Global Market Intelligence) which aggregate news from various sources into a consolidated platform.

3.3.2 Modeling and Analysis. I1 communicated that a model is a representation of how a particular company is going to perform financially in the near future. Analysts take various approaches to come up with these models. In the top-down approach, the analyst starts from the entire universe of their investable space and filter it down to the names that have fundamental, quantitative metrics and

perform analysis at that level. Professionals who use the bottom-up analysis method look at larger themes in the marketplace by gleaning insights at the company level. Irrespective of the approach, the analyst is always adding variables and data to the model to calculate a more accurate output. In I1's own words, analysts are trying to use the model to understand the answer to the following question: "Do I understand industry well enough to put money in these trade ideas?" Each model is unique to each analyst because the variables and strategy which each analyst uses is always specific to him or her.

3.3.3 Calculating Target Price (Output). The output of the analyst's model is a unique price at which a company will be valued in the near future. It is often called the 'target price'. Analysts' income is directly dependent on how well they can predict this target price. They present these price estimates in form of research thesis or trade ideas.

Every time a major event occurs within a particular company, the analyst has to update the target price predictions as the inputs of the model change. For example, if a company comes out with quarterly earnings, the analyst will need to revise their target price numbers based on this updated data.

3.4 Usage of social media by financial analysts

Like news, social media is utilized by analysts as another information source. Opinions on social media are often used to complement the information presented in the news. A major difference between news and social media is that the information available from social media is not something on which analysts put their money on, but rather see as a "head start opportunity" in performing research into newly opened avenues. Within social media, the most frequently used platforms are discussed below.

3.4.1 Blogs. Blogs provide a place for readers to interact with authors, to collaborate with peers, and to share the content with various other readers [14, 15]. Analysts tend to develop trust in particular experts and fellow analysts. They follow these professional's steps and advice, including information from informal writings such as blogs. These blogs provide important information, however, there is an obvious presence of personal judgment involved when analysts develop the list of blogs they follow - these may not be same across analysts even within the same domain. The following quote by I1 shows the extent to which trust plays a factor.

> For example, Wall Street Journal can be good for one industry. Some of the columnists might be good. They are experienced in writing, for example, say one industry as opposed to something else. They have a track record and analysts follow that. Sometimes, they follow just other analysts. If the analyst changes from...these subscribers change too - I1

3.4.2 Collaborative communities. I2 and I5 mentioned collaborative communities as another source of information. These mostly take the form of internet forums where a group of analysts pitch their financial ideas and discuss them, e.g, Yahoo communities. In communities like these, users often post with pseudo-handles to create anonymity as the ideas and recommendations they provide might impact their personal reputation. Due to this, accountability is not as prevalent. At the other end of spectrum there are high-profile forums referred to as 'Investor Clubs' where access is limited to specific groups of professionals to share investment ideas for couple of reasons. I2 mentioned that one reason is for neophyte analysts to build their personal brand. Analysts who present an idea which predicts the future markets well get recognition in their community. Other times, professionals, like investment managers, want everyone else to see their personal view on an issue and help others understand what the market is currently missing.

3.4.3 Twitter. Interviewees unanimously cited Twitter as the most commonly used social media tool by the analysts. One thing that is unique to Twitter usage among the financial industry is the use of cashtags, which are special hashtags that use the ticker symbols for each company (e.g, $AAPL and $MSFT). Tweets about financial content often contain these cashtags. I3, I4, and I5 mentioned that Twitter is used for both quantitative and qualitative analysis. In quantitative analysis, text mining programs are used to provide directional and predictive information. In our interviews, we uncovered a few specific reasons for how and why Twitter is used their qualitative research, which we are more interested in.

Twitter for breaking information - There are times when social media will pick up an event before traditional news wires, as there are individual experts who are tweeting about an event in an unofficial manner. These unofficial tweets by experts hold potential value to the analysts as they give them a head start.

> It is 'first-to-market'. You have the advantage of first knowing something. If you are the first to know, you can take the opportunity before anyone else can take it. In that sense, it became primary source for most of the fund managers and analysts I know. - I1

Sometimes these tweets, especially those by established experts in the field, can also impact the market and move the price of stocks in a particular direction. I6 provided an example where a famous fund had affected the movement of Apple stock.

> What you get out of social media is that often you will have people who have very specific opinions on a stock that they tweet. For example, the famous fund manager like Carl Ichan (@Carl_C_Ichan) he might say Apple is worth $200 a share and in fact he said exactly that. He published a tweet, he said it is vastly undervalued. Once the investor can say that it is Carl Ichan who is doing the tweeting then the stock starts rallying tremendously - I6

Query expansion - In addition to providing access to breaking news, tweets also serve as a mechanism to understand the question of 'why' something is moving in the market. There are times when stocks move tremendously, but the traditional news does not provide an immediate reason. Tweets by knowledgeable people in that industry can help analysts fill these lapses and explain the movements of financial markets.

For instance, I4 mentioned there are instances when there is a big move in the pharma stock industry and stock of a particular company moves 3%. The analyst does not know why the stock is

moving - even the news media is not covering the event. In those situations, tweets by experts in the Pharma industry can possibly provide an answer for the analysts.

> There are times when social media will pick up before the traditional news wires will and in those instances you are involved in the trade in a stock and the stock is moving you don't really know why - I2

Bellwether - I5, who specializes in the retail market sector, reported that many companies use Twitter in the retail and fashion sector to engage customers and inform them about their new product lineup, interesting offers, etc. This engagement is used by analysts as they often provide a bellwether as to how well a company is attracting customers.

Tweets from reliable sources are also used in research reports as a potential reference point. When Bill Gross, a famous financial manager, tweets about American infrastructure falling short of 1.4 trillion by 2025, it has a significant impact and analysts might reference this tweet. Two interviewees explained that data gathered from Twitter is often used as input into the analyst's model. Additionally, financial companies like theirs have created special teams who work exclusively on Twitter feeds. As part of their job, they often manually vet important tweets to push through financial applications like Terminal.

3.5 Problems discovered with Twitter usage

Even though there are definitive benefits to analysts using Twitter, there was a hesitancy by analysts in relying on social media to reap these benefits. In this section, we present the major problems which lead to hesitation to use Twitter.

3.5.1 Problem-1: Difficult to Assess Knock-on Effects. Incidents related to one company often have repercussions on other companies in the same sector, and can even extended to companies in other sectors at times. This phenomenon is often called the "knock-on effect." According to I4, the Mexican government's decision to deregulate oil drilling off the Gulf Coast had a big impact on the cement industry. This is because this type of drilling increases demand for cement for the filling process. Moreover, it is not cost-effective to ship cement from the US or China, therefore, the obvious choice for many oil companies was Cemex - a major Mexican cement supplier. The deregulation effect had a strong knock-on effect on share prices of Cemex.

Successfully predicting tertiary effects such as these creates a rich financial opportunity for the analyst. The trade ideas generated from these knock-on effects are highly efficacious in that they require a deep understanding of events happening around the company, and opinions of a variety of subject matter experts. As a complement to traditional news, Twitter can provide an analyst with additional information about the event or theme in the form of expert analysis, recommendations, insider information to deduce such knock-on effects. Currently, analysts consume these tweets in an out-of-context fashion because they are presented based on subscription and chronology. Therefore, it is prohibitively difficult and time-consuming to effectively leverage Twitter for this purpose.

3.5.2 Problem-2: Difficult to Discover Relevant Tweets. There are a number of reasons that it is difficult for analysts to find the correct experts currently tweeting important information.

Subscription structure - In Twitter, a user can have many followers. When you follow a user, you get all of the tweets that they write. Therefore, to effectively utilize Twitter to find the next breaking news analysts would need to predict which important people will break the story.

Too much noise - An alternative strategy, is to search for specific keywords related to a current event or theme. However, this also proves difficult due to the large amount of tweets and it takes a prohibitively large amount of time to locate the few important tweets.

3.5.3 Problem-3: Small Impact Window. As the market moves quite fast, any breaking tweets lose their value once the the information is known widely thereby causing 'crowding-affect'. Therefore, the manner in which analysts currently consume tweets takes too long to be useful.

4 STUDY2: DESIGN STUDY OF TWEETSIGHT

Based on our findings from our interview study, we present our design study of TweetSight - a tool that assists financial analysts by situating relevant tweets within news articles. As part of this design study, we conducted walk-through sessions of the initial prototype with financial analysts to determine the potential efficacy of our design.

The aim of TweetSight (as show in the Figure 1) is to situate contextually relevant tweets alongside news articles. We chose news articles as the anchor point as these articles represented a common resource that financial analysts organized their information seeking and sensemaking around. As soon as the analyst opens a news article, TweetSight displays the most relevant tweets alongside it. As an example, if the user is reading an article titled "People are already lining up in tents to pre-order the Tesla Model 3," they will see tweets about Tesla's Model 3 on the right-hand side. These tweets are filtered based on additional parameters, such as key people who tweet frequently in the sector, individuals whom the analyst follows, and the presence of Cashtags within the tweets. Once the tweets are loaded, the user can refine the tweets based on either keywords in the news or in the co-occurring statistics.

In our Scenario-Based Design process, we developed five different problem scenarios, each of which was grounded in our previous interviews. Out of these problem scenarios, we developed four corresponding interaction scenarios. We then constructed a prototype based on these scenarios. While our prototype was interactive, in order to receive quick feedback on the design, we only supported the activities presented in the scenario.

4.1 Design Objectives

4.1.1 Objective-1 Discovering Knock-on Effects. The co-occurring statistics bar lets the user to observe related companies and helps them understand how events or themes relate with other companies or people. Additionally, the user can refine these tweets in order to explore tweets which discuss the co-occurring entities. These tweets can assist analysts in understanding the effects a focus company is having on the co-occurring elements.

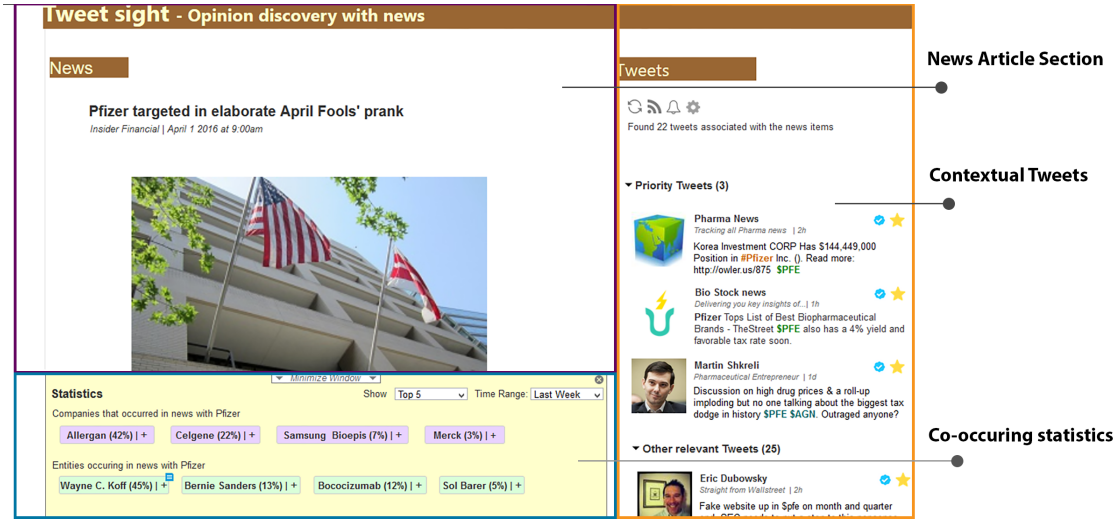

Figure 1: User Interface components of TweetSight Application: a) News article section, b) Contextual Tweets section, c) Co-occurrence statistics of the news article.

4.1.2 Objective-2 Leveraging the short term market impact. The option to subscribe and receive notifications for future contextual tweets using the subscription feature allows financial analysts to get to important tweets much faster. This process can provide them with an opportunity to take advantage of such tweets before the crowding-effect takes place.

4.1.3 Objective-3 Reducing the effort required for query exploration. Using the highlighted keywords in the article, the user can re-formulate the tweets present on the right hand side. It allows users to skim through an article by looking at the highlighted keywords. Additionally, as they are reading the news in detail, the user can perform query exploration by loading relevant tweets using the keywords present in the article.

4.2 Design of TweetSight

The interface is divided into three main components (see Figure1); (a) news article section, (b) contextual tweets section, and (c) co-occurrence statistics of the news article.

4.2.1 News article section. The news article section (1) contains the actual article where the names, organizations, and companies in the article are highlighted as keywords. In the Tesla example mentioned above, Elon Musk is one of the highlighted keywords. The classification and uniqueness of these keywords is determined using Named Entity Recognition (NER) and TF-IDF, two common algorithms which are used in textual analysis of the data. As the user scrolls through the article, they can click on these highlighted keywords to refine and reformulate the tweets on the right hand side, making them more specific. While the user reads through the Tesla article, they may observe the company name - 'General Motors' as a highlighted keyword. If the user adds General Motors to the current query, we display tweets that mention both Tesla and General Motors.

4.2.2 Contextual Tweets. The contextual tweet section displays the most relevant tweets regarding the current news article. The tweets are extracted from Twitter using keywords from the article. In order to restrict tweets to the financial domain, the tweets are further filtered by verified accounts and Cashtags. We further restricted the tweets by categorizing them into *prioritized* and *other* tweets. Tweets are labeled and shown in the prioritized section if they are published by curated tweet handles who have consistently provided valuable opinions in the sector or by the accounts the user personally follows. The list can be edited and maintained in the settings panel. For the purpose of our study design, we used the list provided by the partnered financial company. The user has the option to add tweet handles to this list by clicking on the add person icon beside the tweet. Curated accounts are shown with a star beside the tweet. The above filtration process reduces the volume of tweets, making it easier for the analysts to find valuable and relevant information. Users are also able to sign-up for future contextual tweets related to the current article. For instance, if the user subscribes to the Tesla news article, they will receive notifications for any tweets published after they subscribe. In this way, analysts do not need to actively monitor an article to see how it develops.

4.2.3 Co-occurring Statistics. Co-occurring statistics presents an expandable information bar at the bottom to show frequently co-occurring companies and entities. These co-occurring values are computed by performing text mining on the news corpus within the past month. For instance, in Tesla's article, the most co-occurring companies are GM, Ford, and Nissan. Alongside each keyword, the level of co-occurrence is shown besides each result. Similar to the highlighted keywords in the news article, these results can also be used by the user to refine and reformulate their tweets.

4.3 Design evaluation of TweetSight

4.3.1 Method. In order to understand how TweetSight may help to address the problems discovered in our first study we invited subject matter experts to provide feedback on our tool. For the design evaluation study, we recruited six different participants from the same financial corporation. To maintain similar composition to our previous study, we recruited three application specialists, two financial analysts, and a financial product manager. The average experience in the company for these participants was six years (max = 12 years, S.D = 3.3 years). The participants who were application specialists and product managers had more than 5 years of working experience as a financial analysts before joining the company.

4.3.2 Procedure. The design evaluation sessions were conducted virtually using the WebEx application. Each evaluation session lasted between 60 - 80 minutes. In the sessions, each participant was presented with three interaction scenarios covering the problems discovered in the previous study. An example of an interaction scenario is reproduced below:

Bill is a sell-side analysts who is covering Apple in his portfolio. He comes across the news item labeled "Apple, The FBI And iPhone Encryption: A Look At What's At Stake" on Mar17, 2:18pm. As Apple is in his portfolio item, he is interested in the news item which is becoming a big story. The news item talks about how the FBI vs. Apple is going big about the issue of privacy about which all the tech giants are concerned. He is curious in understanding what stance are other technology giants going to take.

In this scenario, as Bill is navigating through news, his attention is grabbed by Google which is highlighted as one of the key word in the body. He becomes curious by the presence of the competitor company in the news article. He then clicks on the keyword to re-formulate tweets. The resultant tweets contain nexus of 'Apple', 'FBI', 'encryption', and 'Google'. User can observe a tweet released by Sundar Pichai (CEO of Google) showcasing support and declaring stance with Apple. Tweets of support like these can help Bill realize the positive support of other technology companies on Apple in relation to the FBI feud. Additionally, he can click on the button on the top to subscribe to the future tweets which arising in context to the news article.

For each scenario, the participant was presented with the problem, and understanding of it was ensured. Then, we presented a step-by-step walkthrough of how an analyst could arrive at the solution using TweetSight. We chose to do a walk through as we had a limited time with each participant instead of observing how they use the tool, we were more interested in the concepts of the design as opposed to its usability. After completion of each scenario, participants were asked a series of questions. For example, one question for the aforementioned Tesla scenario was: "How does an analyst perceive negative perception (as tweeted by few tweet handles) occurring towards the Bolt while navigating through the Tesla news article? What kind of impact does it create on their analysis of the trade price?" All of the interviews were audio-recorded with participant permission and transcribed for analysis. We examined the data to find how participants responded to our questions.

4.4 Findings

4.4.1 Helping to Discover Knock-on Effects. Interviewees found it useful to view highlighted keywords within the news article and using these keywords to find new social media opinions, as it allowed them to create new exploration threads without losing focus on the current one. They felt that this would allow financial analysts to recognize knock-on effects by helping them find tweets that best informed their research thesis. I7 felt that this method of showcasing tweets was much more efficient and productive for analysts compared to the traditional method of subscribing to tweets.

> Primarily for our users, they are always thinking about what is the investment thesis here. So, let's say the story was negative for Apple (talking about scenario-1). If I know that Apple is in trouble, I would want to think of investment thesis I can generate from that. Maybe I don't want to short Apple, because the news is already out and the whole world is shorting Apple. You are not going to make any money by shorting Apple. Maybe there is a supplier of Apple or a competitor of Apple that has been mentioned in article whose related opinion might be a good information thesis - I9

4.4.2 Finding New Perspectives. Based on the interviewee's insights, we discovered that financial analysts are primarily concerned in understanding the development of a particular event from new perspectives. They felt that this understanding was easier as TweetSight improved the discoverability of tweets. They felt that using our tool's design, the analyst could discover tweets of support or disagreement by important tweet handles such as Sundar Pichai (in scenario-1), the CEO of Google, a Wall Street Journal reporter or another respected financial analyst. They were more skeptical of tweet handles that they did not know.

> The first tweet is... (referring to a tweet which has financial numbers) this tweet has more impact than the other two because of getting to fundamental numbers that might change someone's analysis. The analysis would themselves know that but if they don't, that is the tweet from the article to pull. But again, my point is that the content like that is more impactful - I7

They also felt that TweetSight would allow analysts to form their own perception. However, I3 felt that the analyst might need to verify these opinions with fundamental numbers before presenting these perspectives in a research resport.

> But if you had a very technical article about a very niche portion of cyber-security of semi-conductors, then using this technology would help to find the smart people whom you did not know existed on Twitter that aren't in the social consciousness rather than big news event where a lot of content is being produced where most of it is probably going to be regurgitating what they have in the news article. - I8.

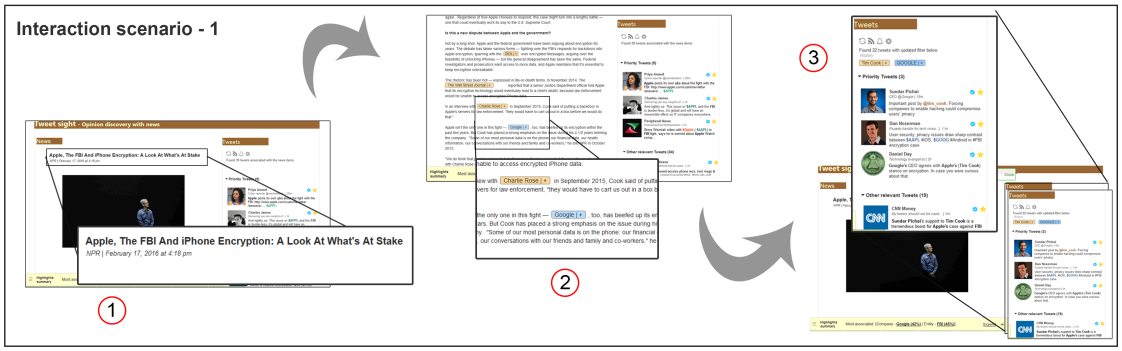

Figure 2: User Interface components of TweetSight Application.

4.4.3 Additional Context. They also thought that TweetSight will be useful when an analyst reads articles containing jargon or technical nuances beyond their understanding. In this case, having the opinion of a subject matter expert on the right hand side can help the analyst to decipher the news article as a part of query exploration process.

> I don't think it improves the reliability, it certainly improves the discoverability. It makes it much easier for the customers to find tweets that they care about - I9

4.4.4 Keeping Abreast. The interviewees felt that subscribing to get future tweets would allow them to follow developments on the fly. Analysts must follow any developing themes, however, it is difficult to constantly monitor numerous themes. Therefore, they appreciated the ability to receive notifications about new tweets as notifications without having the need to go back the the news article.

> That is pretty handy. It is saving me the time which I will spend you know putting in keywords or looking for it myself. If I can get relevant alert setup which notifies me pro-actively it is helpful. - I10

4.4.5 Making Connections. Interviewees found the idea of co-occurring statistics most relevant and useful as a design feature in the tool. I11 felt that presenting co-occurring companies and entities below the news allowed the analysts to gain an overall idea about the direction of themes associated with the company. He saw this happening as an analyst tries to link opinions on Twitter with the companies and entities mentioned in the co-occurrence keywords.

> I think it is useful specifically if you are talking about co-occurring products or those kinds of things. For example, if I want to see what people are saying about the new IPhone, and I am reading an article on Apple; I think I can quickly add Iphone co-occurring keyword to see what people are saying exclusively about Iphone - I7

I8 felt that this feature will be more useful when digging deeper into research and creating new perspectives, versus uncovering tweets which break information on social media. Overall, analysts talked about its potential use case in understanding the developments between rival companies in a particular sector. They felt that this feature has the potential to uncover valuable tweets that cover the competition space between two companies but are not very easy to find.

5 DISCUSSION

Based on the results of our first study, we feel there is a strong scope of increasing the potential of Twitter in financial analysis. We felt that there are many attributes of Twitter which make it very useful as an information source for qualitative analysis. TweetSight's initial design was affective in improving the overall discoverability of relevant tweets.

Additionally, the comprehensive work process followed by financial analysts to come with novel trade insights follow a notional model of sensemaking loop [18].

- **Information gathering** - Our findings show that analysts gather information from various external sources such as news, social media, financial metrics, press releases etc. Based on the companies in their portfolio they search and filter information from these sources. They collect relevant evidences in 'shoeboxes' [18]. Analysts often use notes or electronic documents to collect these pieces of evidence.
- **Representation in schemas** - Analysts use selective evidences from the shoebox to build their *schema* or analysis model. This process happens in an iterative manner as the analyst constantly adds new pieces of evidences to their model from the shoebox. They can also re-represent the financial models to improve their analysis results.
- **Insight Development** - The schema is often used to build insights and support hypotheses. In our findings, analysts often used models to develop their theories and research reports.
- **Knowledge product** - A presentation or publication is made from the insights generated for their audience. Financial analysts reveled that they do the same by pitching trade idea presentations and suggest investment strategies.

6 DESIGN IMPLICATIONS

6.1 In Twitter we Trust?

I7 and I9 raised the reliability of the authors of different tweets as an issue. Despite the assurance of verified accounts, they were hesitant to use tweets that they did not know. We plan to improve this design by showing additional information such as previous historical tweets, facts presented in Wikipedia Infobox about the user, and an option to give endorsements. These design features mimic some of their existing practices in their online communities to improve the provenance of tweets.

6.2 Notification Overload

Another challenge which I12 mentioned is to control the number of alerts which a user receives when subscribing to multiple contextual tweets of multiple news items. This challenge can be overcome by providing digests at specified intervals, instead of a notification for each tweet.

6.3 Refined Refinement

Interviewees provided the potential use of refining news items in reverse using the contextual tweets. They felt that using interesting tweets they can refine and find more contextual news items related to it, thereby saving time.

6.4 Beyond Cashtags

Interviewees also mentioned that cashtags are mostly used by companies listed in American stock exchanges which will limit the tweets results to a particular geographical location. To overcome this, additional filter options such as number of retweets and likes are required to limit the tweets to minimum.

7 LIMITATIONS

Financial analysts have a limited amount of time that they can dedicate to activities which do not contribute directly to their work [26]. Therefore, recruiting several experts, each with extensive experience, was a major challenge in conducting the two studies.

We also used medium fidelity prototypes as a medium to receive quick feedback on our design solutions. Even though they were quite effective, they are limited in their range of activities they provide to the users. Therefore, we plan on performing a longitudinal study after further developing the tool.

8 CONCLUSION

Our design research study revealed how financial analysts utilize social media in various ways to perform sensemaking. We also discovered essential problems around one of the social media tool Twitter, decreasing its potential to be used as a major information source by these analysts. Based on this information, we showcase initial design prototype of TweetSight to reduce the problem and assist in the sensemaking process. We feel our findings provide a significant impact on the society of financial analysts by providing them quality ideas and reducing the overall time for their work process.

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