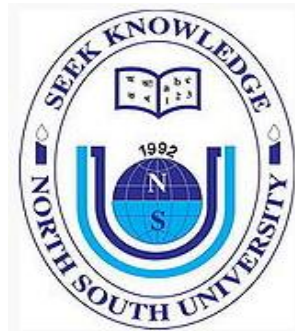


Senior Design Project Report

CSE/EEE/ETE 499B

Android Application for Scheduling Social Media Post



Submitted By

Md. Hasib Zaman (ID: 1712603642)

Jahin Mahbub (ID: 1531552042)

Yeahia Md. Arif (ID: 1410070042)

Supervisor

Shaikh Shawon Arefin Shimon – SAS3

Lecturer, Department of Electrical and Computer Engineering

North South University, Dhaka, Bangladesh.

ELECTRICAL AND COMPUTER ENGINEERING

NORTH SOUTH UNIVERSITY

[SUMMER 2021]

Agreement Form

We take great pleasure in submitting our senior design project report on “*Android Application for Scheduling Social Media Posts*”. This report is prepared as a requirement of the Capstone Design Project CSE/EEE/ETE 499 A & B which is a two semester long senior design course. This course involves multidisciplinary teams of students who build and test custom designed systems, components or engineering processes. We would like to request you to accept this report as a partial fulfillment of Bachelor of Science degree under Electrical and Computer Engineering Department of North South University.

Declared By:

Md Hasib Zaman

.....
Name: Md Hasib Zaman
ID: 1712603642

Jahin Mahbub

.....
Name: Jahin Mahbub
ID: 1531552042

.....
Name: Yeahia Md. Arif
ID: 1410070042

Approved By:

Sk. Shawon Arefin

Date: September 18, 2021

.....
Supervisor

Shaikh Shawon Arefin Shimon

Lecturer, Department of Electrical and Computer Engineering
North South University, Dhaka, Bangladesh

Mr. Shaikh Shawon Arefin Shimon
Lecturer
Department of Electrical & Computer Engineering
North South University

.....
Dr. Rezaul Bari

Chair, Department of Electrical and Computer Engineering
North South University, Dhaka, Bangladesh

Android Application for Scheduling Social Media Post

With the development of IT technology and information processing technology, Internet usage is rapidly increasing and various smart devices are appearing. Accordingly, modern people can obtain the information they want regardless of place and time. Smartphones are used in daily life such as leisure activities. Social Media involvement in our lives has been increasing daily, and maintaining this social media life has become more complex. Sometimes we might have to post our content remotely even when we are away from our workspace, or we might have to post something at a specific time, but we might be busy at that time. So, these issues bring to our solution the social media scheduler application where people can schedule their social media posts, and they can post from multiple platforms from one hub. In this project, we designed and implemented a schedule management application that is helpful in effective management of social media sites. It is expected that the application of this paper, which is different from other schedule management apps and has improved usability, will be helpful in efficient management of different social media sites at the same time.

Details of your project with significance, in 10-20 lines.

Focus general reader, and do not use any abbreviation, write in such a way that a reader from non-engineering background can get overall idea.

Link to our GitHub Repository: <https://github.com/NSU-SP21-CSE499-18/Group-03>

Table of Contents

CHAPTER 1	7
INTRODUCTION	7
1.1 Introduction.....	8
1.2 Purpose.....	9
1.3 Audience	9
1.4 Possible Features.....	9
1.5 Motivations	10
1.6 Objectives	11
1.7 Organization of Project Report	11
1.8 Conclusion	12
CHAPTER 2	13
EXISTING SYSTEMS	13
2.1 Introduction.....	14
2.2 What is Social Media Scheduler	14
2.3 Types of Social Media Scheduler	15
2.4 Existing System	15
2.4.1 Buffer	16
2.4.2 eClincher	16
2.4.3 Facebook Business Suite.....	17
2.4.4 Hootsuite	18
2.4.5 Sendible.....	18
2.4.6 Agorapulse	19
2.4.7 Sprout Social.....	20
2.4.8 Social Pilot.....	20
2.4.9 Combin Free Instagram Scheduler.....	21
2.4.10 TweetDeck	22
2.5 Advantages of Social Media Post Scheduler	23
2.6 Disadvantages of Social Media Post Scheduler	23
2.7 Conclusion	24
CHAPTER 3	25

PROPOSED METHODOLOGY	25
3.1 Introduction.....	26
3.2 Proposed System Methodology	26
3.2.1 Conceptual framework for the proposed system.....	27
3.2.2 Facebook:.....	29
3.2.3 Instagram.....	29
3.3 Flow Diagram for proposed System	30
3.4 Authorization	31
3.5 Facebook Business Suite.....	32
3.6 Interface	32
3.6.1 User Interface.....	32
3.6.2 Software Interface.....	33
3.6.3 Communication Interface.....	33
3.7 Essential Parts and Devices	34
3.8 Implementation Process	35
3.8.1 Share Post in Instagram Process:	35
3.8.2 Facebook Authorization Algorithm	36
3.8.3 Function for initializing the Facebook SDK	36
3.9 Advantages of Proposed System.....	37
3.10 Conclusion	37
CHAPTER 4	38
RESULT ANALYSIS.....	38
4.1 Introduction.....	39
4.2 Financial Plan and Costs	39
4.3 Feasibility Study	39
4.3.1 Product Feasibility	40
4.3.2 Technical and Operational Feasibility	40
4.3.3 Social & Market Feasibility	40
4.4 Privacy	40
4.5 Security	41
4.6 Testing and Output.....	41
4.6.1 User Access Token	42
4.6.2 Facebook Post Scheduling	42

4.6.3 Successfully Posted in Instagram.....	43
4.7 Problem Faced and Solutions.....	44
4.8 Work Break Down Structure.....	44
CHAPTER 5	46
CONCLUSION.....	46
5.1 Introduction.....	47
5.2 Challenges.....	48
5.3 Future Research	48
5.4 Conclusion	49

List of Tables:

#	Name	Page
01	Features of different social media sites	15
02	Features of different post schedulers	23
03	Development Components	34
04	Share Instagram Post Functions	35
05	Facebook Authorization Algorithm	36
06	Function for initializing the Facebook SDK	36

List of Figures:

#	Name	Page
01	Buffer Scheduler	16
02	eClincher	17
03	Facebook business suite	17
04	Hootsuite scheduler	18
05	Sendible Scheduler	19
06	Agorapulse Scheduler	19
07	Sprout Social	20
08	Social Pilot	21
09	Combin Scheduler	21
10	TweetDeck	22
11	Architectural Pattern	27
12	MVVM Architecture	28
13	Make post in Facebook with Graph API	30
14	Make post in Instagram with Graph API	31
15	Facebook Connected Page	42
16	Set Facebook Post Scheduler	42
17	Publish Content Successfully	43
18	Gantt Chart for CSE499A	45
19	Gantt Chart for CSE499B	45

CHAPTER 1

INTRODUCTION

1.1 Introduction

Social media is a part and parcel of our daily life nowadays. With the development of information and communication science and technology, the use of the Internet is rapidly increasing and various smart devices have appeared, and the quality of life is also improving along with changes in the expansion of daily life into cyberspace [1]. This social media, in a sense, controlling our personal and business life expressing our ideas posting unique contents. But it is not an easy task to come up with a unique idea every day or just remember to post it later. Moreover, ideas come all on a sudden and hard to remember them as an idea grows with thoughts. So, people often forget them. Modern people who are familiar with the digital environment and use mobile information often use mobile phone SMS, mobile messenger, and schedule management applications for simple expressions of intention or personal appointments. Not so long ago, people usually followed the traditional ways of writing the ideas in their notebook. Later, software like notepad makes it easier but not so efficient. But in recent times, the scheduling system has been made easier with improved efficiency for posts in social media. Moreover, there are a handful of applications and social media that one needs to maintain at a regular basis. Because social media has not only become the way of expressing oneself but also a medium for conducting business. In particular, various schedule management services are used to organize and remember tasks or to-dos that are suitable for one's role. Planner, One Day, Naver Calendar, Google Calendar, Apple Calendar, and various scheduler apps are used as tools for simple schedule management and time management.

An application that appoints or schedules post or tweets for social medias is commonly known as Social Media Scheduler. It is a mobile application for users as an everyday use. It can run in both iOS and Android operating system. We try to extend it comprising posts, likes, comments, views etc. It will enable not only the common people to make their life easier but also pave the way for various business to grow more. It can open a new dimension in the era of customer service-based business where the whole business is built on the satisfaction of the customers. Marketplace along the social medias will be more accessible for the customers following the trending posts of the seller creating a more competitive environment for the e-commerce business. Altogether, the social media scheduler application can create a huge impact both in our daily life as well as the socio-economic development of a country.

1.2 Purpose

Our main target is to reach the common people motivating them to use our application for increasing their productivity. We will try to build our application as a user-friendly system for expressing their ideas in all the popular social media. This will eventually result in a community development of thoughts and ideas that can help the society to be established as a futuristic tribe. In addition to this, we will also try to enable the business user to have a analysis on the market predicting the posts, likes, comments, reviews that are followed by the customers. Hence, all the people can use social media remotely. They can easily maintain their social media accounts form one hub and post when they are on the roam. Personal profile management will be much easier for common people following an easy use of every social media application. Lastly, the purpose of our project is to provide a solution to our target audience and that we plan to launch an android application.

1.3 Audience

Firstly, we will approach to include pages and groups in different social medias to use our application to maintain their pages and groups. There are many agencies and NGOs for different purpose like Hajj agency, banks, business agencies, organizations, garments, fashion houses, rural development etc. Maintaining a social media account in different format is a must for every agency to communicate with the users more frequently and efficiently. It not only extends the scope of the organization but also creates a positive impact on the peoples' perspective. There are many e-commerce-based businesses which are being conducted using these types of social media. Our application can be a great help for those who are starting new. Again, our application can be much useful to large groups too for maintenance, keeping the irrelevant posts or community rules violating comments away. Even if our audience is not so vast, but it can be extended with time.

1.4 Possible Features

Our program is a firebase-based application. The application will have several features like sign in, sign up and registration. Upon appropriate registration, user can verify information and login to individual account in specific social media. User can also provide images of respective account or holder and maintain his or her profile as per need. Using this registered profile, user can login to fb, twitter, Instagram etc. User can create a post with text input or image or both. It will be a

post as per the individual social media rules. For example, fb posts can contain texts, links, images, animation etc. Page will be updated in real time following every comment and reacts. These posts can be scheduled in the profile for a specific time according to the chosen time zone. Thus, posting contents will be automated. Moreover, user can also create stories both in Instagram and fb. They can be edited as it can be in fb or Instagram. User can also add location to the post and feelings tagging emoticons. Lastly, user can update the scheduled time if one wants to change it.

1.5 Motivations

There are many business organizations or startup companies who are conducting their business and connect with the customer through social media. These social media interactions create a huge revenue increasing sale and providing better customer service. So, they need to keep their social media accounts up to date posting any type of recent notices or news. Let's say McDonald's' wants to post about their breakfast special at 6 am acknowledging the available items from 7 to 10 am. But the items are unsured and depend on the supply. So, they need to schedule a post for that time with a tentative menu of items. They can edit the post later confirming the final menu at the very end without posting the final draft.

Again, a fashion designing company may want to announce their spring collection prior to regular posting of their new designs every alternate day. This is a natural effect that can happen on people, as Kanurai et al. [2] researched. They can post their designs one by one at each day scheduling via an app.

A very common example of today's world is handling different social media accounts like Instagram or Twitter by the celebrity or their fans. To boost a page or account of any fans account, it is a must to post regularly informing the very details. It provides a great advertisement to the celebrity and even to the accountholders. Collier [3] explained the scenario providing the example of Instagram. If a page or account makes at least three post per day, the account will become more engaging and active. The algorithm of the social media will promote that account automatically on their discover page. Therefore, the urge to support all these ventures motivating us to build a simple, easy to use yet efficient mobile application to schedule post in social media.

1.6 Objectives

The purpose of this project is to build a mobile application that can connect with different social media and schedule post. The followings are the objectives of this project:

- Reviewing the development of a mobile application
- Build an app that is supported both in iOS and Android
- Learn the usage of APIs
- Saving all necessary data and monitoring
- A system with no trust issue
- An easy-to-use system that can deliver real time information
- Build the APK file supported for different versions
- Hands-on experience to design a real-life application
- Provide a business solution to the business organization

1.7 Organization of Project Report

In chapter 2, we describe the existing system and their different features. The advantages and disadvantages of similar existing applications will also be discussed. The different types of schedulers and their purposes are discussed.

Chapter 3 will explain the system design and methodologies in detail. In this chapter, we will discuss the whole process of developing our post scheduler application. The software engineering methodologies and step by step organization of the project are discussed. The algorithms we use to build the app are explained and necessary flowcharts are provided to explain the whole thing easily making it more understandable. The requirements like hardware and software and project overview interfaces are also being discussed in this section.

Chapter 4 will provide a comprehensive analysis of the output of our application. We have tested our app in different module and explain the results in this section. We have discussed the type of testing is needed to develop any mobile application. The issues and shortcomings are also being discussed in this section.

Chapter 5 will finally conclude the report discussing some future prospect and research of our project.

1.8 Conclusion

Post Scheduler Application is gaining popularity gradually with increasing number of social media nowadays. Social media become the fastest way to reach the common people and customers without any large investment on advertising. So, it is cost efficient to the business organizations. But it is hard to manage so many social media at the same time and keep updated the page and information. Services need to be provided in all the social media. Hence, comes the necessity of post scheduler software. Organizations can post at a certain time in different social media at the same time or separately. It can enable a better business strategy of being available to the customer 24/7. Eventually it will increase the brand value and help the business in many other prospects. In this report, we will explain the process of making a post scheduler mobile application that can make a great impact in our personal and professional life.

CHAPTER 2

EXISTING SYSTEMS

2.1 Introduction

There are a considerable number of social media sites that people follow on a regular basis these days. So, covering all of the social media sites for our scheduling is near impossible. Hence, we select some of the most popular sites in our country after a thorough research to support with our application that will allow us to test our application considering the privacy and available API. They are: Facebook, Twitter, Instagram, LinkedIn, TikTok, Reddit, Snapchat and Quora. Different social media sites have its own characteristics based on their purpose and methods of posting. Some of them can only post a message or some of them can post only images or video clips and some can do both at the same time.

With this increasing number of social media sites, comes the necessity of managing all of these efficiently and smoothly. Keeping up to date in all required sites is quite a difficult job. To ease this hard work, post scheduler app can be really handfull. There are a number of researches and real-world applications and software are in action.

In this section, we will explain the background of a post scheduler application and different types of it. We will also put forward some state-of-the-art review to clear the concept of post scheduler app and its prospect.

2.2 What is Social Media Scheduler

A social media scheduler is an application or a digital tool to write posts or add images and schedule a specific time to publish it on respective social media site [4]. One can schedule all type of contents supported by the individual social media like texts, images, videos or links with this application. Many of the schedulers can also provide special services to the business organizations to connect multiple brand pages supporting them to manage their company or clients in a single place. Many of them wants to have a team of social media manager to run their connections. But this can prove costly for a start-up or new business. Social media scheduler can play a big role on this regard. They operate the social account efficiently using this scheduling tool. It also provides an ample opportunity to post as many as the audience want and push more content. Different audience expect posts at their preferrable time and social media scheduler can enable the chance to show appropriate post to the appropriate audience at an appropriate time.

2.3 Types of Social Media Scheduler

There are different types of schedulers for different purposes. There are schedulers for jobs, tuitions, events, medicines, calendar etc. But most of them are notification-based schedulers. Social media schedulers are one step ahead having the authentication process and access to the respective account for posting contents [5].

Table 01 shows features in different popular social media sites.

Social Media	Post	Image	Video	Caption	Character Limit	Stories
Facebook	✓	✓	✓	✓	63,206	✓
Twitter	✓	✓	✓	✓	280	✗
Instagram	✓	✓	✓	✓	2200	✓
LinkedIn	✓	✓	✓	✓	1300	✓
TikTok	✓	✗	✓	✓	100	✓
Reddit	✓	✓	✓	✓	40,000	✗
Snapchat	✗	✓	✓	✗	✗	✓
Quora	✓	✓	✓	✓	40,000	✗

Table 01: Features of different social media sites

2.4 Existing System

There are many post schedulers in action who can be considered as the potential market competitors against our project. They are: Buffer, eClincher, Facebook Business suit, Hootsuite, Sendible, Sprout Social, Social Pilot, Combin Free Instagram Scheduler etc. [6]

2.4.1 Buffer

Buffer is a social media tool that can manage a number of accounts at the same time with pricing. Using Buffer, one can connect with Facebook, Instagram, Twitter and LinkedIn. It has its own cloud storage to store the contents. Anything, including texts and images, can be posted using Buffer. It also provides an insight about the contents scheduled in a dedicated analytic section.

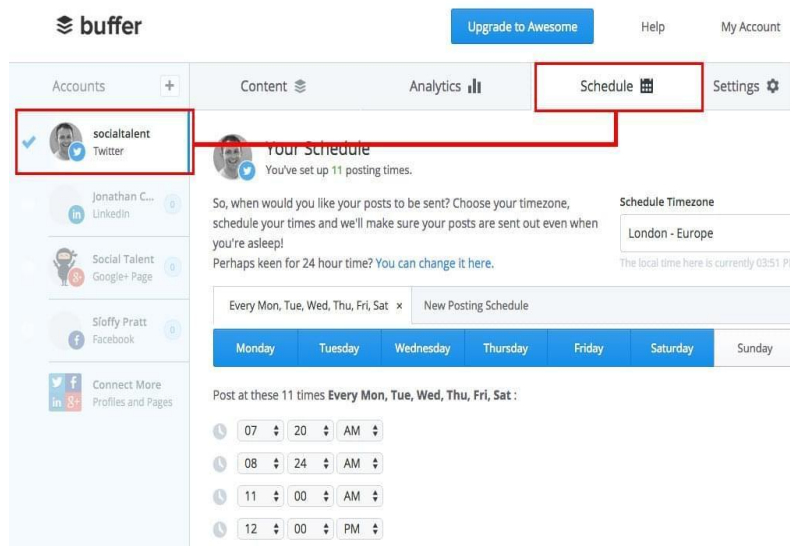


Figure 01: Buffer Scheduler

2.4.2 eClincher

eClincher is an app that is built specially for business organizations. It provides an intuitive but yet powerful solution to increase reach, reputation and growth of the brands. Popular features include suggested content & free media assets, live inbox to interact across all channels/message types, post-editing, scheduler & visual calendar, post-boost, monitoring with live feeds, smart queues & auto-posting, analytics & reports, team collaboration & workflows, mobile app.

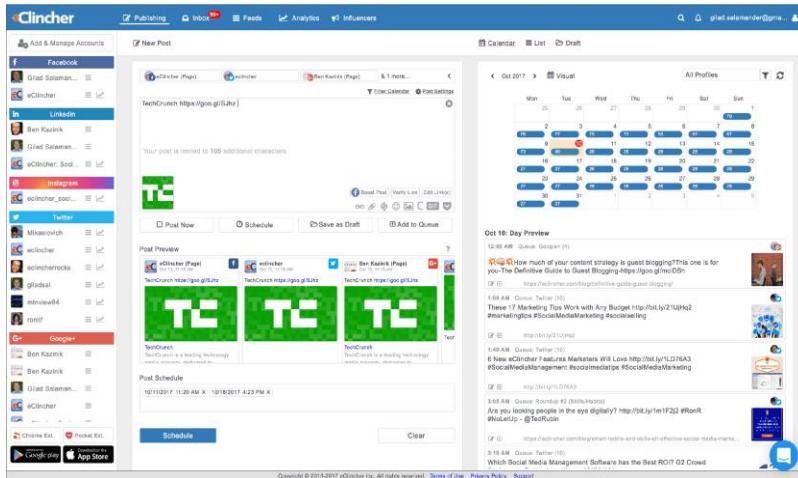


Figure 02: eClincher

2.4.3 Facebook Business Suite

Facebook provides a suitable API to develop apps like post scheduler. Its very own Facebook Business Suite is a perfect solution for those who conduct business through Facebook. It is the official application tool to manage Facebook page and Instagram page for business purpose. It provides different types of features like view activity and business, create posts stories, ads, schedule posts etc. It stores the scheduled content in its server and publishes at the scheduled time. It also provides a preview of the scheduled post.

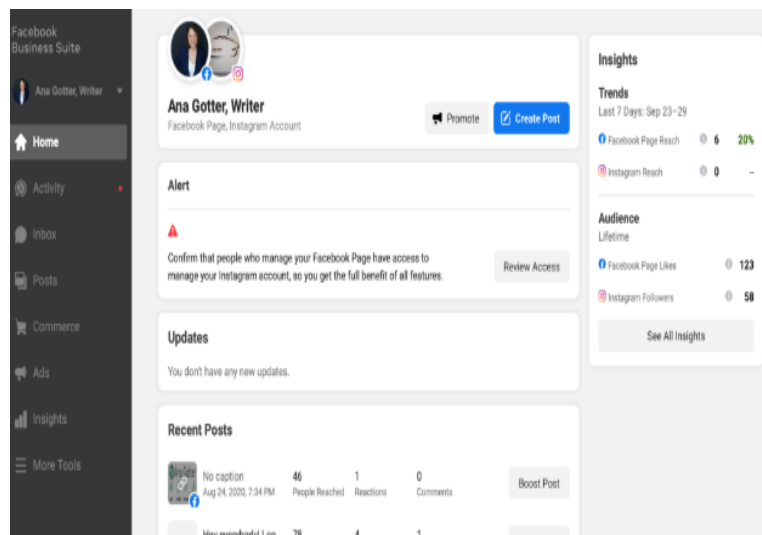


Figure 03: Facebook business suite

2.4.4 Hootsuite

Hootsuite is another useful application for managing social media network channels. Often referred to as a social media management system or tool, it enables you to view multiple streams at once and monitor what customers are saying. You can post updates, read responses, schedule messages, view statistics, and much more. Many international brands—including Coca-Cola and Sony Music—utilize this time-saving approach to social media marketing. With Hootsuite, you can post updates, review responses, and connect with your customer base on over thirty-five popular social networks. Including Twitter, Facebook (includes Profiles, Events, Groups, and Fan Pages), LinkedIn (includes Profiles, Pages, and Groups), Google+, Foursquare, WordPress blogs, and several other platforms via third-party apps.

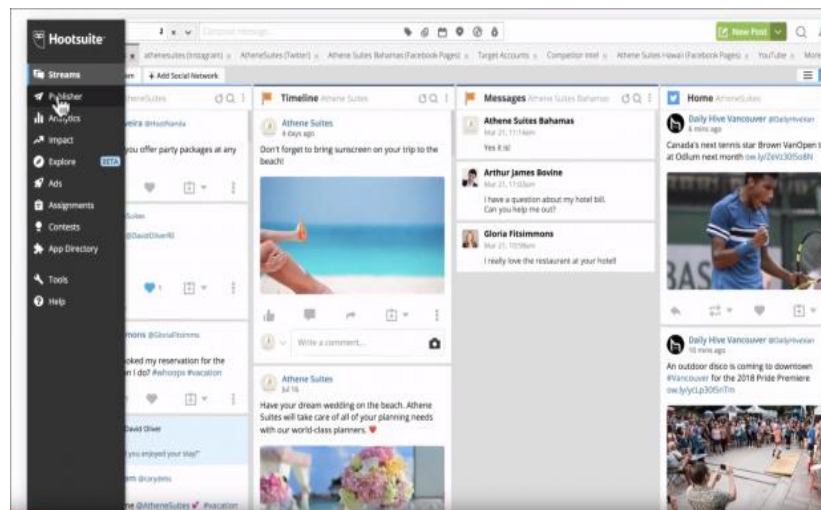


Figure 04: Hootsuite scheduler

2.4.5 Sendible

Sendible is another scheduler app with lots of features set to manage and amplify brands. It allows to schedule posts individually following a queue or in bulk. It extends its scope to adding relevant captions, hashtags, emojis in its suggestion. Announcing campaign in all the social media sites at once is a unique business strategy followed by many brands nowadays and Sendible does the work perfectly. Moreover, it provides its own calendar to schedule posts and move one date to another just with a swipe if needed. There are many more features that make it one of the most popular scheduler apps in 2021.

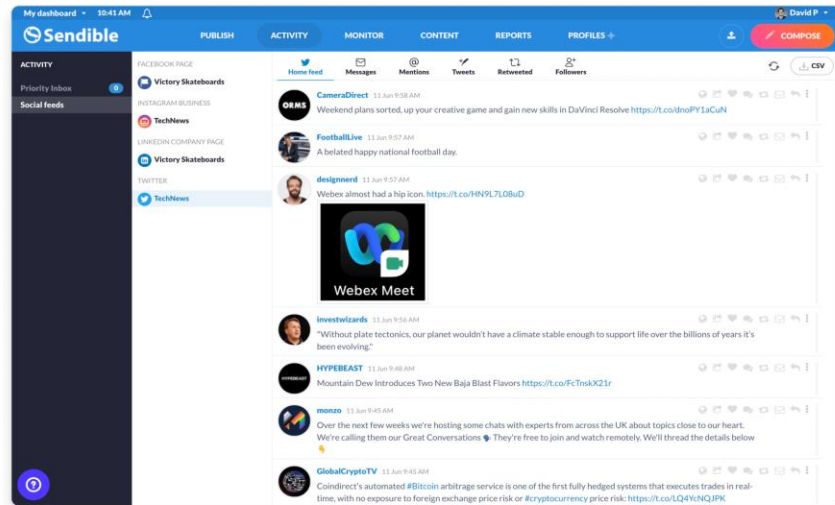


Figure 05: Sendible Scheduler

2.4.6 Agorapulse

Agorapulse is a very flexible, easy-to-use scheduler application with features more than needed. It has excellent scheduling functionality with publishing options to publish once, schedule again, or program a post to republish regularly. It also provides the scope to organize campaign uploading image posts or links in RSS feed and then publish in a bulk.

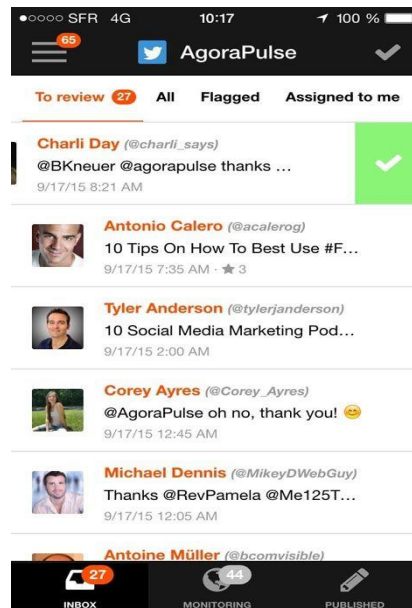


Figure 06: Agorapulse Scheduler

2.4.7 Sprout Social

Sprout Social offers robust social customer service solutions for leading agencies and brands, including Hyatt, Ogilvy, Leo Burnett, Evernote, and Microsoft. Sprout enables brands to simplify social monitoring, listening, customer service, engagement, and much more. Sprout supports Facebook, Twitter, Instagram, LinkedIn, and Google+ & integrates with Bitly, Google Analytics, Zendesk, Feedly & UserVoice.

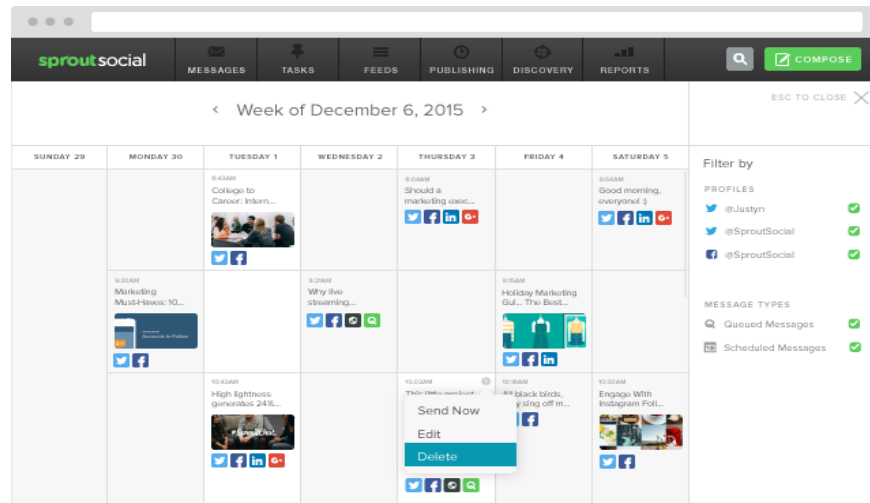


Figure 07: Sprout Social

2.4.8 Social Pilot

SocialPilot is a social media scheduling and marketing platform developed specifically for agencies and social media professionals. Used by over 40,000 agencies and social media teams, SocialPilot is designed to help users enhance the efficiency of their online marketing strategies and efforts and save time and money. Moderately priced and appropriately integrated, SocialPilot is meant to be accessible for businesses of all scales and industries. There is a free starter package for three connected profiles you could use to examine the features and confirm SocialPilot is an intelligent choice for your business.

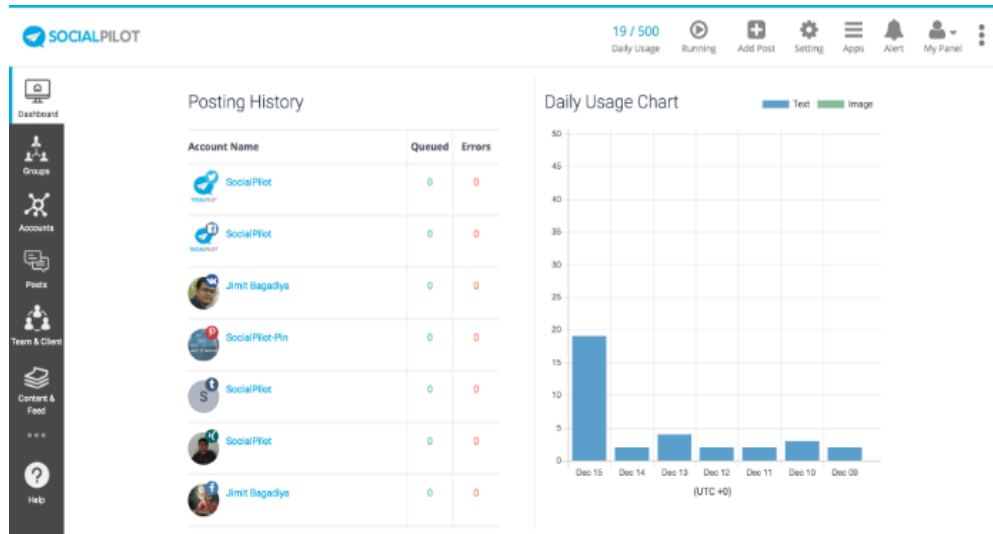


Figure 08: Social Pilot

2.4.9 Combin Free Instagram Scheduler

Combin's goal is to provide efficient Instagram marketing solutions. It doesn't have any mobile version. It only offers a desktop version. The application has to be running in the background to post on Instagram. It doesn't support any other platform and media.

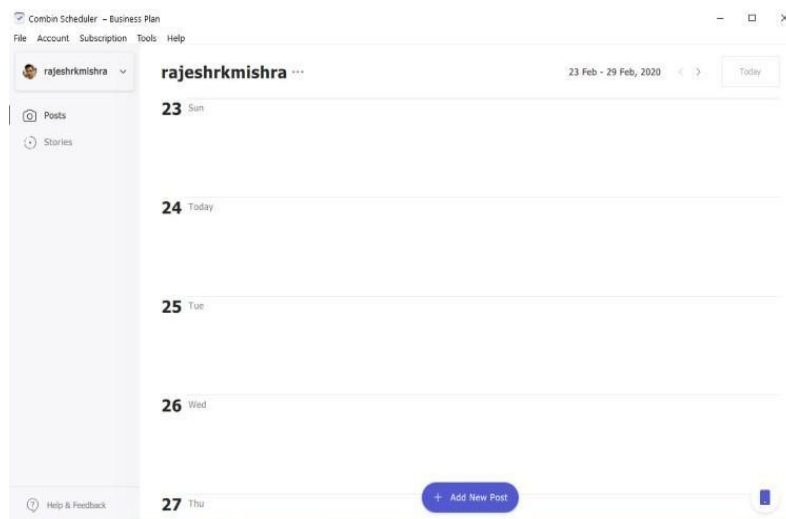


Figure 09: Combin Scheduler

2.4.10 TweetDeck

TweetDeck is a post scheduler app to manage Twitter accounts only. It is integrated to the Twitter interface and allows. It allows to tweet messages immediately or schedule them for later. Posts including images, videos, and GIFs can also be maintained with this app.

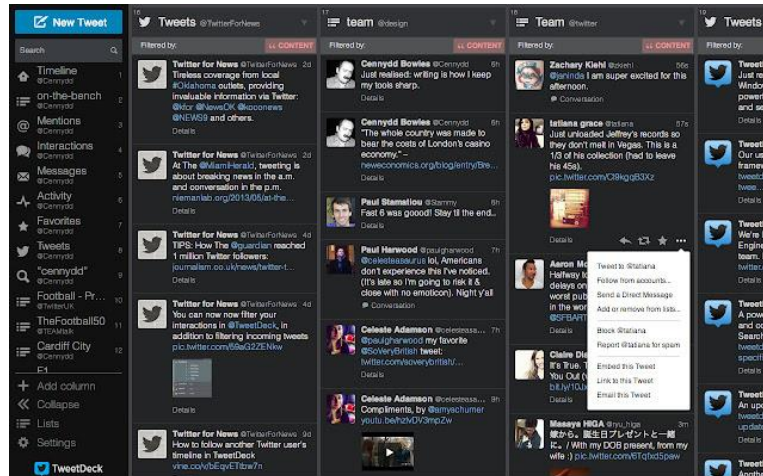


Figure 10: TweetDeck

Table 02 shows features and availability of different social media post scheduler applications.

Application	Scheduling	Analytics	Moderation	Collaboration	Content Curation	Bulk Scheduling	Cost of 5 user	Free Version
SocialPilot	✓	✓	✓	✓	✓	✓	50/m	✗
Hootsuite	✓	✓	✓	✓	✓	✗	599/m	✓
Buffer	✓	✓	✗	✓	✗	✗	99/m	✓
Sendible	✓	✓	✓	✓	✓	✓	199/m	✗
AgoraPulse	✓	✓	✓	✓	✗	✗	199/m	✗
Sprout Social	✓	✓	✓	✓	✓	✓	149/m	✗
CoSchedule	✓	✓	✗	✓	✗	✗	400/m	✗

Zoho Social	✓	✓	✓	✓	✗	✓	200/m	✗
eClicher	✓	✓	✓	✓	✓	✓	219/m	✗
MavSocial	✓	✓	✓	✓	✓	✓	199/m	✗
MeetEdgar	✓	✓	✗	✗	✗	✓	49/m	✗
SmartQueue	✓	✓	✗	✗	✓	✓	79.99/m	✗

Table 02: Features of different post schedulers

2.5 Advantages of Social Media Post Scheduler

Social media post scheduler helps us in a number of way that we cannot even realize of. It increases productivity and efficiency [7]. Some of the important benefits are:

- **Time Management:** Scheduling upcoming posts for future helps to plan working hour and daily tasks.
- **Vast Reach:** For any business, it is a must to reach the customer. Post scheduler enables one to reach them even when he or she is offline!
- **Efficient Management:** Social media post scheduler helps organization to maintain a handful of social sites at the same time. Multiple platform management increases the productivity.
- **Increase Concentration:** Pre-scheduling posts decreased the burden of works proportionately helping to increase focus in day-to-day works.
- **24/7 Presence:** The impression of any business will increase when customer will get service as soon as it asks. This consistence presence can help greatly in the company's potential growth.

2.6 Disadvantages of Social Media Post Scheduler

There is nothing without issues that brings benefits in our life. Social media post scheduler also has some drawbacks. Some of the most crucial disadvantages are:

- Social Media without being “Social’: The scheduling app makes the whole process fully automated making it a robot that is only following some instruction while publishing any content. It just makes the social media a little less ‘social’.
- Slow Response: Some schedulers are slow in response lagging behind necessary updates.
- Unwanted Appearance: Let’s say an unimaginable tragic event takes place and many have suffered. But the posts regarding happy times are scheduled and published as it was. This can be really frustrating making an image issue and a loss in business.

2.7 Conclusion

In this section, we have discussed the background of social media post scheduler and some of its existing systems. We have learnt that these post schedulers have different characteristics based on the differences of social media sites. The existing systems that we have discussed are high in quality but not without shortcomings. There are still chances of improvement and provide better support. We have also discussed how social media post scheduler eases our lives with its great advantages specially on business field. But there are some disadvantages too that make a complete dependency on these types of application very unlikely. Hence, proper use of applications and more advancements are needed to improve user experience both in personal and professional level.

CHAPTER 3

PROPOSED METHODOLOGY

3.1 Introduction

Proposed architecture shows the great process for the social media scheduler. There are different types of schedulers like job scheduler, tuition scheduler, food menu scheduler, medicine scheduler and many more. Basically, this app will give an amazing service to the content writers who will certainly write content in social media. So, anyone can understand that what we are talking about. Our proposed methodology is all about social media scheduler. A user can schedule a social media post by selecting specific time and date, Facebook post with image, Instagram post with image, both Facebook and Instagram post with image could be scheduled or post in real time. These features are also for reddit, twitter, LinkedIn and many social medias which we showed in a single interface.

One who needs to make schedule these types of posts or contents should use some business pages. Without business page our system will not work properly due to the API. This type of scheduler technology can work as a reference point that makes the schedule process more fluent. Eventually, this reference point facilitates users' work and enables faster and better performance anytime and anywhere. There are some differences between traditional content posting in social media and social media scheduler. This type of scheduler follows some specific criteria and security measures that are very different from other type of social media platform. But common necessities like create post with image in Facebook, Instagram, twitter, reddit etc. are saved and maintained for further works. If a person has a business page in Facebook and in Instagram which are connected virtually, then the user can post anytime from anywhere in the social media through the social media scheduler. Sometimes user can post something with an image URL through this app in multiple platforms like Facebook and Instagram. Then the same content will be published in the different pages. Which is the great feature from our proposed methodology.

In this chapter, we will discuss the detail of social media scheduler. We will also present a detailed discussion on our engineered scheduler with step-by-step design methodology.

3.2 Proposed System Methodology

In this section, we will explain our proposed android application in detail. This is a conceptual framework and a demo implementation that can be further used in several types of social media scheduler.

3.2.1 Conceptual framework for the proposed system

We used MVVM architecture for our application framework. This is a Model-View-ViewModel architecture.

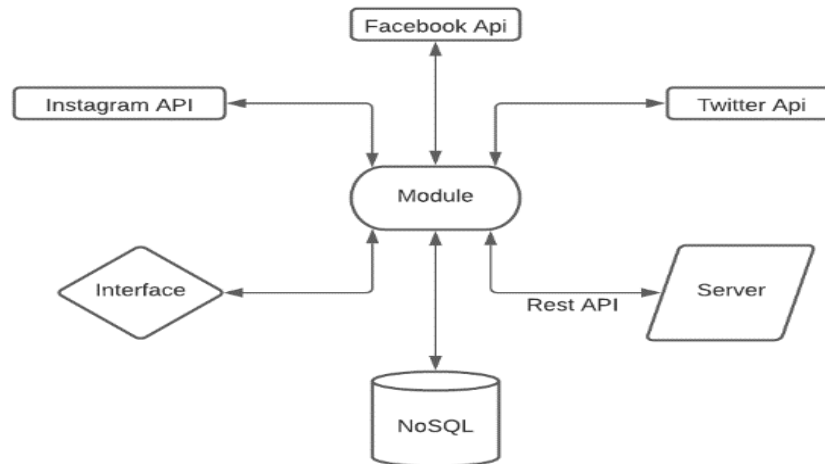


Figure 11: Architectural Pattern

Each component has the tight coupling between themselves which is not good for the architectural pattern in practical. This tight coupling between each component has been removed by the MVVM architecture that makes our project more efficient.

In MVVM architecture, there are three main layers which are Model, ViewModel and View. In android application there are many business logics which are bounded as data. The layer 'Model' represents these data. The business logic contains local data, session data, remote data source, model classes and repositories etc.

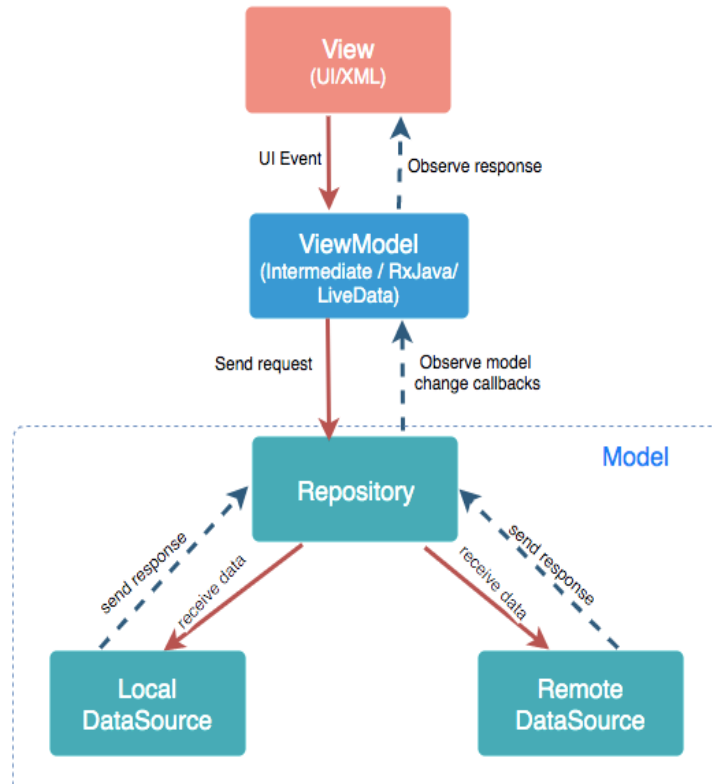


Figure 12: MVVM Architecture

In the layer ‘View’ contains the XML files. Basically, view represent the frontend for any project. User only can see the View model as UI and can interact with this. So user create a particular action by clicking a button or by filling an input field. That action will call the ViewModel and ViewModel response through the Model. In this case ViewModel works as a third party. ViewModel just check some queries like the user registered or not, logged in user or not etc. If these conditions create successful results, then ViewModel call business logic which is Model. Then Model will do his operations according the users’ actions.

In our system, we go through some following steps before content can be published on our social media platform. In this case, for better understanding, we just give the example for Facebook platform.

3.2.2 Facebook:

First, we need a Facebook graph application programming interface to done the project appropriately. Without graph API, our system will not work rather it will show an error page. Before integrating with the post scheduling or posting in social media and before Facebook login we must ensure some technologies which will find Facebook developer option. First need to go this link “<https://developers.facebook.com/>” through a user’s Facebook account. Then user follow the on-screen direction to be registered in the system.

Then we have to go the link “<https://developers.facebook.com/tools/explorer/>” and click on the generate access token. Then it will automatically give a lengthy page access token which is necessary for the project. This is how we register our app in Facebook and our app can completely ready for the Facebook integration.

After that, we set up our project environment in android studio. After that, we inject Facebook SDK to our app through Kotlin programming language. Then we implement authentication system in Facebook and check whether the user is logged in to Facebook or not through the Facebook SDK initialization. If the user access token saved in the session storage or local storage, then the user is logged in. Otherwise, no user data will be found if session storage and local storage became empty.

Then we get a user access token by fetching Facebook user access token. Furthermore, the user access token will be needed for getting the page access token. Through the page access token, anything can be posted in social media. This logic works like this way, if Facebook page access token which we get sometimes earlier has been stored in the session or local storage then user can able to write something on the page. Those written value will be set on the state. If state data publish on the social media, then it will show a toast message according to the action. This is how our system works.

3.2.3 Instagram

Similar things happen when we publish same thing in different platform, both Facebook and Instagram. For Instagram we need to create a Instagram business account and connect the

Facebook page to the created Instagram business account. After that, we need to set up Instagram Graph API. So, the basic things done this way. To publish a post in Facebook and Instagram both in real time need to follow some basic things which are similar to the Facebook post publishing.

First, we need to log in with a Facebook account. Then get the page access token through the user access token. Then create a media object container with an image and a caption for the Instagram account. Then generated media object container ID publish the media object on social media through the Instagram post ID.

3.3 Flow Diagram for proposed System

Here is the method we followed to implement sharing a post to Facebook with Graph API. Step by step functionality discussed in the previous section.

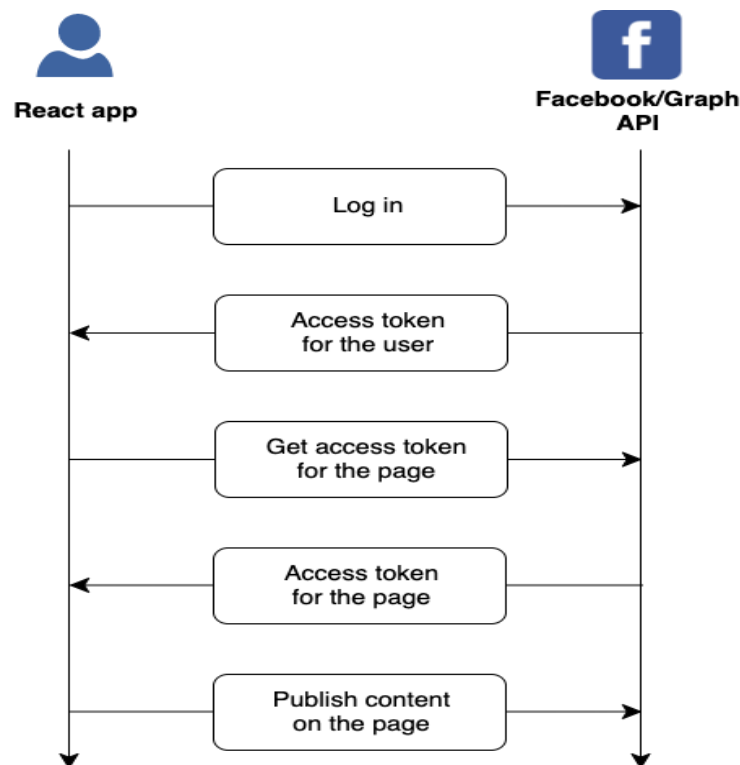


Figure 13: Make post in Facebook with Graph API

Here is the method we followed to implement sharing a post in Instagram with Graph API. Step by step functionality discussed in the previous section.

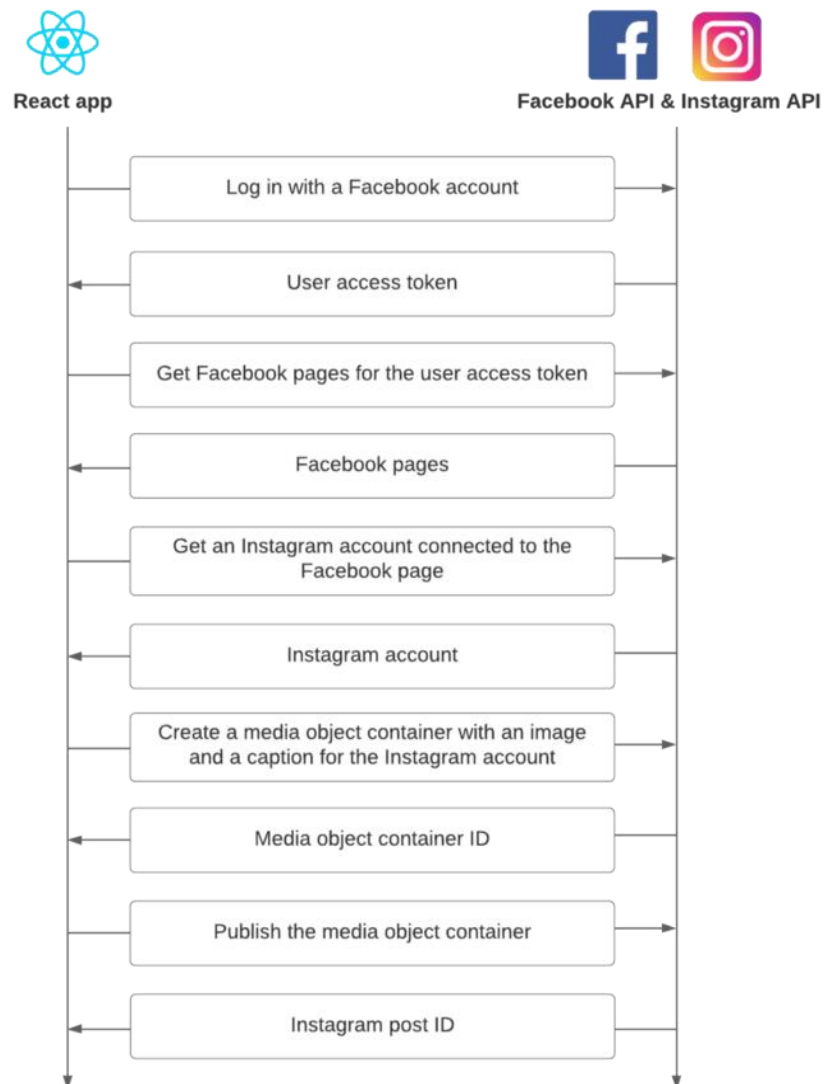


Figure 14: Make post in Instagram with Graph API

3.4 Authorization

At the first view of our app, we wanted to show a login and logout page in where the user authentic themselves. This process was made through the firebase authentication system. In our main system, a user needs to obviously authorize himself via user access token. This user token is only for Facebook or Instagram or any other platform. But we need some data where we can see that, how many users are there whom use our app certainly. So, to get this data, we use firebase authentication system. Simple email and password system implemented. In this method,

furthermore, we can give support our particular customer if the user faces any problem afterwards. This authorization system made our system more secured and free from complication or difficulty.

3.5 Facebook Business Suite

Facebook business suite is an application which manage the facebook business and instagram as well. It is an official application of facebook. Every version like, web, iOS and android are available. It gives an extraordinary support who has facebook or instagram page. Actually it views your business at a glance, showed the view activity, manage inbox in a fluent way, admin or moderator can create posts and stories, access commerce manager, can create ads for particular customers, view insights, schedule posts and access more tools. Besides, it shows the data of your past activity in a graphical format which is much needed thing to grow a business.

3.6 Interface

Software interfaces are the messages or languages that actually communicate with each other and to the hardware. In this social media app, there are lots of interfaces. Among them user interface, hardware interface, software interface and communication interface are most essential. We will go through in details below:

3.6.1 User Interface

Every application needs some access points. In this access points users interact with designs. As we said earlier, in MVVM architecture, view layer is the phase which is interact with users. User create action using the View and this user interface call the ViewModel to complete the action.

UI just focusing on the looks or styles of a software. UI designer give the design of the software interface using some software like Figma. From the figma, frontend engineer implements the design through the XML code. Design must be easy to use, eye catchy and pleasurable.

3.6.2 Software Interface

Software interface is actually an operating system in which the programs will run. Every system or OS will not support our application. Our application only made for android users. So that, only those smartphones in which android operating system is running can able to run our software. iOS operating system will not support because apple has locked down the firmware of the iOS hardware, software drivers, kernel, and many more technologies.

3.6.3 Communication Interface

Communication interface in one word is the internet. So we need to be connected by LAN/WAN network when we initiate the post.

In our application, we have to need to get access the facebook or instagram graph API. This API's request method sometimes HTTP, sometimes GET, sometimes POST, sometimes PUT, sometimes DELETE, sometimes PATCH. Besides to get access token of the user and page the internet communicates with the software interface. Otherwise these operations will not pass successfully. So communication interface is must for our system. There are many other interfaces. Hardware interface is essential. This interface is common for every software. For our application a smartphone with android operating system is act as a hardware interface.

3.7 Essential Parts and Devices








Kotlin		Kotlin was used to develop the whole application and backend design
XML		XML was used to frontend design
Firebase		Firebase was used to create and manage database.
Android Studio		Android studio is the environment where we develop our app.
Photoshop		Photoshop was used to design the graphical user interface of activities. (Backgrounds, images, and icons)
Draw.io		Draw.io was used to draw the different diagrams of the design part of the project.
Visual Studio Code		Visual Studio was used to modify the code for the application.

Table 03: Development Components

3.8 Implementation Process

In this section, we will discuss the execution of the theoretical process we have explained before. We will discuss necessary algorithms to implement important functions with effective and efficient use for the user establishing confidence in the new system.

3.8.1 Share Post in Instagram Process:

Algorithm 01: Publish content in instagram Process

Output: Instagram posting.

Input: Facebook User Access Token, Facebook Page ID, Instagram Account ID

```
constant getFacebookPages = ( ) => {  
    return Facebook User Access Token ;  
}  
  
constant getInstagramAccountID = (Facebook Page ID ) => {  
    return Instagram Account ID ;  
}  
  
constant createMediaObject = (Instagram Account ID ) => {  
    return Media Object ID ;  
}  
  
constant publishMediaObject = (Instagram Account ID, Media Object ID ) => {  
    return Media Files ;  
}
```

Table 04: Share Instagram Post Functions

3.8.2 Facebook Authorization Algorithm

Algorithm 02: Check Authorization Algorithm

Output: User is logged in to Facebook.

Input: Facebook SDK, Facebook User Access Token

```
if ( FB SDK Initialization == True )  
    if ( FB User Access Token == True )  
        return Successfully Logged In  
    else wrong credential  
else undefined  
end
```

Table 05: Facebook Authorization Algorithm

3.8.3 Function for initializing the Facebook SDK

Algorithm 03: Initializing the Facebook SDK

Output: Function that will use for the app.

Input: Facebook App ID

```
export default function initFacebookSDK ( ) {  
    return new Promise (( resolve )) => {  
        Facebook App ID = "particular ID"  
    }  
    resolve ( ) ;  
};  
  
/* Now Load Facebook SDK Script */
```

Table 06: Function for initializing the Facebook SDK

3.9 Advantages of Proposed System

Lots of benefits we found in our proposed system. A person cannot give all his time to active in the social media to run a business. But he/she can be active through our application without being physically available. You don't need to worry about the internet while you scheduling a post through our application. This system captures the schedule through graph API and publish automatically the captured content which was scheduled before without internet connectivity. It's a great advantage for the users. In modern world, we have problems with social media. Social media distract us from works. User's don't need to open the social media to post a content rather than user can publish content by using our social media. This is how it will reduce the distraction from the work. With our proposed system, you can schedule posts to publish contents outside of working hours and on holidays. Though your work station or office may not be open but social media is active all time. One of the great advantage of our system is, user can use multiple accounts from one place. User can post content in social media. These media can be facebook, twitter, instagram, reddit, tumblr etc. User don't need to put the content for the different places. They can publish the content for multiple platform at a time.

3.10 Conclusion

In this chapter, we have discussed our proposed conceptual solution for the social media schedule in detail. The system overview and flow diagrams are the base of the entire project. It explains the scope of the project in short. The algorithms are easily understandable and makes it easier to implement the functions. We have also discussed some crucial point that should be taken into consideration for implementing social media based project. Essential tools and devices which are used for implementation have also been pointed out. We discuss about the different interfaces like, software interface, user interface, communication interface and hardware interface. MVVM architectural pattern is used for our project. What is View, Model and ViewModel everything is discussed in this chapter. Moreover, authorization system is very important for our project which also be pointed out in this chapter.

CHAPTER 4

RESULT ANALYSIS

4.1 Introduction

In this chapter, we will show the output of our project and present a detail evaluation. We will follow some engineering standards. We will consider these standards based on the risk and cost management. Moreover, our testing and results will also be outlined. Our project aims for a better solution of key management for android operating system based social media scheduler. Our system scheduler enables anyone to schedule any social media content. We have used Kotlin programming language making it easy for the user to use and harder for the hackers to hack.

4.2 Financial Plan and Costs

An interface for android based schedule system reduces the cost of using and maintain schedule system greatly. Traditional schedule system has many works that need much longer times. That means, more works involve more pages. While the pages reloaded it will generate extra cost in terms of time, space and money. But, our system can complete these tasks within a really short time. Our designed system is much faster than other conventional systems considering the duration of schedule approval and database update. Again, implementing social media scheduler for multiple platforms found that, this scheduler performs better in mitigating some trust issues. Therefore, it is a great invention for business environment.

Again, in some cases, there are no need to buy extra APIs except graph API. Besides there are no need to invest much for hosting. Because database works are very limited in this project. On the other hand, play store service give some space for hosting the app there which is enough for our hosting space.

4.3 Feasibility Study

The feasibility study phase is a very important phase, because it is the one that helps the software engineer to see the negative sides of his project and it helps him to refine the software process. In fact, the feasibility study can make any project a successful one if it is done in a correct way. For our social media schedule application, we have found these accordingly.

4.3.1 Product Feasibility

The system that will be developed will help the client achieve their objectives. Which are expanding their business and open up to the online market. This will be achieved thanks to the mobile application that will make the access to the user's features and communicate with the social media platform extremely easy. Talking about communication, the mobile application will allow the users to schedule a content. Then, application can exploit the modular architecture of enabling systems using easily scalable components, which increases availability.

4.3.2 Technical and Operational Feasibility

For this project, we will be using Kotlin & XML for the mobile application using Android Studio as it is the official IDE for android applications' developing.

For the backend, we will be using Firebase as a database engine; as it is known for its high reliability, full-featured, and self-contained. More than that, it is the most suitable database engine to use with an android application.

4.3.3 Social & Market Feasibility

Since smart phones are being used by almost everybody, we believe that a mobile application will be of great benefit. Moreover, this can be converted to any sort of social media based market like for job scheduler, tutor scheduler, medicine scheduler etc. Hence, it has the potential to create a huge impact on the social service with a huge demand.

4.4 Privacy

Privacy is a common thing in our daily life. Everyone has their own secret things which is not good to reveal. Our app has no access about the privacy system though it contains very secured privacy system. Maybe our application not able to manage privacy system of the user but the privacy and terms managed heavily through the social media itself. Our API just call the particular platform in which user wants to work. If the user logged in through the social media, then that social media will maintain the user's privacy. Because, we get permission to access the page through the page access token and user access token. Social media platform gives the tokens, that's why we integrate with them. This is how the privacy maintained in our application. But in case, a

user from our application complain us, someone get access their page through the social media tokens then how we will solve that? To get rid from this situation, we used login logout system through firebase while opening the app. So that, no one can able to access the user's access token.

Moreover, privacy in social media life like media privacy, location privacy, search privacy everything is need to maintain. We don't allow anyone to see our activity or history. We implemented these features in a very well mannered. Hence, it provides every privacy a technology can provide to its user [2].

4.5 Security

In modern technology, maximum developer use firebase to implement an android application. during the implement period they make an opening interface. Between the opening interface and home screen they authenticate the user. So they display a login logout interface in which user authenticate themselves by providing appropriate credentials. Similarly, we done the same thing for implementation. So, user need to be registered in our platform and we will provide option for changing their password if someone forgets. It ensures their security in the system. High security system makes our app more flexible and trustworthy.

The application has concrete security that restricts cyberattacks. The common cyberattack weapon is DDoS attack. Almost every hacker uses this system to attack on a system. Our user uses this application for their business purposes. So it must need to be provide extra security and privacy systems. So, we don't get much risk to do this. That's why we use graph API which fetch data from the social media through the user access token and page access token. This is why there are nothing in our hand in depth of security purposes. But it should be constantly improving for future threats as 100% security can never be promised by any technology.

4.6 Testing and Output

We have used Kotlin, XML languages for our frontend and backend development. In some cases, we use firebase to portray the database. Every time the system is launched, it checks the database and import data to connect. Any user who has not registered cannot use the scheduler and don't have access to database as well.

4.6.1 User Access Token

This is the first user interface of our application. Facebook connected means; this graph API found the appropriate user access token. That's why it shows the Facebook connected button. Instagram and twitter are not connected, if they are connected also then the button also showed the Instagram connected and twitter connected respectively.

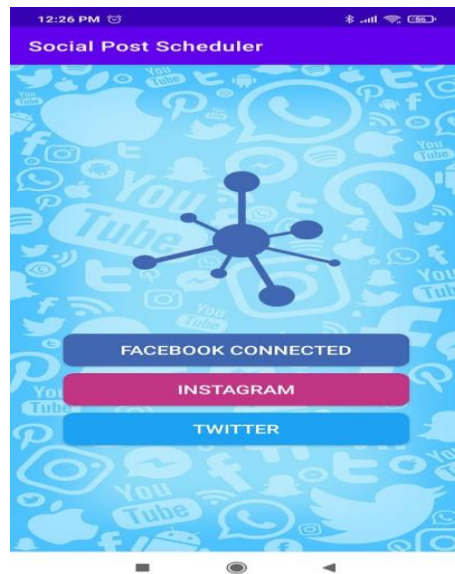


Figure 15: Facebook Connected Page

4.6.2 Facebook Post Scheduling

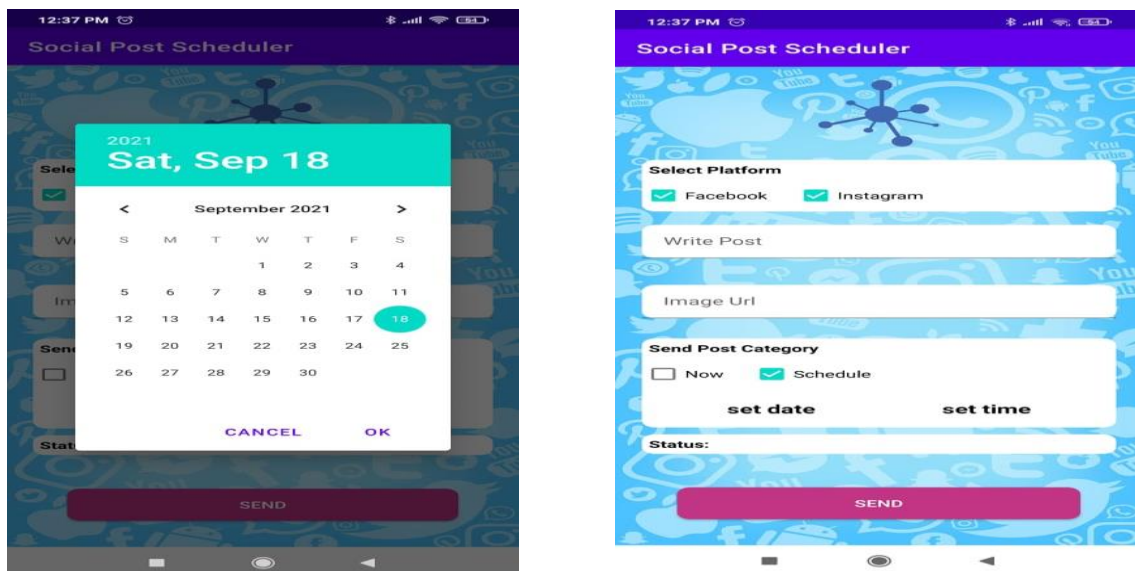


Figure 16: Set Facebook Post Scheduler

This is the important part of our system. User just select the platform where they want to publish their content and after that write the post with respective image URL. Then user select schedule category and can able to pick a date with time from a calendar. After clicking the send button, the schedule system will be set and publish the content on time.

4.6.3 Successfully Posted in Instagram

These figures just showed the output of our mission. When the content will be posted on the page's timeline then the scheduler sent a toast message. This toast message passes the output that the content posted successfully or not. Then if user go to the instagram page, he or she can able to see the post on their timeline.

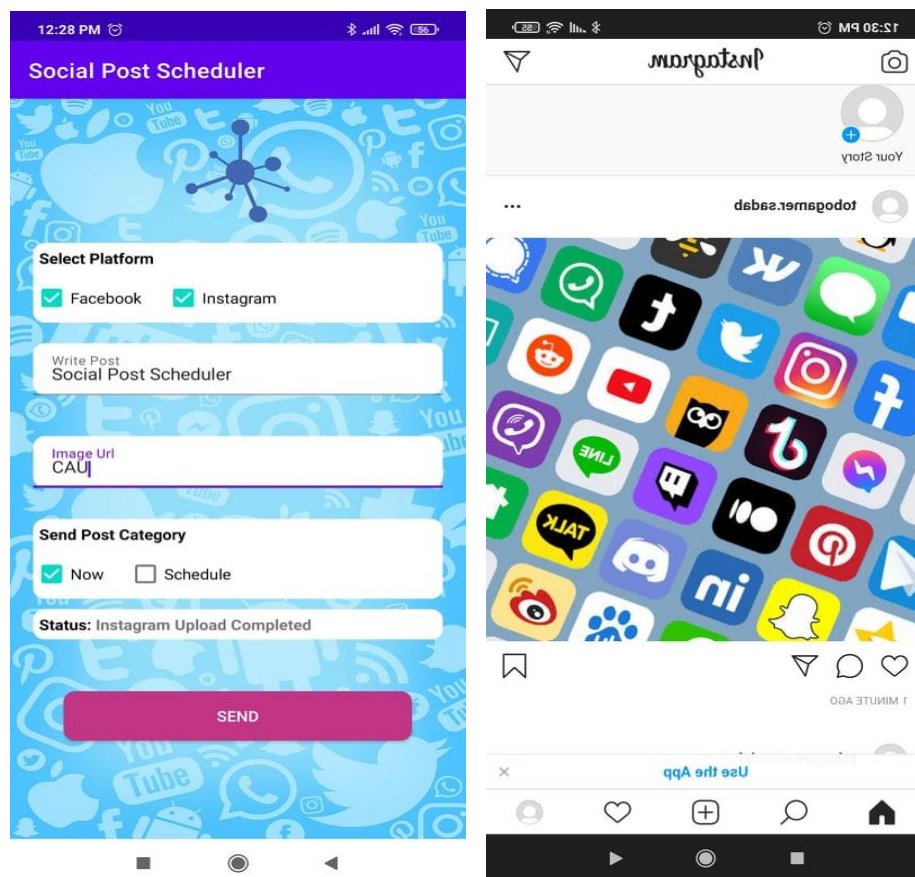


Figure 17: Publish Content Successfully

4.7 Problem Faced and Solutions

During the development period of the application, we faced several problems. There were also issues with designs which we solved by the use of stackoverflow and YouTube. Following are some issues and solutions of social media scheduler:

Issues Regarding Facebook Posting: Normal Facebook user cannot publish content from their personal Facebook account. But they can post in Facebook business pages. For the Instagram, the same output will be showed. User cannot post in normal Instagram account.

Issues Regarding Reddit: We tried to implement the Reddit authentication with reddit OAuth2 system. Due to some reasons, our API couldn't successfully fetch. So that, we were unable to implement the Reddit platform in our application.

Issues Regarding Twitter: We also tried to integrate the twitter login API into our android application. For integrating twitter API, first we use consumer key. Consumer key is one kind of API key and another one is Consumer Secret. Consumer Secret also an API secret. These secrete keys can be generated from the official site of twitter. After implementing the system, suddenly our app crushed. Further, we found the exact solution that the twitter just banned our API keys for using in the third-party application which is not verified.

4.8 Work Break Down Structure

In order to build a good project, we must need to put great importance to the task scheduling. Otherwise, it is hard to make thorough progress.

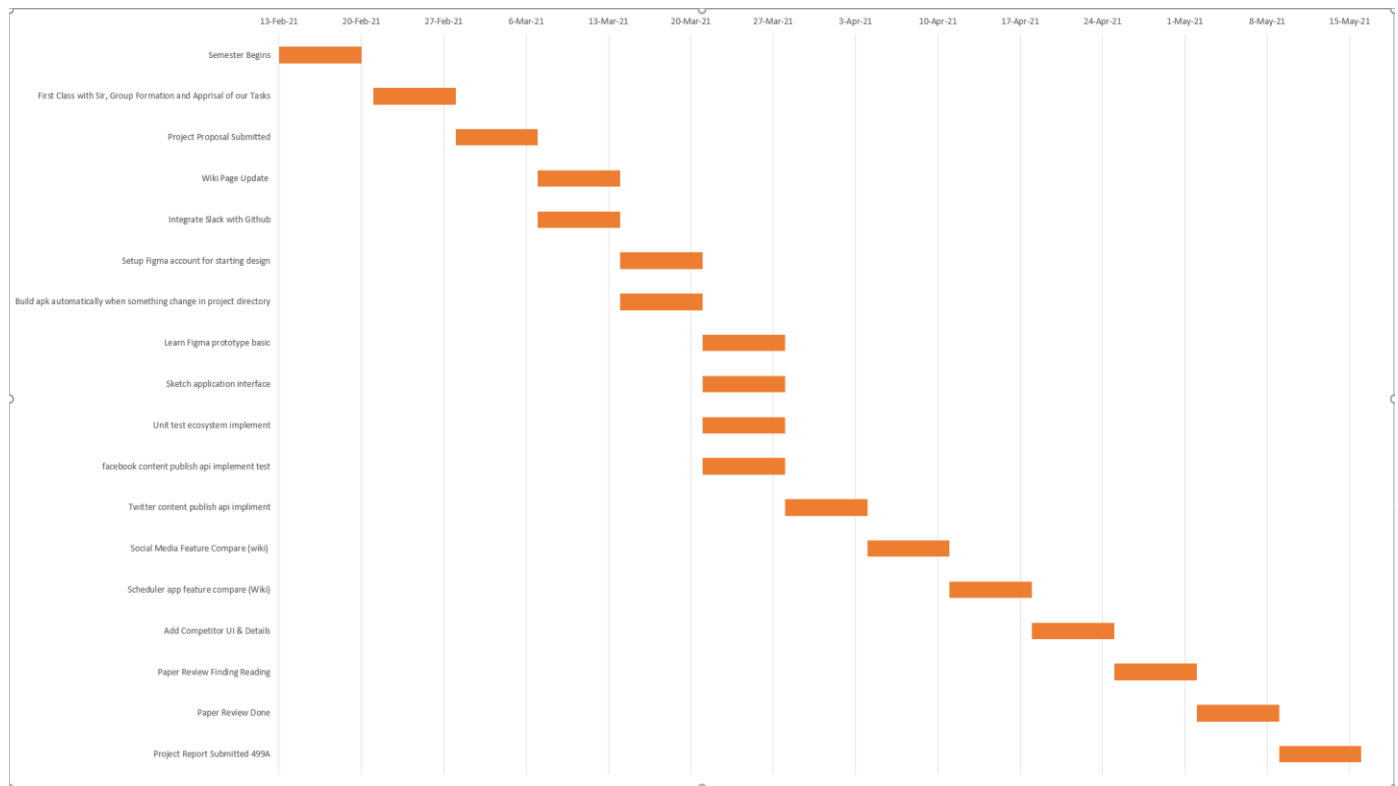


Figure 18: Gantt Chart for CSE499A

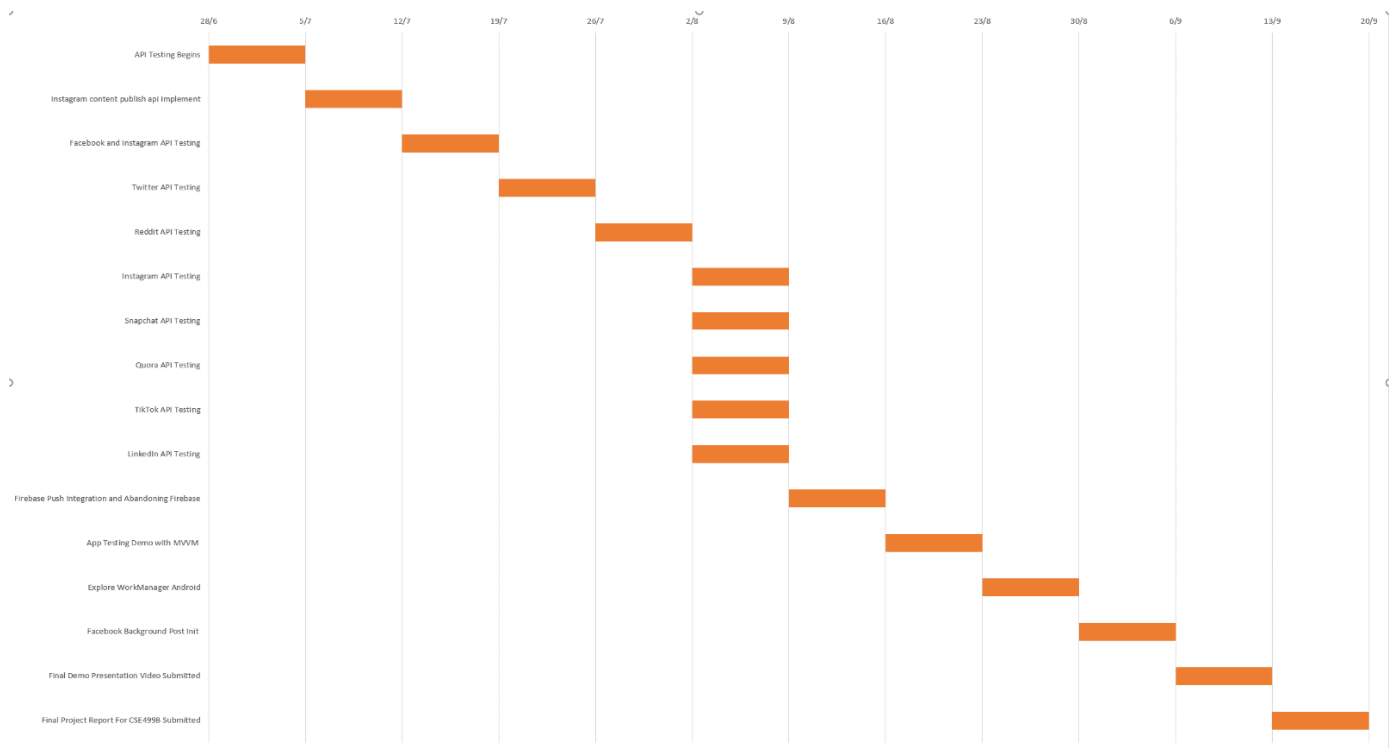


Figure 19: Gantt Chart for CSE499B

CHAPTER 5

CONCLUSION

5.1 Introduction

Researching for this application, we have found out about many metrics and ways of understanding social media that were unknown to us before.

As socially inclined creatures, human beings have embraced technology that connects us with others. Every year, there is an increasing number of people signing up for and using social media. While there weren't even a billion people using social media back in 2010, the number exceeded more than 2 billion within just five years. In 2019, around 2.77 billion people were using social media. And, with smartphones and internet connectivity becoming cheaper and easier to access, we should expect to see these numbers grow even higher. By 2021, more than 3 billion people will be using social media. This means for marketers that there is enormous potential to reach a massive and engaged audience on social media. And that's not just limited to the popular social media sites like Facebook, Twitter, and Instagram. [8]

When Pew Research Center began tracking social media adoption in 2005, just 5% of American adults used at least one of these platforms. By 2011 that share had risen to half of all Americans, and today 72% of the public uses some type of social media. [9] Users spend more than 20% of their time online on social media sites. Facebook alone has a worldwide market penetration rate of over 12% of the entire online population; in North America, it is 50%. These rates are snowballing, with Facebook alone gaining 170 million new users between the first quarter of 2011 and the first quarter of 2012, increasing 25%. Facebook mobile use is growing even more quickly, at a 67% annual clip, as of Summer 2013. In 2019, the platform had over 330 million monthly active users. Facebook is currently the largest social media site in the world. With 2.6 billion monthly active users as of 2020, it's safe to say that nearly every social media user is on Facebook.

On the other hand, Instagram is one of the fastest-growing social networking platforms. While it is primarily app-based, users can also access their feed through the website version. In June 2018, it finally reached 1 billion monthly active users. Instagram is a highly visual platform where users share videos and images. You can also use Instagram Stories and Live features. It is prevalent among the younger generations. According to Statista, 32% of users are aged between 18 and 24, and 33% are aged between 25 and 34. [10] On the other hand, Twitter doesn't have as many users as other top social media sites; it does have a highly engaged user base. Twitter users send out at least 500 million tweets per day on average.

In an article written by Fan and Gordon [11], they had discussed the growth in use and engagement of social media over the years and how corporations interact with them. It used to be in the mid-2000s corporations would only monitor their customer's feedback on their respective websites. Over the years, they had figured out that monitoring is not enough. If you want to grow your brand, you have to interact with your customers directly. The brand can later verify that through account analytics.

5.2 Challenges

Many works have been done before to meet the challenges that can arise in this type of application. Still there are some shortcomings that need to be mitigated.

- ❖ To handle different social media at a time is big task considering the amount of data. Processing this huge amount of data is a big challenge to improve the efficiency.
- ❖ It is also important to ensure the security of this data. Most of the schedulers save the post in its own cloud server from where it is posted later. During this time, hackers may try to manipulate the post or change it. Hence, security and privacy to this database management is a big challenge.
- ❖ These scheduler apps need many permissions to access individuals' social media account. During these permissions, user provide crucial personal data to the scheduler app. Protecting these data from going to wrong hands and clear statement of how the scheduler apps will use it are some big challenges to solve.
- ❖ Another big challenge is to synchronize an app in all types of operating system irrespective of characteristics and behavior.

5.3 Future Research

Social media post scheduler has improved a lot. But there is still a vast scope to improve and initiate new features. There are a lot of post scheduler applications for android. But for iOS and web development platform, there needs a lot more improvement. We have also implemented our app for android and iOS. A website for our app will enhance the productivity. It also needs some more features like post editing options. Image editing and filter adding are some nice have features. Connecting our app with Firebase can make a huge improvement. It can provide user services like

counting likes, views and comments. Finally, with some more modification, our post scheduling application can not only be used for business purposes but also for common people user level experiences.

5.4 Conclusion

In this project, we have tried to make an application that will enable users to schedule posts to publish at an appropriate time across Facebook and Instagram. What we have done in this project, has been done before. Many services like this exist like Hootsuite, Sprout social, Buffer, and so on. [12] None of them are entirely free, apart from some exceptions like Combin and Crowdfire. And the idea of having a completely free social media scheduler has been done before. Like what Osman et al. did with their app Odoo.[13] Also, the exciting effort to use Twitter as an e-learning tool through a Twitter Scheduler. [14]. That is what we have tried to do here. A free tool to schedule your content across Facebook, Instagram, and Twitter. With plans to expand support to other platforms like Pinterest, LinkedIn, Tiktok, and so on. Initially, we plan to release the app with new financial incentive, but down the line, we have some plans to monetize it through advertisement spaces while keeping to our original promise of keeping the app free. After all, the idea of Fee or Free [15] will cross any app developer's mind.

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- [1] Sung-Joong Kim, JiHoon Yoo, HaengRok Oh, Dongil Shin, DongKyoo Shin, "A Study on the Operation Concept of Cyber Warfare Execution Procedures", *Journal of Internet Computing and Services*, Vol. 21, No. 2, pp. 73-80, Apr. 2020. <https://doi.org/10.7472/jksii.2020.21.2.73>
- [2] Kanuri VK, Chen Y, Sridhar S (Hari). *Scheduling Content on Social Media: Theory, Evidence, and Application*. *Journal of Marketing*. 2018;82(6):89-108. doi:10.1177/0022242918805411.
- [3] Collier, A. 2020. How to create a social media posting schedule. Article. Retrieved 6 August 2020 from <https://blogs.constantcontact.com/social-media-posting-schedule/>
- [4] Zhang, Heng, et al. "Moodbook: An application for continuous monitoring of social media usage and mood." *Proceedings of the 2018 ACM International Joint Conference and 2018 International Symposium on Pervasive and Ubiquitous Computing and Wearable Computers*. 2018.
- [5] Zhang, Jingwen, et al. "Efficacy and causal mechanism of an online social media intervention to increase physical activity: Results of a randomized controlled trial." *Preventive medicine reports* 2 (2015): 651-657.
- [6] Garg, Priyanka, and Saloni Pahuja. "Social media: concept, role, categories, trends, social media and AI, impact on youth, careers, recommendations." *Managing Social Media Practices in the Digital Economy*. IGI Global, 2020. 172-192.
- [7] Hajli, M. Nick. "A study of the impact of social media on consumers." *International journal of market research* 56.3 (2014): 387-404.
- [8] Influencermarketinghub.com, "103+ Social Media Sites You Need to Know in 2021," 2021. [Online]. Available: <https://influencermarketinghub.com/social-media-sites/> [Accessed: 22-May-2021].
- [9] "Social Media Fact Sheet", Pew Research Center, Washington, D.C. (7 April 2021.) <https://www.pewresearch.org/internet/fact-sheet/social-media/#how-often-americans-use-social-media-sites>
- [10] Statista.com, "Distribution of Instagram users worldwide as of January 2021, by age group" 2021. [Online]. Available: <https://www.statista.com/statistics/325587/instagram-global-age-group/> [Accessed: 22-May-2021].
- [11] Weiguo Fan and Michael D. Gordon. 2014. The power of social media analytics. *Commun. ACM* 57, 6 (June 2014), 74–81. DOI: <https://doi.org/10.1145/2602574>
- [12] Segura, A. 2020. "The Top 15 Tools for Managing Social Media Accounts" Retrieved 22 February 2020 from <https://www.searchenginejournal.com/social-media/top-tools/#close>
- [13] Osman, A. A., Adam, A. S. M. and Shire, A. M. O. 2017. POSTING/SENDING MESSAGES ACROSS FACEBOOK, MESSENGER, TWITTER, AND WHATSAPP ALL FROM A SINGLE

DASHBOARD. SUDAN UNIVERSITY OF SCIENCE & TECHNOLOGY., Retrieved October 2017from
<http://repository.sustech.edu/bitstream/handle/123456789/21309/POSTINGSENDING%20MES SAGES%20ACROSS%20FACEBOOK.pdf?sequence=1&isAllowed=y>

[14] A. AlSoufi, A. Obead, S. Althawadi, and Z. AlHayki, "Twitter Scheduler System as e-Learning Tool," 2015 Fifth International Conference on e-Learning (econf), 2015, pp. 161-164, DOI: 10.1109/ECONF.2015.54.

[15] Lambrecht, Anja & Misra, Kanishka. (2016). Fee or Free: When Should Firms Charge for Online Content?. Management Science. 63. 10.1287/mnsc.2015.2383.