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Software Architecture For Smart Farming (Fasal)

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Master of Science in Computer Science

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SOFTWARE ARCHITECTURE FOR SMART FARMING (FASAL)

This Project report is submitted to the Department of Computer Science as partial fulfillment of Master of Science in Computer Science degree

by

Muhammad Asad Bin Khalid

Supervised by

Waqas Mahmood

Visiting Faculty

Department of Computer Science

Institute of Business Administration (IBA), Karachi

Fall Semester 2021

Institute of Business Administration (IBA), Karachi, Pakistan

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IBA SMCS
School of Mathematics and Computer Science

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(Student Number: 21070)

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Dedication

I dedicate this project to Allah Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding. He has been the source of my strength throughout this program. I also dedicate this work to my Parents; Khalid Khan and Safia Khalid who has encouraged me all the way and whose encouragement has made sure that I give it all it takes to finish that which I have started. To my siblings who helped me out in whatever way they could possibly help. Along the journey my friends were really cooperative as well specially I would like to thank Abdul Mateen who stood with me when I needed him the most.

I would also be thankful to my fiancé Muniza Javed for being my support in this journey. Thank you All. My love for you all can never be quantified. God bless you.

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Acknowledgement

In the start, all praises and thanks to the Almighty ‘Allah’ as he helps me throughout the journey of my Research & Development and makes me capable of completing it properly and timely.

Then I would like to thank whole heartedly to my respected supervisor Mr. Waqas Mehmood, Visiting Faculty, Institute of Business Administration Karachi for believing in me and supporting me throughout this project, his guidance is like a flambeau in my difficult times which lightens my way. He has taught me the methodology to carry out the research and to present the research work as clearly as possible. It was a great privilege and honor to work and study under his guidance. I am obliged for his full support and would thank him for being patient, giving prompt expert advice and clear explanations for all the queries.

In the last, I would like to be grateful to my family and friends for their love, sacrifices and prayers.

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Abstract

The paper represents the urge of making this application for betterment of agricultural sector of Pakistan and how this application could result in the growth of the sector. Moreover, the paper presents the research papers work consulted during the research and also contains the flow of application made for POC. Future work is also illustrated at the end to make sure there is a gap that needs to be filled for a proper mature application.

Keywords: FASAL, SQI, POC, Software Architecture, Smart Farming, Software Architecture for Smart Farming

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1. Introduction

The research project discusses about the issues of the agricultural sector of Pakistan and how its lacking in digitalization of the processes. In other countries major steps have been taken already to improve the efficiency of their agricultural sector and provide their farmers with the ease to manage the processes easily. Pakistan although lacks in the process.

Pakistan's agriculture sector holds a central part in the economy as it contributes 18.9 percent to Total national output and ingests 42.3 percent of labor force. It is moreover a huge wellspring of new exchange pay and energizes advancement in various regions. The public power revolves around supporting pretty much nothing and underrated farmers and advancing restricted degree creative developments to advance improvement around here. According to the 6th Population and Housing Census of Pakistan 2017, the country's general population is creating at the speed of 2.4 percent per annum. This fast development in people is raising interest for cultivating things. The current government is based on cultivating this region and in this affiliation began different measures such as collect improvement, useful use of water what's greater headway of high worth harvests including biotechnology, diminishing increment rates, cultivation credit overhaul, financed manure costs and unobtrusive power for agri-tube wells. Consequently, this current region's execution extended complex later seeing a moderate and stifled advancement in latest 13 years.

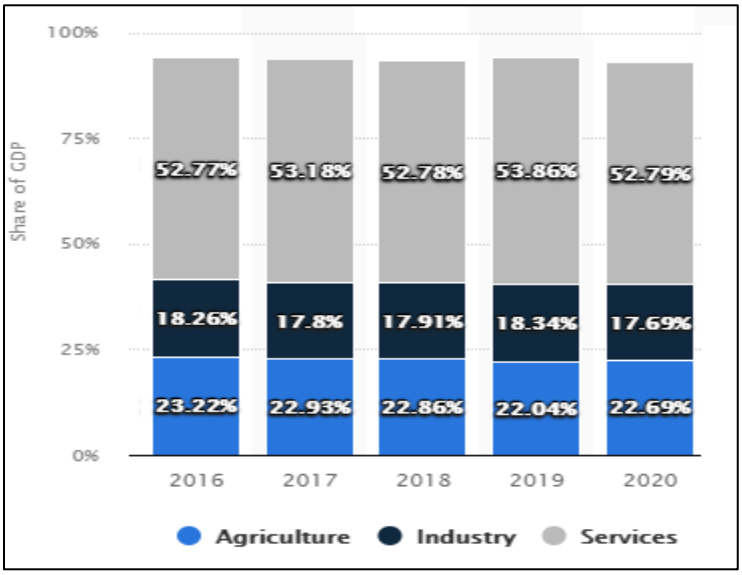

Figure 1

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Even though this sector is contributing vastly but still it's not digitalized to serve more efficiently and productively. Figuring out the issue we decided making some architecture for the agricultural sector which might later on result in Smart farming, improving the efficiency of the sector overall and boosting the economy as well as the individual condition of the farmers and their business. The software architecture for smart farming was the name of the products infrastructure whereas we named it FASAL. **FASAL** itself is an Urdu word which means **Crops** when translated to English and it's the abbreviation on **Farming Assistance System and Ledger**. The idea behind making FASAL is to provide a software solution for our farmers. It can help them in managing not only the field but also their ledger.

Table 1: Application Abbreviations

Name	Abbreviation	Features
Farming Assistance System And Ledger	FASAL	Software Architecture for Smart Farming
Soil Quality Index	SQI	Measure for soil quality
Proof of Concept	POC	Application type

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2. Methodology

2.1 Purpose of Research and Development

Pakistan's agriculture sector holds a central part in the economy as it contributes 18.9 percent to Total national output and ingests 42.3 percent of labor force. It is moreover a huge wellspring of new exchange pay and energizes advancement in various regions. Even though this sector is contributing vastly but still it's not digitalized to serve more efficiently and productively. Figuring out the issue we decided making some architecture for the agricultural sector which might later on result in Smart farming, improving the efficiency of the sector overall and boosting the economy as well as the individual condition of the farmers and their business. The software architecture for smart farming was the name of the products infrastructure whereas we named it FASAL. **FASAL** itself is an Urdu word which means **Crops** when translated to English and it’s the abbreviation on **Farming Assistance System and Ledger**. The idea behind making FASAL is to provide a software solution for our farmers. It can help them in managing not only the field but also their ledger.

Figure 2

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2.2 Approach of Research and Development

FASAL system is actually a mobile based system, the mobile app platform was chosen because of the availability of the module. Mobile is the medium which is available to everyone in this age. We didn't opt for a web module because of the unavailability of the laptops and computers at the targeted audience end as well as it doesn't come in handy that much.

We choose initially to develop the application using following technologies:

1. Microsoft SQL Server (Database)
2. .Net Core /. Net5 (Backend)
3. Flutter (Front-end)

The reason to initially choose these technologies was that we won't be having a lot of data in the start so we can go with some relational database approach which will allow us to keep the things straight and maintained. Later, if we feel a need to move towards any No-SQL approach like Firebase or MongoDB we can move towards them with a clear plan and managed data.

Creating the database architecture will be the primary task in our development cycle. We will create tables for different modules and will start managing things from this end.

Next step is our backend which will be the bridge between our hybrid language frontend and the data side. We will be creating the backend API's using Microsoft's platform i.e. .Net Core, purpose of using it is that its cross platform supportive and can be deployed on any server (Window, Mac-OS, Linux etc.), Moreover these API's are light-weight and last but not the least it can communicate with MS SQL Server quite easily, so we won't be needing any third party connector for or DB and Backend connectivity. Also, our Web API's will be secure for data transfer and the front-end will also face no problem communicating the API's.

Now it all comes where most of the users are focused i.e. the front end. We will be using flutter due to its flexibility of providing hybrid applications. Moreover, it's a google platform so we won't be having much difficulty integrating google API's for maps.

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2.3 Process of Research and Development

For the research part of the system, I used the research work "An Architecture model for Smart Farming" by Triantafyllou et al (2019). The paper provided an idea to implement such a system as these systems are being deployed in other countries, so why not in Pakistan also as it's a major agriculture country, it stated that cultivating intelligently is an improvement that weights on the use of present-day developments in the advanced genuine field the chiefs cycle. Developments like the Internet of Things (IoT) and Cloud Computing have accelerated the high-level difference in the customary agrarian deals with promising extended creation rate and thing quality. The gathering of astute developing anyway is hampered because of the shortfall of models provide guidance to experts as for the fundamental parts that set up IoT based really looking at systems. To coordinate the technique associated with arranging and completing Smart developing actually taking a look at systems, in this paper we propose a regular reference designing model, pondering in like manner an essential non-useful essential, the energy use impediment. Furthermore, we present and inspect the advances that intertwine the four layers of the designing model that are the Sensor Layer, the Network Layer, the Service Layer and the Application Layer. A discussion is moreover coordinated upon the challenges that insightful developing checking systems face. Although it discussed much about IoT and advanced **technologies,** we kept focus on the mobile application only and not to involve any hardware as the financial ability of farmers is not yet stable. But this could be added to future work.

I also went through different other papers **during** the literature review for my modules and functionalities such as the soil quality Index. The Article discussed how soil quality index is analyzed. It stated that Various individual soil limits or essential records are for the most part used in soil quality evaluation, but this strategy has various limitations. The place of the audit was to choose a joined soil quality document in provincial soils as affected by different levels of anthropopressure. The soil quality not entirely settled **through** the decision of the appropriate pointers for a base educational assortment, score rendezvous for picked markers and the coordination of markers in a document. The audit was done in two locales under cultivating use with relative soil cover yet with a substitute history and force of receptiveness to defilement input. Soil tests assembled from the surface layer (0-30 cm) were taken apart for physicochemical (for instance surface, incomplete

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game plan of soil normal matter, pH), and natural (breath, dehydrogenase activity, microbial biomass and nitrification) properties and the levels of unfamiliar substances (16PAHs and profound metals). The level of anthropopressure was assessed in view of pollutions transmission records. A genuine appraisal considering head part assessment engaged the selection of characteristics of basic importance to soil quality. The level of anthropopressure was considered to be a critical part influencing soil quality; higher soil quality document regards not completely agreed to the area of low anthropopressure.

For the development part we tried using the waterfall methodology because it is direct and clear to use. Easy to supervise on account of the firmness of the model - each stage has express assumptions and a study cycle. Stages are dealt with and completed one by one. Works outstandingly for humbler endeavors where requirements are unquestionably known.

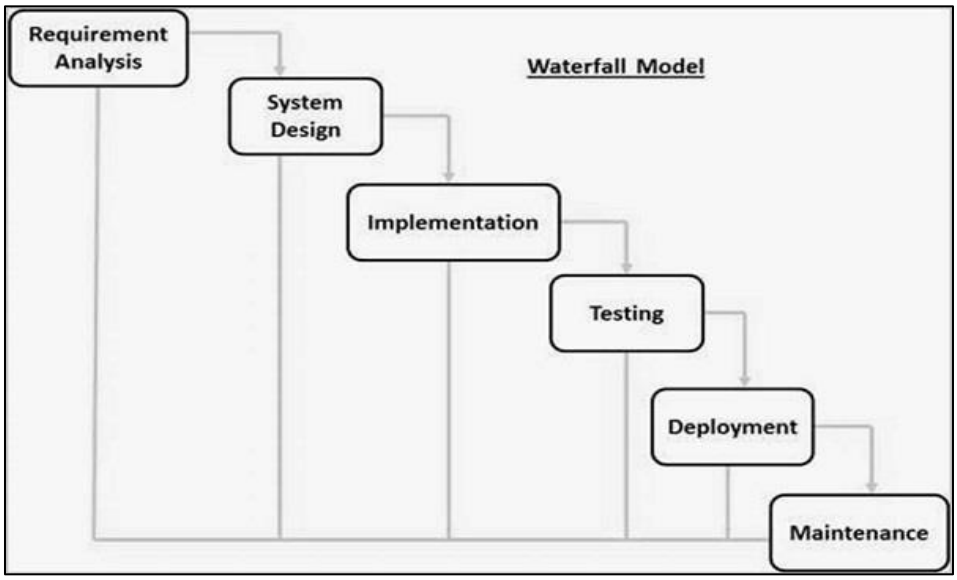

Figure 3

The above picture presents how the waterfall model was helpful to us in completely walking through our project dependencies.

2.4 Core Functionalities of Product

We shall be providing a complete system for a farmer to manage things accordingly. The system will include,

- Satellite scanning of farming land,
- Soil Quality Index according to climate of any area,

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- Types of crops that could be grown in any specific area,
- Farming guide for desired crops,
- Scheduler in order to run a timely cycle of a crop with alerts on mobile.
- Ledger to maintain the sale and purchase of goods.

2.4.1 Satellite scanning of farming land

This feature enables the user to find their location on an integrated Map and lets them analyze the Soil Quality of a particular area. User can name the city in the provided field and navigate to the desired area on the Map.

2.4.2 Soil Quality Index according to climate of any area

After navigating to any particular area user will see the Soil Quality Index of that area which has been max graded to 10 on scale. Any value near to 10 depicts the fertility of the land in specified area, whereas any value not close to 10 depicts a non-fertile or a less fertile land.

2.4.3 Types of crops that could be grown in any specific area

After the map navigation and checking soil quality index of that area, one more option will be visible for the user where they can see the types of crops already grown in their selected location for guidance that they can also invest their money and time in the following crops as they will be beneficial for them due to better yield, as the conditions are suitable for those crops and others are already doing the farming.

2.4.4 Farming guide for desired crops

A farming guide module is separately provided for a new farmer who doesn't have any prior experience in farming and wants to go ahead with it can also take assistance from the application to start farming. A step-by-step guide is being provided for certain crops that could assist the new comer in starting the farming process.

2.4.5 Scheduler in order to run a timely cycle of a crop with alerts on mobile

One more functionality has been added to the product which might come in handy for the farmers in order to work timely. There is a problem with usually all of us that we sometime forget things to do. But after the involvement of technology in our daily lives we usually use reminders and alarms to remind us of the to-do list or tasks. The Scheduler will also help the farmer in sort of the same way. Once the farmer starts irrigation of a crop, he needs to put an entry into the application. The application will then give timely popup reminders

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on mobile to either water the crops or to put pesticides on the crop etc. It would involve entering the start date and crop name to start a scheduler.

2.4.6 Ledger

Ledger is the screen being provided in the application for the farmer to maintain and record their expenses and sales accordingly. This will help them keep a record of their account that whether they are going in profit or loss.

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3. Flow of System

The Application goes through following set of steps to complete its journey and provide the user the experience they want.

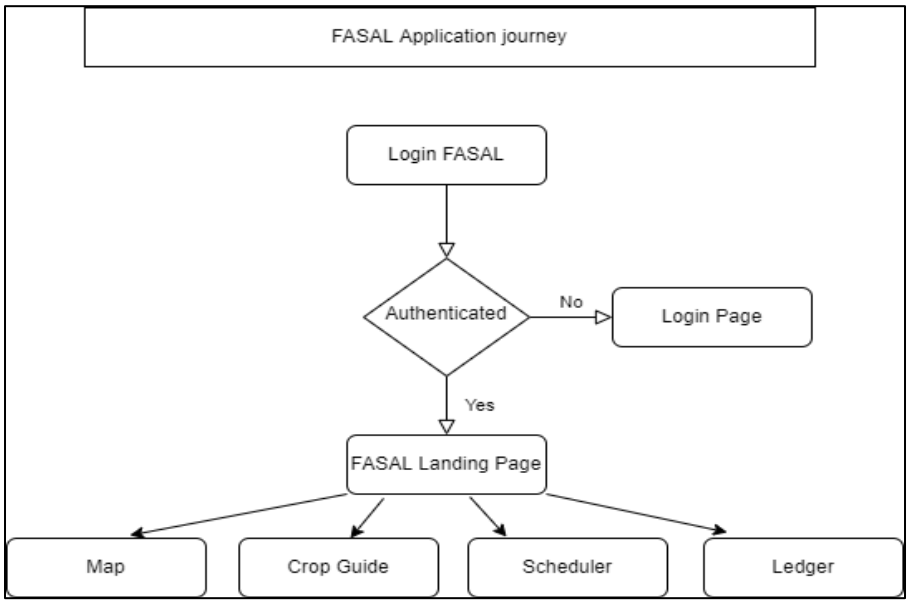

Figure 4

The application first requires the user to sign up. Once the user signs up they can now log in using their username and password they provided at the time of sign up. Once they are logged in, they have now landed on the dashboard page. They see four options available to them.

1. Maps
2. Crop Guide
3. Scheduler
4. Ledger

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Sign Up

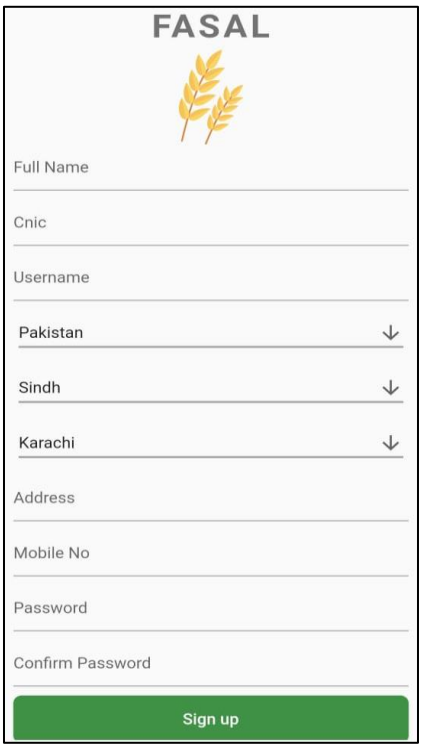

Figure 5: Sign Up

Login

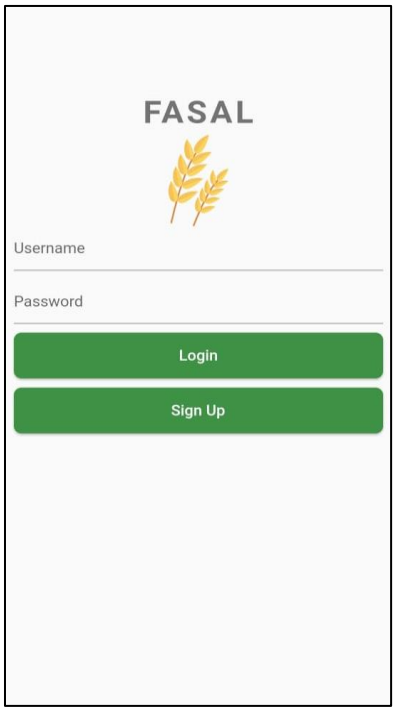

Figure 6: Login

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Check Map

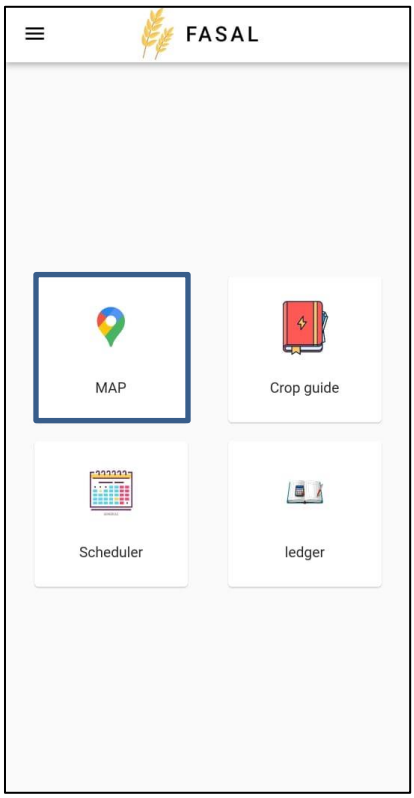

Figure 7: Check Map

The map feature enables the user to find their location on an integrated Map and lets them analyze the Soil Quality of a particular area. User can name the city in the provided field and navigate to the desired area on the Map. They can also see the crops that can be grown in that area.

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Crop Guide

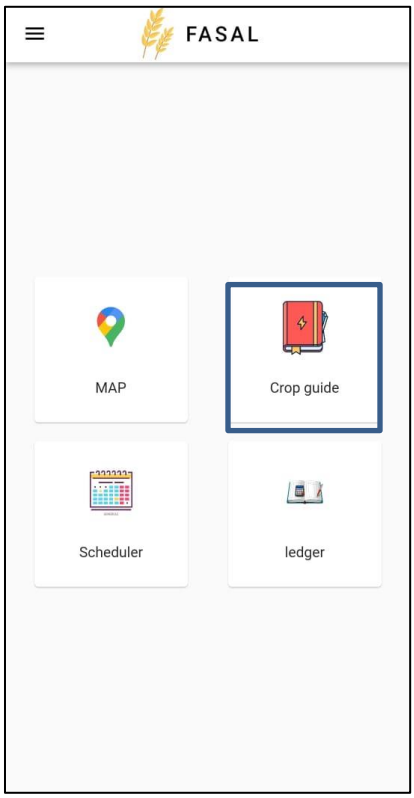

Figure 8: Crop Guide

A cultivating guide module is independently accommodated to another rancher who doesn't have any related knowledge in cultivating and needs to proceed with it can likewise take help from the application to begin cultivating. A bit by bit guide is being accommodated sure harvests that could help the new comer in beginning the cultivating system.

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Scheduler

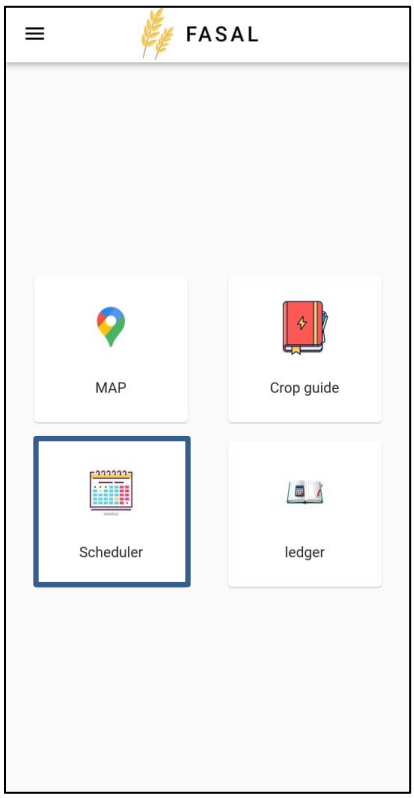

Figure 9: Scheduler

The third screen portrays a choice accommodated the client to begin a scheduler for any yield they need to develop. The client needs to give start date and the harvest name to start the scheduler. The framework will itself break down the harvest name and draw out the water system cycle and afterward give cautions likewise.

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Ledger

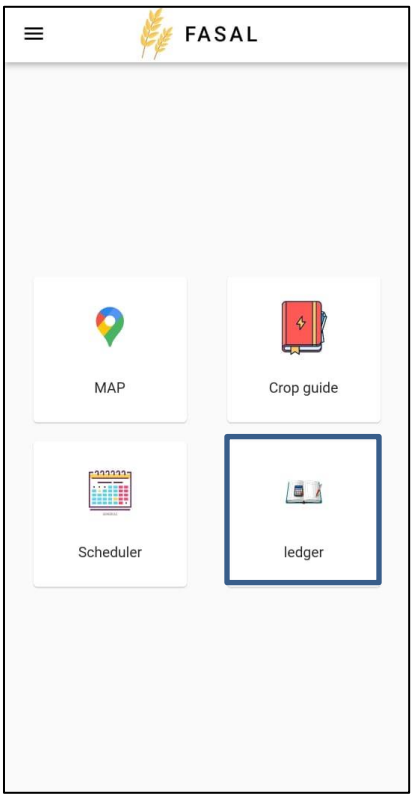

Figure 10: Ledger

The ledger is the last choice for the rancher. This screen will have an even view containing data about the Expenses and Sales of the client. The client can add another section in either record by adding a name of the thing, its complete amount and its base cost. Completes will be displayed at the lower part of the tables for all costs or deals.

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4. Literature Review

The literature I followed throughout my research was usually related to precision farming or smart farming. The idea and approach were followed using some papers like research work "An Architecture model for Smart Farming" by Triantafyllou et al (2019). The paper provided an idea to implement such a system as these systems are being deployed in other countries, so why not in Pakistan also as it's a major agriculture country, it stated that cultivating intelligently is an improvement that weights on the use of present-day developments in the advanced genuine field the chiefs cycle. Developments like the Internet of Things (IoT) and Cloud Computing have accelerated the high-level difference in the customary agrarian deals with promising extended creation rate and thing quality. The gathering of astute developing anyway is hampered because of the shortfall of models provide guidance to experts as for the fundamental parts that set up IoT based really looking at systems. To coordinate the technique associated with arranging and completing Smart developing actually taking a look at systems, in this paper we propose a regular reference designing model, pondering in like manner an essential non-useful essential, the energy use impediment. Furthermore, we present and inspect the advances that intertwine the four layers of the designing model that are the Sensor Layer, the Network Layer, the Service Layer and the Application Layer. A discussion is moreover coordinated upon the challenges that insightful developing checking systems face. Although it discussed much IoT and advanced technologies, we kept focusing on the mobile application only and not to involve any hardware as the financial ability of farmers is not yet stable. But this could be added to future work. **(Triantafyllou, et al. 2019)**

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The literature review helped in getting points for development and how this work could be done. But still I was not able to get the actual data related to the Pakistani farming industry because no work is yet done in the sector so very little data was available regarding the crops and their guidelines.

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5. Future Work

This project and research regarding the farming industry of Pakistan have a lot of research work to do. Right now, the data available is very minimal and it's also not very clean. For taking this application to perfection a lot of research and data collection will be required to make this project into a complete mature product. Like we don't have complete set of crops that can be grown in certain areas of Pakistan, moreover we don't have lab experimented soil samples to completely justify the Soil quality indexes using (Mukherjee and Lal 2014):

$$\mathbf{SQI= \sum wi\ Si,}$$

where: wi is the not entirely settled from the proportion of the complete level of difference from each element to the most extreme aggregate difference coefficients of the head part considered; Si is the score of every boundary in the base dataset.

5.1 Conclusion

To conclude the topic, I would say that this research and project could be a step towards the improvement and betterment of the agricultural sector and hence as a result could improve the efficiency of the farmers and their output as far as crop yield is concerned.

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References

Mukherjee, Atanu, and Rattan Lal. 2014. "Comparison of Soil Quality Index Using Three Methods." *Plos One* e105981. doi:https://doi.org/10.1371/journal.pone.0105981.

Rautela, Piyoosh, and Bhavna Karki. 2015. "Weather forecasting: Traditional knowledge of the people of Uttarakhand Himalaya." *Journal of Geography, Environment and Earth Science International* 3 (3): 1-14.

Triantafyllou, A., D.C. Tsouros, P. Sarigiannidis, and S. Bibi. 2019 . "An Architecture model for Smart Farming." *15th International Conference on Distributed Computing in Sensor Systems (DCOSS).* IEEE: Santorini, Greece.

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ADDITIONAL COMMENTS

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