



International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

<http://gssrr.org/index.php?journal=JournalOfBasicAndApplied>



Case Study: A Mobile ERP to Handle Multiple Sand Mining Sites (Welithota App)

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Abstract

Construction industry has been growing rapidly from 2002 due to massive constructions done for rehabilitation. Further post-tsunami construction also contributed to the exponential growth of the industry from 2004. Recent mega projects including Sothern, Central and Airport highways, lotus-tower, condominium housing projects, and tourist hotels are few examples which contributed directly to the growth in the economy. However, the construction industry directly depends on supply sand and other raw materials. Hence the mining industry governs productivity in the construction industry. The main concern when it comes to the mining industry is the environmental concerns due to excessive consumption of earthy resources. The natural resources are non-renewable and require thousands of years to recreate the extracted minerals. The sustainability within the mining industry attracts major concerns as ill-management in extraction jeopardizes the nature, industry and also the economy. The Sri Lankan government has imposed Laws and By-laws by act number 33 of 1992 and established Geological Survey and Mines Bureau (GSMB) to ensure that construction raw material extraction industry functions with sustainability without compromising nature. This case study has been conducted to acknowledge how the Information Communication Technology had incorporated within the industry stakeholder; raw material mining contractors for sustainable sand mining.

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Miners with valid licenses were integrated with mobile based technologies to manage the day-today operations and the systematic adherence to imposed Laws. Furthermore, the paper discusses how technology has improved governance and management in technologically unattained industry. This case study resulted in the mobile based Enterprise Resource Planning (ERP) mobile application "Welithota", titled to be the first mobile only ERP system in Sri Lanka which works standalone without an internet access or other technological infrastructure.

Keywords: ERP; Sand; Mining; Environment; Mobile; Portable Printer; Sustainable.

1. Introduction

Information Communication Technology has impacted almost every business, industry and moreover has provided assistance in managing operations at a management context. The caliber and potentiality within novel technologies have formulated worthy solutions for a wide range of problems ranging from space voyages to sub-atomic particle observations. Furthermore, all sorts of communities and societal levels are being assisted by computer aided technologies. But, in Sri Lanka, there are many technologically unattained communities, mainly due to the lack of the availability and difficulty in usage for technological infrastructure. Currently, Sri Lanka conducts huge construction projects to boost the economy in different aspects. Construction raw materials are in vital need for huge construction projects. Construction raw materials, mainly sand extraction happens in most of the rural areas in Sri Lanka. Technology penetration in Sri Lanka is exponentially evolving, but yet the local areas lack the basic infrastructure for better communication.

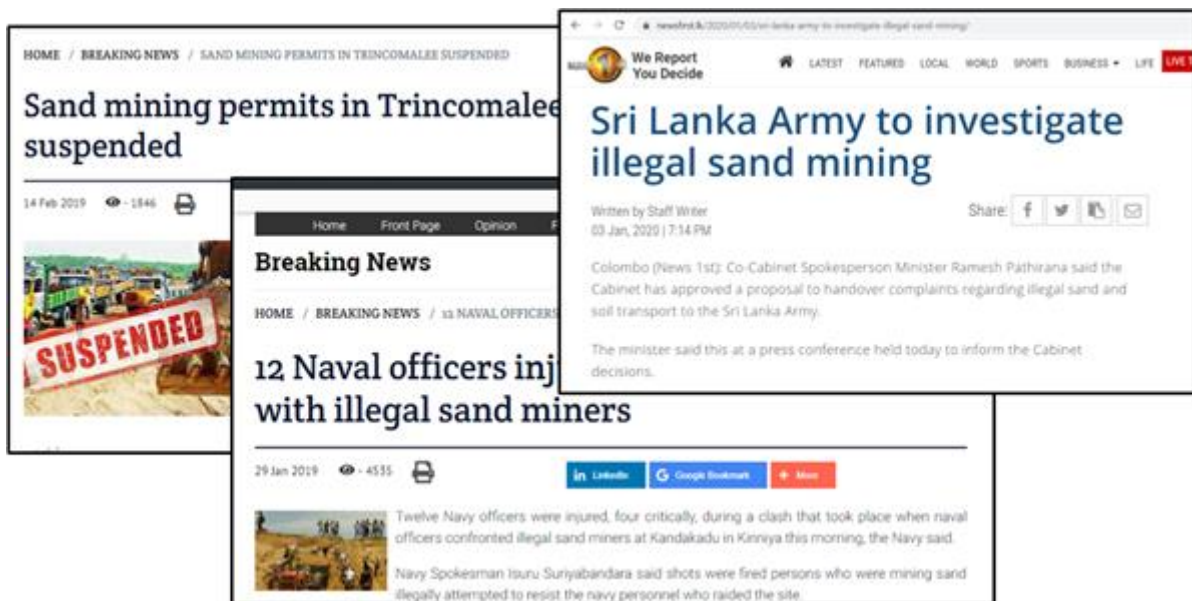


Figure 1: Newspaper Articles Sand Extraction Activities in Sri Lanka

Most of the extraction sites are located in very rustic and rural areas. Figure 1 shows some of the news articles about the activities in the sand industry in Sri Lanka.

2. User Requirements

The Lower Yan Oya Project started in 2012 and identified one of the biggest sand deposits in Sri Lanka in 2015 [1]. The extraction of sand was not regulated properly at the initial stage, but later on licenses were issued for proper sand excavation later in 2017 [2]. The operation on-site needed huge investment over 50 million to acquire land of 5-50 hectares, deploy 5-40 Backhoes, 2-5 loaders, 5-30 lorries and facilitate 10-50 employees including rest of the support services including food, transport and power. Meanwhile the owners who invest mostly live in the town. So they need total transparency of the operation on-site. On the other side, sand mining sites are located in very remote areas. In most locations they do not have data or mobile connectivity. Therefore, the solutions we provide should be able to work on devices without remote cloud connectivity. The mining license owners who expect site management solutions can afford a smartphone. However, the site managers and operation team on site are not tech-savvy to manage complex mobile application or software solutions. Therefore, they need simple interfaces which can be operated on in their native languages.

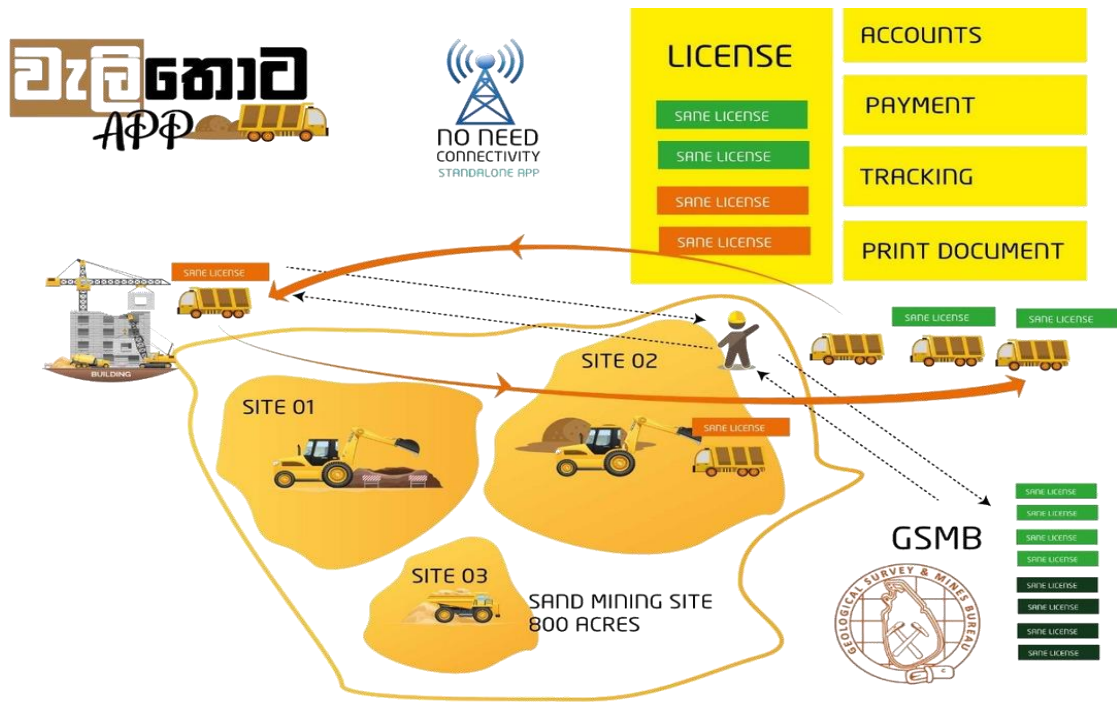


Figure 2: Welithota App Overall Requirements

A single owner can have multiple sand mining sites. The solution requirement is to manage all their accounts, payments, internal external transport, managing mining licenses and corresponding transport license without any data connectivity as indicated in Figure 2. At the end of the day or whenever needed, the owner should be able to request site manager to send operational and financial status of each site.

3. Solution Architecture

There are mobile based ERP products in the market for general purpose. Most of them are to work with a centralized cloud system [5]. Based on the user requirement of this niche market, the solution wanted to be a

mini ERP system which runs on the mobile device. It needed multiple modules to address above specific functionalities on-site as given in Table 1.

Table 1: Solution Modules

Module Category	Module
1. Activities	1.1. Sand Sales
	1.2. Employee Salaries
	1.3. Receive Cheques
	1.4. Operational Expenses
	1.5. Transport to Store
	1.6. Excavation Operations
	1.7. Bank Deposit
	1.8. Bill Printing
	1.9. TPL Handling
2. Basic Information	2.1. Excavation Sites
	2.2. Organization Details
	2.3. Mining License
	2.4. Personal Information
	2.5. Vehicle Information
	2.6. Transport License
	2.7. Bank Accounts
	2.8. Operational Rates
3. Operational Reports	3.1. Daily Operational Report
	3.2. Sand Sales Report
	3.3. Lorries yet to arrive
	3.4. Internal Transport
	3.5. Expenses Report
	3.6. Cheques in Hand
	3.7. Cash Payable

4. Process of Development, Deployment & Continuous Improvement

Application development and version releases were tracked on the GIT version control system as illustrated on Figure 3 based on the industry standard of the software development [4].

G...	Actions	Author	Date	Message
		nimesh	2/26/2018 4:46:18 PM	origin/WelithotaV_1.7.4 Check deposit option, bring money forward
		nimesh	2/22/2018 10:33:22 PM	origin/WelithotaV_1.7.3 add receive check function, tpl remove function
		nimesh	2/20/2018 7:26:37 PM	origin/Welithota_V1.7.2 Arrange tpl list in sales page
		nimesh	2/16/2018 7:48:18 AM	origin/Welithota_V1.7.0 modified tpl enter process add function to view upcoming lorries
		nimesh	2/13/2018 2:36:41 PM	origin/Welithota_V1.6.0 acknowledgement message for multiple entries for tpl
		nimesh	2/12/2018 4:15:58 PM	origin/Welithota_V1.5.0 Merge remote-tracking branch 'remotes/Mob.git/Welithota_V1.4.0' into Mob.git/Welithota/main
		nimesh	2/12/2018 8:37:16 AM	origin/Welithota_V1.4.0 release changes.
		nimesh	2/8/2018 4:11:17 PM	origin/Welithota_V1.3.0 added excavator work tracking system and updated the internal sand transport system cording
		nimesh	2/8/2018 8:52:10 AM	origin/Welithota_V1.2.4 fix errors from unfinished processes
		nimesh	2/7/2018 2:33:28 PM	origin/Welithota_V1.2.3 fix bugs and published v_1.2.3
		nimesh	2/5/2018 5:16:26 PM	origin/Welithota_V1.2.1 calculate functions for advance in sales
		nimesh	2/2/2018 9:37:07 PM	origin/Welithota_V1.2.0 change advance collect system and add week tpl
		Dhanuka Ramanay...	2/1/2018 4:31:02 PM	origin/Welithota_V1.1.0 Installed missing packages.
		nimesh	1/11/2018 2:26:22 PM	origin/Welithota_V1.0.0 add functions to add week tpls
		nimesh	1/4/2018 3:54:27 PM	origin/weli.master remove unused imports
		Dhanuka Ramanay...	12/12/2017 12:40:42 AM	origin/Welithota_V0.7.1 Errors fixed in build. Show a message after sync and added a spinner.
		Dhanuka Ramanay...	12/11/2017 4:33:22 PM	origin/Welithota_V0.7.0 Sync code changed to work with new datastore json.
		Dhanuka Ramanay...	11/29/2017 9:36:20 AM	origin/Welithota_V0.6.0 Welithota app V0.6.0
		Dhanuka Ramanay...	11/24/2017 4:43:24 PM	origin/Welithota_V0.5.0 App icon, splash screen, login bug fixed.
		nimesh	11/24/2017 11:50:59 AM	origin/weli.app/v0.2.0 test and fix some errors
		Dhanuka Ramanay...	11/20/2017 2:35:44 PM	origin/Welithota_V0.4.0 App launch time reduced by deleting module.ts file in pages.
		Dhanuka Ramanay...	11/11/2017 12:48:19 AM	origin/Welithota_V0.3.0 package.json and config.xml modified
		Dhanuka Ramanay...	11/4/2017 12:24:54 AM	origin/Welithota_V0.2.0 Problem building the APK has been solved.
		nimesh	10/31/2017 7:05:13 PM	origin/Welithota_V0.1.0 rearranged app structure

Figure 3: Welithota App Version Tracking on GIT

The development team went to the mining site on each major version release to assure the functionalities developed were used by the operating team on site. Based on their feedback the interfaces and functional flows were changed for better user experience. A prototype based iterative software development process [3] was followed since it was difficult for the users to spell-out the real requirement. This way, users could start using the application with the minimal viable product at a very early stage of the development. Further we could accommodate the continuous changes of the application they expected with minimal delay. So they could use the application on their multiple sites.

5. Constraints & Limitations

- Very first challenge faced in this project was to understand the real user requirement and operational environment. Since the solution was expected to deploy and run on very remote area and the operation was very unique to Sand mining process, the development team could not remotely understand exact operational conditions on site.
- The digital divide objectified another major constraint in the design for the use of the mobile phone by underprivileged youth in Sri Lanka [7].
- The Welithota application needed to run the entire day on a remote site, which was not guaranteed to have any data or mobile connectivity. Therefore, all the application data needed to be stored in local storage. When needed they should be able to go to a location they have data connectivity and transfer to the mining license owner to receive on his mobile.
- Another requirement was to provide a receipt to the lorry driver. Under the operational condition on site, doing it manually is very difficult. Printing the same using standard computers and printers also not possible as they have concerns of getting power and space to keep a printer.
- Generally, software engineers are well paid and work on luxurious working environment with AC,

comfortable and movable chairs, tea and snacks to the desk and having friends to go out evening activities, diners or drink. Therefore, having resources to develop a solution to run at a remote sand mining site which could be used by an under-privileged user group to operate effectively was the major challenge faced in this solution.

6. Addressing the Constraints & Limitations

To overcome the problem of understanding the real user requirement and operational environment, we engaged with a mining license owner to gather his requirement and agreed on a minimum viable product (MVP) [6] to start operation. Then the development team went on-site for all major deployment of MVP and stayed with the team and trained to use the application. To empower the users on site who were underprivileged objectified by the digital divide, the application interfaces were provided in native language with specific color codes for different operations as in Figure 4. These developments were done based on the outcome of day-to-day interaction with the real users.



Figure 4: Color Coded Native Language Interfaces

The requirement of working remotely with no data or mobile connectivity was accommodated by providing an offline operation model to the application with facility to share the running data as a compressed file to the owner via email, WhatsApp, Viber or other available sharing mechanisms. To provide the receipt, the Welithota application was integrated with a portable mini printer via Bluetooth. This let the manager on site feel more proud and smart as per Figure 5.



Figure 5: Bill Printing with Portable Bluetooth Printer

Two trainee software engineers from well recognized universities in the country (University of Moratuwa & University of Colombo) was used at the beginning under well experience software solution architect who accepted to face the challenge. The trainees were staying few weeks on a room closer to the Yaan Oya site to assure the application MVP was really used by the site operation team. The team was improving the features to meet customer convenient then and there. One of those trainees was continued as a permanent employee after six months of their training. Latter development of the product was continued under his supervision with the guidance from the senior software architect. This assured the quality software solution, which last for three years with expansion of multiple sites.

7. Real User Experience

With the use of the Welithota application, site managers could generate all needed reports and balance the cash-in-hand without spending hours at the end of the day. Using a few clicks, the site manager could send all needed reports to the owner via any sharing application as illustrated on Figure 6. With the success of Yaan Oya deployment in 2017, the same mining license owner extended the application to two more sites he was running in parallel (Thelulla, Okkampitiya). Additionally, he was extending the application to all his sites started till the date of writing this case study in Feb, 2020. Now two more sites (Nikaweratiya, Thelulla) are running the application and he is ready to deploy the application to the new site to start in Buttala.

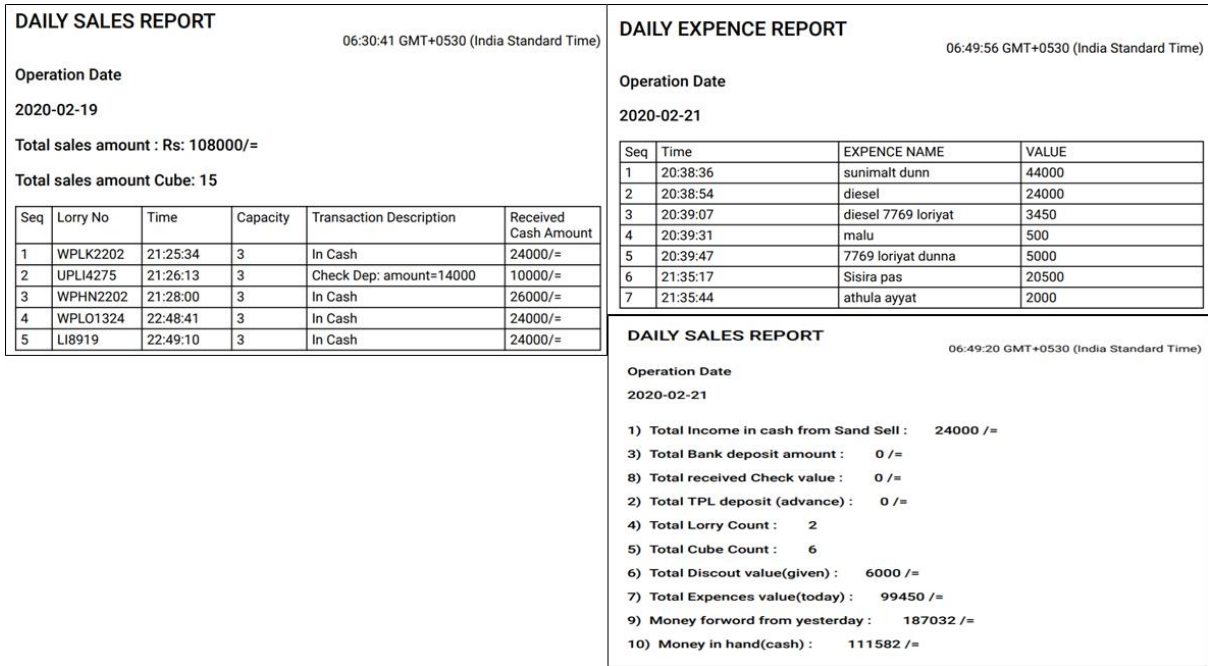


Figure 6: Operational Reports Shared by Site Manager to the Mining License Owner

Additionally, users could generate different reports for different aspects of the operation as listed below:

- Figure 7: Daily Sales & Collection Report
- Figure 8: Weekly Expenses Report
- Figure 9: Monthly Transport License Status
- Figure 10: Weekly Transport Summary

Sales and Collection

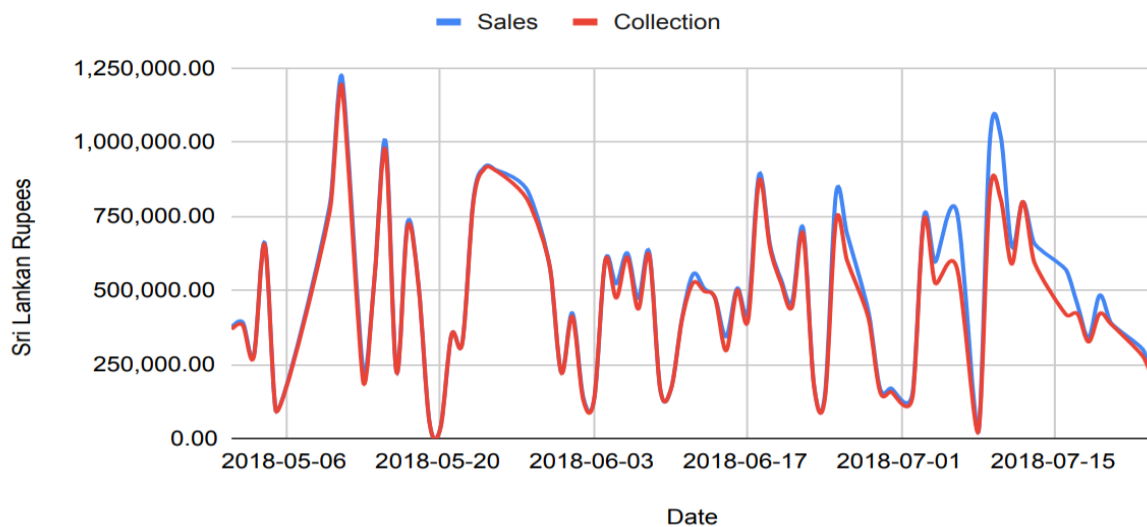


Figure 7: Daily Sales and Collection Report

Weekly Expenses Report

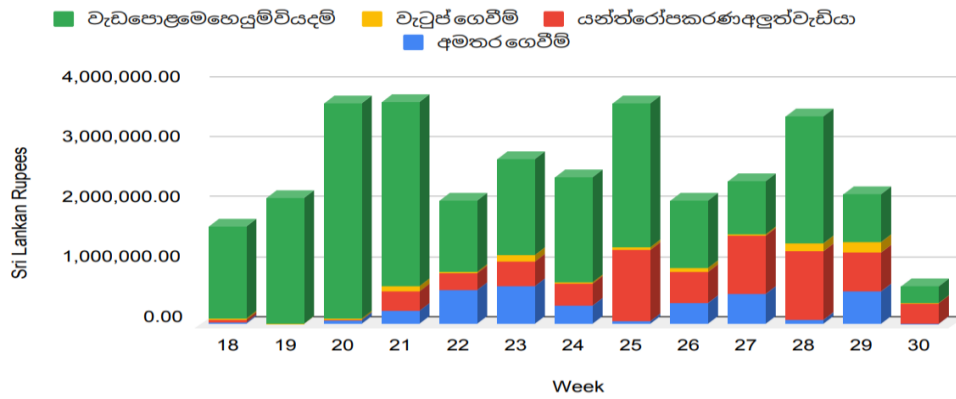


Figure 8: Weekly Expenses Report

Transport License Status

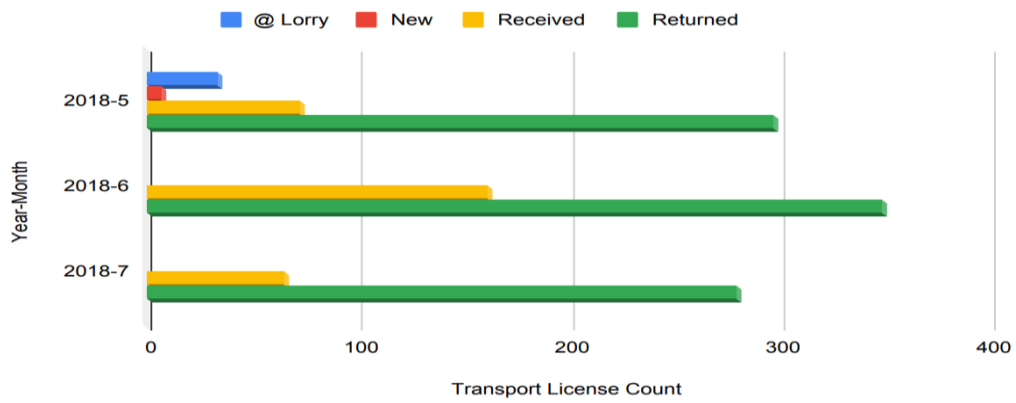


Figure 9: Monthly Transport License Status

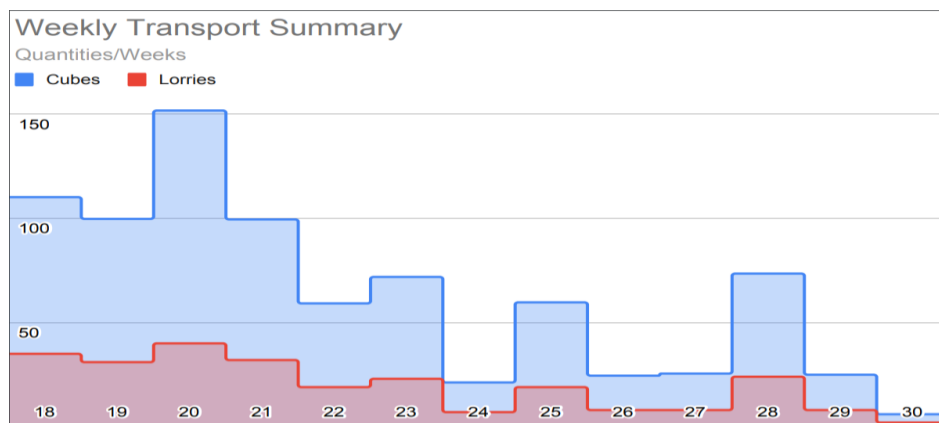


Figure 10: Weekly Transport Summary

The effort spent on the software development could not be covered with a single user deployment. The customer also had the understanding from the beginning and supported in pitching the solution to other mining license owners known to him. We met 5 customers during the year 2019. All of them were interested in software, but

could not afford the solution with up-front payment due to the crisis in the sand market [8]. They were interested in a solution which could pay per sand dispatch.

8. Conclusion

As per the user feedback Welithota was a practical solution which uplifted operational standard of the sand ports and the employees work there. The solution exposed the transparency of the finance while saving a lot of time and effort of the site managers which were spent on manual book keeping. Welithota served for both site operators and owners avoiding shortage of cash when they reconciled at the end of the day.

9. Recommendations

However, the business model of the solution needs to be revisited to facilitate the affordability of the solution by any sand minor irrespective whether they are individuals who are finding the living for the day or industrial giants who own multiple mining licenses. Additionally, it is important to collaborate with regulatory bodies to enforce the procedures for legal sand mining while increasing the transparency of illegal mining, transportation, storage and usage of sand empowering regulatory bodies (E.g. Geological Survey & Mines Bureau), enforcement units (E.g. Police, GSMB enforcement unit) and general public to assist in stopping illegal sand mining. Further, this is a solution can be extended not only for Sand, but also for other minerals including Soil, Gravel, Rock, Graphite, etc. So, future development and studies are recommended to be carry out based on these potentials.

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