Developing an Intelligent Platform for Construction Machinery Calculations and E-Procurement

FINAL YEAR PROJECT UG – 2017

By

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Year 2021

CERTIFICATION

This is to certify that the thesis entitled

DEVELOPING AN INTELLIGENT PLATFORM FOR CONSTRUCTION MACHINERY CALCULATIONS AND E-PROCUREMENT

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has been accepted towards fulfillment of the requirements
for the undergraduate degree
in
CIVIL ENGINEERING

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ABSTRACT

With the rise of the construction industry in Pakistan and the shift of major sectors towards automating their workflow for a greater yield overall, we introduced Constructnet, the first web-based intelligent platform for construction machinery calculations and equipment acquisition.

The idea of Constructnet is mainly focused on the construction machinery sector. Through our online domain the clients can effortlessly calculate productivity, costs and time to complete their specific tasks and will have a variety of machinery to choose from. Constructnet also provides rental services via connecting the supplier and the customer through our web-based portal.

We aim to reduce the barriers currently existing in the construction industry of Pakistan and focus on ways in which a project manager can pick out the right machinery for his project, which is cost and time effective. Furthermore, we aim to make machinery rental services accessible to an ordinary man, who could require it to start up a construction project.

DECLARATION

It is hereby solemnly and sincerely declared that the work referred to this thesis project has not been used by any other university or institute of learnings part of another qualification or degree. The research carried out and dissertation prepared was consistent with normal supervisory practice and all the external sources of information used have been acknowledged.

DEDICATION

We hereby dedicate this project to our parents, teachers, the labor force of Pakistan and the unfound potential of the construction industry. May we get to live our lives to the fullest of our potentials.

ACKNOWLEDGMENT

We express gratitude toward The Almighty Allah for giving us the quality and faith in ourselves for the endeavor of this final year project. We additionally accept the open door to offer our thanks and regard to our folks, without whose supplications and wishes we could never have possessed the capacity to fulfill our objectives.

It is of most extreme important to recognize and thank our advisor and mentor Lec. Muhammad Hasnain, for all his admirable direction, help and inspiration given all through degree of our project. It is with his bolster that we have been fruitful in accomplishing our goals.

We might likewise want to specify and thank Techno Time who furnished us with their time, help and information. Without their collaboration, active participation and help this project would not have seen the light of day.

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CHAPTER 1

INTRODUCTION

1.1 Background

Our idea is to develop an intelligent web-based platform for construction machinery cost and time calculations along with providing data base of construction machinery in a locality for renting purposes.

1.2 Problem Statement

As a project manager, it is important for you to select the most time and cost-effective construction machinery for the completion of the project. Your decision could help save your company time and costs at the same time. But, how would you know which is the best machinery? There is a lack of uniform and standard platform which covers all the machinery aspects of a project from productivity to cost of a certain job. Adding to it the varying costs and inconveniences present in the construction industry with regards to machinery and the manual calculations which are long and tedious, it gets very time consuming with possibility of human error.

Furthermore, there is no construction project management web-based platform in Pakistan which can be accessed by both clients and contractors. This makes ineffective communication between the parties.

Hence there is a sheer lack of a single centralized platform for construction machinery calculations and acquisition. This window of opportunity is the reason behind creation of Constructnet. it aims to address all these problems simultaneously while giving the client a complete sense of hold over the entire process.

1.3 Research Objectives

The objective for research is to shift the machinery calculations and equipment acquisition to an online based system. The purpose is to study how efficiently this system can run considering the complexity of the problem along with the fact that it is a new and tech-based introduction to the industry

1.4 Competition

There is no competitor in Pakistan as of now who provides an option to calculate machinery productivity and allow renting at the same time. There are many apps like Pakwheels, Olx etc. but those apps are mainly based on selling and leasing automobiles. On the other hand, Constructnet focuses on the construction industry and also provides an in-depth analysis of the cost and productivity of a certain task.

1.5 Methodology

The study will be carried on by extensive research, data collection, website development, rates centralization and the digitization of information which will then serve as a means of development of a smart portal.

We aim to fill in this gap with our new and improved online platform with help of our consultancy services and aiding the everyday client to find the best contractor for the job through our data archives. The whole purpose of proposing this idea is to improve client satisfaction and help bring clients and suppliers on a single centralized system along with improving the basic knowledge of productivity and cost for a variety of machinery.

1.6 Conclusion

Keeping in view the recent advancement and development of smart management system for ease and facilitation of clients and suppliers to acquire large scale projects worldwide, we aim to introduce a new readily available and accessible smart application for the masses to aid them in their construction projects, helping them find suitable suppliers through competitive machinery rates via our online database and archives of registered firms along with managing and engaging the clients by helping them through our system to find the best possible option for them.

CHAPTER 2

LITERATURE REVIEW

2.1 Automation

Automation is taking place, and it will have a significant impact on businesses and economies around the world, but it will take time. Whether we like it or not, machines will be replacing us and will be doing a better; more accurate and precise job than us.

2.1.1 Recent Trends in Automation

Recent progress in automation indicate that robots and computers now are very much equipped for achieving exercises that incorporate psychological abilities once thought to be too hard to even consider automation effectively, for example, making unsaid decisions, detecting feeling, or in any event, driving. Automation in business also comes in handy by reducing errors and completing the task much quicker. Increases productivity as proven by history. It would likewise help counterbalance the effect of a declining portion of the working-age population in numerous nations. In view of our situation displaying, we estimate automation could raise efficiency development all around the world by 0.8 to 1.4 percent yearly. (Manyika et al., 2017)

The process of automation will be a slow and depends on factors like technological advancements. Machines will be compared with the labor for the same job on cost, skill and dynamics, keeping in mind the demand and supply concept. It is believed that half of today's work activities would be automated by 2060 or even earlier depending on the above-mentioned factors.

2.1.2 Unemployment Concerns

Most of the debates related to automation are about mass unemployment. Past experiences confirm that this is a possibility, but machines will always need a human to be controlled by. Along these lines, our productivity estimates expect that individuals uprooted via automation will discover other work. Numerous laborers should change, and we expect business cycles to be changed. Nonetheless, the size of movements in the workforce over numerous years that automation advancements can release isn't unprecedented.

2.2 Machine Productivity and Costs

The expense of equipment for construction projects can go from 25% to 40% of the overall project's cost. (Terex Corporation, Hudson, OH.). Construction equipment is a fundamental piece of development process. Expense of construction is the component of the plan of the development activity.

Since most considerate construction development projects are granted dependent on least expense, it is of most extreme significance to the contractor to choose the convenient construction machinery, giving the most reduced construction cost for the project.

2.2.1 Equipment Cost

Moreover, constructor can rent equipment or buy it. On the off chance that the equipment is rented, deciding equipment cost is easy, in light of the fact that the rental rate will be set up. On the off chance that the machinery is going to be purchased, expected buying and working cost should be decisive.

Following are the factors which should be kept in mind when leasing the machinery:

1. Time basis of the rates cited
2. Cost of repairs
3. Operator

4. Fuel and lubricants
5. Condition of equipment
6. Freight charges
7. Payment and taxes
8. Insurance

2.2.2 Transferring of Equipment

Below stated are elements that should be kept in mind whilst transferring equipment from one point to the other

- Category of machinery
- Rates
- Equipment assessment (weight, height, width, length)
- Permits (vary with state)
- Regulations set on trucking industry

2.2.3 Bulldozer Productivity

Most bulldozer equipment manufacturers will arrange production information. Manufacturer's production information is helpful in managing a comparative analysis when establishing a conceptual estimate or schedule. Production data arranged by manufacturers (or any other source) must be applicable to a particular situation. However long the conditions that the production curves depend on are acknowledged, they can be utilized for different conditions by utilizing the proper rectification factors utilizing a typical production curve. (Halpin, D.W. and Riggs, L.S. 1992)

As long as the conditions that the production curves are based on are accepted, they can be used for other conditions by employing the appropriate correction factors using a common production curve.

Common correction factors comprise of:

- Operator competence
- Category of material being managed
- Process of dozing
- Transmission type

2.2.4 Excavator Productivity

Excavators are a very common and versatile type of heavy construction equipment.

The efficiency of the excavator is mainly the operation of the digging cycle (Peurifoy, R.L. and Schexnayder, C.J. 2002), below are a few points which effect the digging cycle:

- Duration required to fill the bucket
- Duration required to sway with a fully loaded bucket
- Duration to unload the bucket
- Duration to sway with an empty bucket

2.3 Renting vs Buying Analysis for Construction Equipment

Building destinations ordinarily require a scope of hardware for putting away, sifting, burrowing, lifting, digging, stacking, and exhuming. The choice to lease or to purchase will have an enormous effect in construction activities and the spending plan.

The decision may change starting with one organization then onto the next. However, the variables that basically drive the expense versus advantage examination are:

- Your venture spending plans
- Availability of aptitude and assets to deal with the stock and armada
- Cost of purchasing versus leasing
- Duration for which the claimed or leased hardware will be utilized
- Urgency – how soon your task needs the hardware

2.3.1 When to Buy Construction Equipment

1. Accessibility of the equipment – Rental organizations work with multiple customers. There is a slight possibility that the equipment may not be accessible with the rental organization when you need it. In the event that your project is high-priority and can't bear to stand by, think about purchasing the equipment. With your equipment accessible 24×7, you are prepared consistently to deal with crises and last-minute jobs.

2. Cost of financing and devaluation versus rental – Construction Equipment corporations regularly think of financing plans at appealing loan fees to help you purchase the gear. Yet, you should realize that the equipment begins losing its resale value instantly. An examination of the costs in financing versus leasing life cycles should be done.

3. Purchase used equipment – Rental organizations additionally offer utilized equipment available to be purchased that you can get at exceptionally alluring costs.

2.3.2 When to Rent Construction Equipment

Organizations decide to lease construction machinery over buying them for various reasons. Bigger organizations can increment or reduce their fleet depending on the situation. Little to moderate size organizations can lease particular construction machinery at impressively lower costs. Be that as it may, there are numerous different advantages when you go with the rental option.

1. Save the up-front investment – Heavy equipment, for example, excavators and earthmovers can take up a ton of venture that will stay stuck until you sell it. Also, when you sell, you may not get the value that you expected. Leasing the equipment can save you from this problem. (American Rental Association, http://www.ararental.org/. 2005.)

2. Avoid operational expense – On the off chance that you purchase the equipment, you will likewise have to keep a small team to service the machine routinely. With leasing, this can be dealt with by the rental specialist organization.

3. Free up the cost of storage and transportation – With a rental, you can let the specialist co-op convey and get the equipment on request. You don't have to build extra storage places for times when the equipment isn't required.

4. Tax reductions – Rental instalments are repeating costs that can be more advantageous than the forthright expense of procurement, which is determined as a deteriorating resource over the long run. You may likewise get some tax reduction with rental relying on the idea of your business. (Nevitt, Peter K. Equipment Leasing for Commercial Bankers. Robert Morris Associates. 1987.)

5. Decrease the holding up time – As a construction organization, you would prefer not to keep your work inactive while the equipment shows up or remains stalled at the site.

6. Keep up market competitiveness – Even on the off chance that you are a little organization, you can get projects since you approach all the equipment that a major organization possesses. This gives you an upper hand when you negotiate for new projects.

7. Try the machinery prior to purchasing – If you need to purchase a piece of equipment but aren't sure about it, you can rent and test it before buying.

All things considered rental of equipment can empower a greater organization to expand its fleet when and where required, while it can help a little or medium-sized organization to propose work that requires specialty equipment or machines to satisfy the necessities. Rental alternatives can fill in during a crisis and give an adaptability that stretches out to logistics and finance, at least. Equipment rental appeals to numerous enterprises in light of its numerous advantages and benefits.

2.4 E-Procurement

E-procurement is characterized as the buy and offer of products on the web. This is a service utilized for moving towards digitization and adapting to the tech-based changes across the globe.

2.4.1 Difference between Procurement and E-Procurement

Both the procurement and e-procurement have same interaction yet the platform happening region is unique. E-procurement is done electronically with in the PC with the assistance of internet connection which doesn't comprises of administrative work in regards to the documents. However, in the procurement the interaction is extraordinary and there incorporates a ton of administrative work which must be done before the tender goes into tender box.

2.4.2 Why is E-Procurement better than Traditional Procurement?

During the process of conventional procurement this process had the correspondences made on telephones or sends or in the immediate gatherings and the customers use excel sheets and messages to discuss the information with the organization and customer, so it has too many pulls out and the primary concern is there is an absence of straightforwardness during the time spent procuring the tender. The other explanation is the point at which the information is to be refreshed or to make a review it will be a little hard to discover and look. Along these lines, this e-procurement measure gives most arrangements with high achievement rate and can be overseen effectively by individuals engaged with the project and can be utilized from anyplace worldwide. (Ramayah et al., 2007)

2.4.3 What Challenges are Faced when Implementing E-Procurement?

During the time spent carrying out the e-procurement there are numerous difficulties to be looked by the organizations. Some of them are that the data in regards to the customers and representatives have to be clear and the qualities are to be appropriately kept up. Assuming the data is to be passed, every one of the workers should be cautious while posting in the site and the challenges of attempting to change the errors are to be done formally that is by counseling the legitimate specialists. Different troubles, for example, while executing the e-procurement the organizations need to bear a significant expense in obtaining the e-procurement software for both establishment and for permit and then again, they should prepare their representatives to get information on this product and because of this e-procurement is done online so every single individual or little organizations likewise get the advantages of it. (Croom, 2000)

CHAPTER 3

METHODOLOGY

3.1 General Background

We aim to introduce a new readily available and accessible website for project managers and other relevant individuals to aid them in their construction projects, helping them find the right machinery for the job with respect to their priority between time and cost through a web-based productivity calculator and e-procurement platform.

Construction machinery costs range between 25-40% of the entire project costs. (Terex Corporation, Hudson, OH.). This provides us with the opportunity to improvise and make smart decisions to reduce this cost as much as possible. Hence, our productivity calculator would allow project managers to calculate the time and cost different machinery, which is readily available in their locality, would take to complete the given task. The manager could then go on to rent that given machinery that they require, which could connect them directly with the supplier. We will reach out to our clients and suppliers through below-the-line marketing.

Our main aim in this business is to make the process of choosing and acquiring construction machinery easier and to bridge the gap between the suppliers and the clients through a web-based application. This would also increase the competition within the machinery market, pushing suppliers to provide the clients with the latest technology to meet their requirements.

There is no direct competitor in Pakistan to Constructnet. There are a few machinery listing apps like Fleet and Rental Machinery.pk etc. which provide a data base of machinery which can be rented by emailing your requirements to their customer support but our idea is much more different and efficient since we allow the client to calculate the number of hours, they would need the machinery for and the respective rates, along with a database of machinery available for rent in the locality of the user.

Suppliers would be contacted through word of mouth and direct calls/meetings, with their machinery being registered and uploaded onto the website once they provide us with their database. Clients will be targeted by traditional marketing and registered on the portal to make machinery renting transactions.

3.1.1 Our Share

The renting per hour rates for each machinery will be provided by its supplier. We will be charging 10% of the total renting cost being paid by the client, which is justified as our platform allows the client to save time and costs.

3.2 Steps

Following steps will be conducted in order to complete the project. The methodology is predominantly divided into three major parts:

1. Machinery Database
2. Web development
3. App usage

These three major categories have been further sub divided into various steps to ease the flow of project.

3.2.1 Machinery Database

Various contractors and suppliers were contacted within the Islamabad/Rawalpindi region to provide a database of construction machinery that they own and are willing to put up for rent on Constructnet.site. Techno Time, a CA-1 company were kind enough to provide us with their confidential database of machinery.

The list was categorized according to the functions of the machinery and we decided to find the productivity of the following types for the prototype of the website:

1. Dozers
2. Excavators
3. Asphalt Plant and Pavers

Other machines such as graders, cranes, rollers etc. were not included in the prototype as their calculations were complicated and required a much-advanced plug in than what we could specialize in within the given time frame, and also because their production factors weren't accessible on the internet and we would've had to reach out to the manufacturer which would've been a long and lengthy process.

3.2.2 Web Development Phase

This marks the second stage of our project expanding on the data acquired from the construction firms. This details the steps by which the web platform was created from scratch using various plug ins and tools

3.2.2.1 Website Initiation

Websites require a domain and web hosting service (where the website data is stored). We will be using GoDaddy.com to obtain these services for a varying monthly subscription cost. Once this is set up, we will be using WordPress, which is an open-source content management system, to design the outlook of the website and incorporate different plug ins to achieve the functionality required.

3.2.2.2 WordPress Plug In

We will be using the following plug ins and programming language for their respective functions to achieve the results required:

1. Cost Calculator

2. WooCommerce
3. Java Script

3.2.2.3 Productivity Calculations

To find the time and costs required to get a job done, we will need to find the productivity of the machinery being used. The steps required to calculate the productivity for each category of machinery is explained below:

- Excavators:

1. Input from user – "Select Excavator Model"
    - Give drop down options:
        i. Doosan DX-220
        ii. Daewoo 300LC-V
        iii. CAT 374 DL
2. Input from user – "What type of Material is being excavated?"
    - Give drop down options:
        iv. Bank Clay
        v. Rock-Earth Mixture
        vi. Shale
        vii. Rock – Well Blasted
        viii. Rock – Poorly Blasted
    - User picks an option
    - Extract fill factor value from table 1

Table 1: Materials and their fill factors

Material	Fill Factor
Bank clay	1.05
Rock-earth mixture	1.1
Shale	0.90
Rock – Well Blasted	1.05
Rock – Poorly Blasted	0.9

- Assign value to ‘FF’

3. Input from user – “What best describes the Material to determine swell factor?”
    - Give drop down options:
        i. Clay
        ii. Earth
        iii. Gravel
        iv. Rock – Well Blasted
        v. Sand
    - Get swell factor value from table 2

Table 2: Materials and their swell factor

Material	Swell Factor
Clay	1.05
Earth	1
Gravel	0.85
Rock – Well Blasted	0.67
Sand	0.45

- Assign factor to SF

1. Input from user: “What would be the working minutes per hour?”
    - Take numeric answer
    - Assign value to ‘EF’
2. Input from user: “How much material needs to be excavated (bcy)?”
    - Take numeric answer
    - Assign value to ‘M’
3. Find hours for each machine from table 3

Table 3: Excavator model and its respective cycle time and bucket capacity

Excavator	Cycle Time ‘t’ s	Bucket Capacity ‘Q’ cy
Doosan DX-220	15	1.67
Daewoo 300LC-V	18	2.29
Caterpillar 374 DL	21	5

$$Hours = \frac{3600 * Q * FF}{t} * \frac{EF}{60} * \frac{1}{(1 + SF)} * M$$

4. Find cost for each machine
    - Use table 4 for hourly rate
    - Perform calculation of

      Hours * Rate

Table 4: Excavator model and its hourly rate

Excavator	Rate/hr
Doosan DX-220	2600
Daewoo 300LC-V	3100
Caterpillar 374 DL	6250

5. Display total cost and hours required to complete the work

- Dozers

1. Input from user – "Select Dozer"
    - Give drop down options
        i. Caterpillar D7R
        ii. Caterpillar D8T
2. Input from user – "Enter Tree Count per Acre?"
    - Take input for the following diameter ranges
        i. "<1ft" – assign value to 'B'
        ii. "1-2ft" – assign value to 'N1'
        iii. "2-3ft" – assign value to 'N2'
        iv. "3-4ft" – assign value to 'N3'
        v. "4-5ft" – assign value to 'N4'
3. Input from user – "Total Area for Clearing (acres)"
    - Take numeric answer
    - Assign value to 'X'
4. Find total hours for the selected dozer by using the formula and its respective values from table 5

Table 5: Dozer model and its windrow piling factors

Dozer	B	M1	M2	M3	M4
Caterpillar D7R	50.6	0.4	0.7	2.5	5
Caterpillar D8T	42.1	0.1	0.5	1.8	3.6

$$Total\ Hours = (X)\ /\ (B + (N1 * M1) + (N2 * M2) + (N3 * M3) + (N4 * M4))$$

5. Find cost for selected machine
    - Use table 6 for hourly rate

Table 6: Dozer model and its hourly rate

Dozer	Rate/hr
Caterpillar D7R	2430
Caterpillar D8T	2900

6. Display total cost and hours required to complete the work

- Asphalt Plant and Pavers
    1. Input from user – "Road Dimensions"
        - Take input for the following dimensions
            i. "Width" – assign value to 'W'
            ii. "Length" – assign value to 'L'
            iii. "Depth" – assign value to 'D'
    2. Input from user – "Select Asphalt Mixing Plant"

- Give following options
    i. Barber Green – 120 tons
    ii. SSG Korea – 80 tons
    iii. NIKKO – 100 tons

3. Input from user – "Select Asphalt Paver"
    - Give following options
        i. Vogue Super 2500
        ii. Caterpillar AP800C

The following calculations are completed with the relevant data and displayed on screen:

1. $Total\ Asphalt\ Required\ (tons) = \frac{L*W*D*145}{2000}$
2. $Total\ Cost\ for\ Aspalt\ (PKR) = Asphalt\ Required * 4200$
3. $Time\ Required\ for\ Plant\ (hours) = Asphalt\ Required/Plant\ Capacity$
4. $Total\ Cost\ of\ Asphalt\ Plant\ (PKR) = Time\ Required\ for\ Plant * Hourly\ Rate\ (from\ table\ 7)$

Table 7: Asphalt plant model and its hourly rate

Asphalt Plant	Rate/hr
Barber Green – 120 tons	17300
SSG Korea – 80 tons	12000
NIKKO – 100 tons	14000

5. $Total\ Time\ of\ Paver\ (minutes) = \frac{round\ off\left(\frac{W}{mW}\right)*L}{s}$

Table 8: Asphalt paver model and its max paving width, speed and rate per ton of asphalt

Asphalt Paver	Max Paving Width (mW) ft	Max Paving Speed (s) ft/min	Rate per Ton of Asphalt
Vogele Super 2500	31	59	50
Caterpillar AP800C	21	250	60

6. $Total\ Cost\ of\ Paver\ (PKR) = Total\ Asphalt\ Required/ Rate\ per\ Ton\ of\ Asphalt$

The Cost Calculator Plug in by Stylemix themes was used to solve the above calculations and provide the user with an interactive and user-friendly layout. Furthermore, JavaScript was used in order to perform certain IF Statements for when the user would select a particular machine and its values would change in the formula being used.

3.2.2.4 E-Procurement of Machinery

One of the objectives of this project is to provide a e-procurement platform for construction machinery. In order to do this, we used the WooCommerce plug in, which allowed us to enter details of the machinery available in our database and make an online catalogue. The user would be able to browse through different machines in this catalogue, add them to cart for the number of hours required, enter their billing details and pay for it through bank transfer. The payment would be received by the supplier. Additionally, we added different rates for different delivery locations. Once the user adds their address, the plug in identifies which delivery band it falls into and adds the cost to the total checkout value. This was kept Rs. 5000 for delivery within Islamabad and Rs. 35000 for delivery to Lahore.

The above-mentioned Cost Calculator plug in also allowed the user to select booking dates for the respective machinery they are conducting calculations for and to add it to the basket for checkout.

3.2.2.5 App Usage

1. Firstly, we would approach different suppliers and ask them give us a database of their machinery, along with their rates and condition. The machinery would be subdivided into categories for easy classification. Following are a few examples:
    a. Earthwork Machines
    b. Asphalt Mixing and Paving
    c. Concrete Mixing
    d. Transportation
2. After we've received a database, we will be extracting the relevant data for the respective machinery from their performance books in order to calculate their productivity. This includes, but not limited to, cycle time for excavators, windrow piling factors for dozers, bucket capacity for shovels etc.
3. The productivity formula's will be implemented in the plug in
4. Each type of machine would have its own cost and time calculator
5. All calculations will be thoroughly tested for different scenarios. Limits will be applied where applicable with regards to machinery capacity
6. Machinery from database will also be added to the catalogue in order to allow user to book for renting without having to use the calculators
7. Client can then perform calculations and/or use the e-procurement page in order to rent machinery
8. Payments will be made to our account, which will then be transferred to the suppliers account upon confirmation with the client
9. Email receipts of the transaction will be provided to all three parties involved, the supplier, the client and our team
10. Supplier will ensure delivery of machinery to the clients address on the specified date. Our team will make sure the machinery is marked 'out of stock' on the website
11. Process repeats

CHAPTER 4

RESULTS

4.1 Results

As it is easy to conclude from our research that Pakistan's construction industry is still very much reliant on the old and outdated traditional methods of construction machinery calculations and procurement. Unlike other process industries that have already or are in the process of shifting their business and service provisions online, it is observed that the construction industry is also in dire need of a web-based platform for the ease of access and procurement of construction machinery.

Moreover, there is a need for implementing a system which will help the average person to start a construction project with minimal drawback. Our project generated mostly positive reviews when pitched to concerned parties such as National Logistics Cell (NLC) and Techno Time and it gave our vision a promising outlook and a push in the right direction. This review was imagined to benchmark and also show the acts of Pakistan's construction industry in terms of construction machinery management.

4.2 Prototype Working

Following steps will explain how Constructnet will function when someone wants to opt for our services:

1. Client visits our site and opts either of the following
    i. Machinery Calculations
        - Selects the category of machinery i.e., Earthwork
        - Selects type of machinery i.e., Excavators
        - Selects the make/model they want to perform calculations for

- Enter the data required for the calculation
- Pick the suitable machinery with respect to time and/or cost
- Add machine to basket

ii. E-Procurement

- Select category of machinery i.e., Earthwork
- Select type of machinery i.e., Excavators
- Browse through the list of items available and pick one or more
- Add number of hours the machine is required for
- Add to basket

2. Go to basket for checkout
3. Add shipping address in order to calculate delivery costs
4. At checkout, enter the following details:
   i. Name
   ii. CNIC
   iii. Address
   iv. Occupation/Company
   v. Phone number
   vi. Email Address
5. Enter payment details for bank transfer
6. Receive confirmation email

4.2 Online Platform Development

Using the literature review on how important machinery costs in a projects overall budget and a market gap with regards to a platform which can easily calculate productivity for construction machinery, it was identified that this system is feasible and can be implemented. To develop the web portal, we bought a domain with the name of Constructnet. The web-based platform was made using php and WordPress system. The platform is currently online, with calculations of the machinery provided in the database by Techno Time.

The platform consists of:

1. A landing /home page
2. Calculation's page
3. Renting page for e-procurement
4. A keyword-based search engine
5. Contract's page

4.3 User Interface

The following figures show the screenshots of the web-based platform:

Main Page (top):

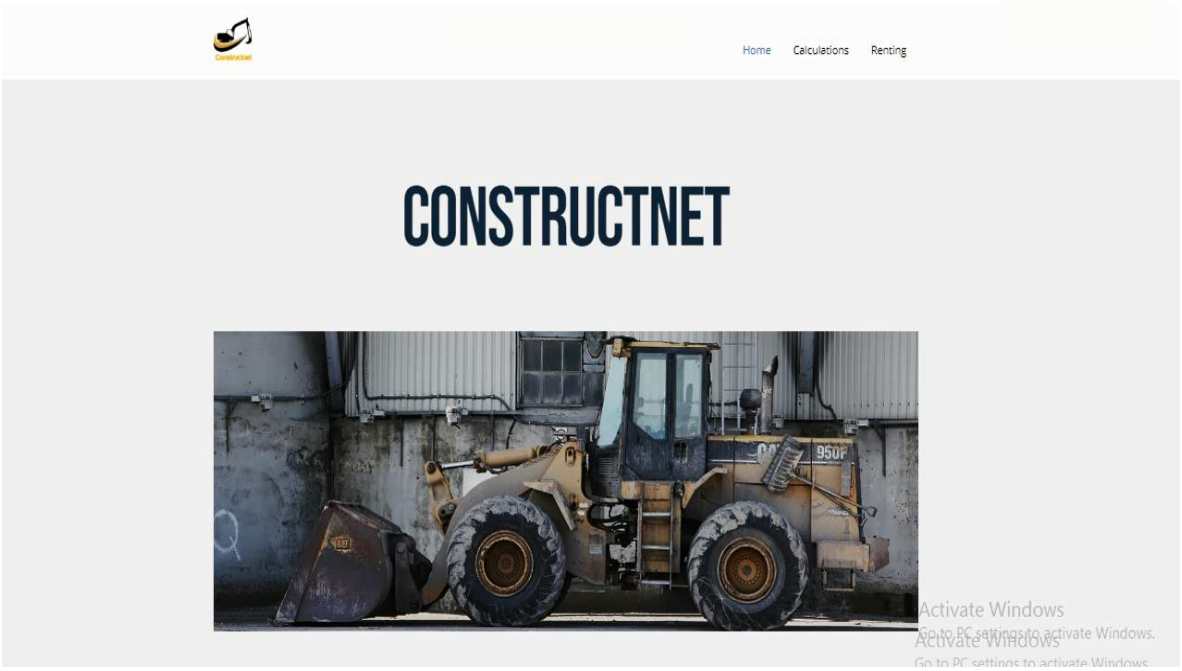

Figure 1: Main Page (top)

Main Page (bottom):

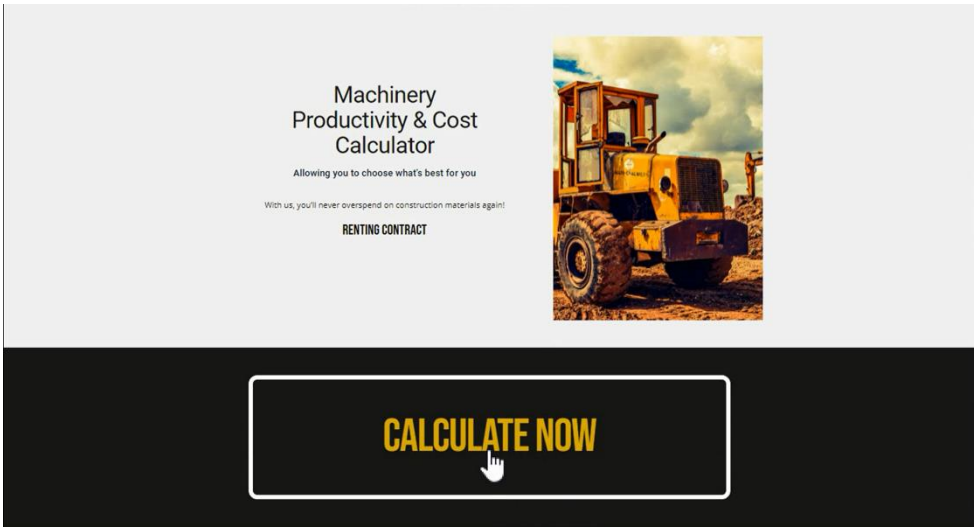

Figure 2: Main page (bottom)

Domain Page:

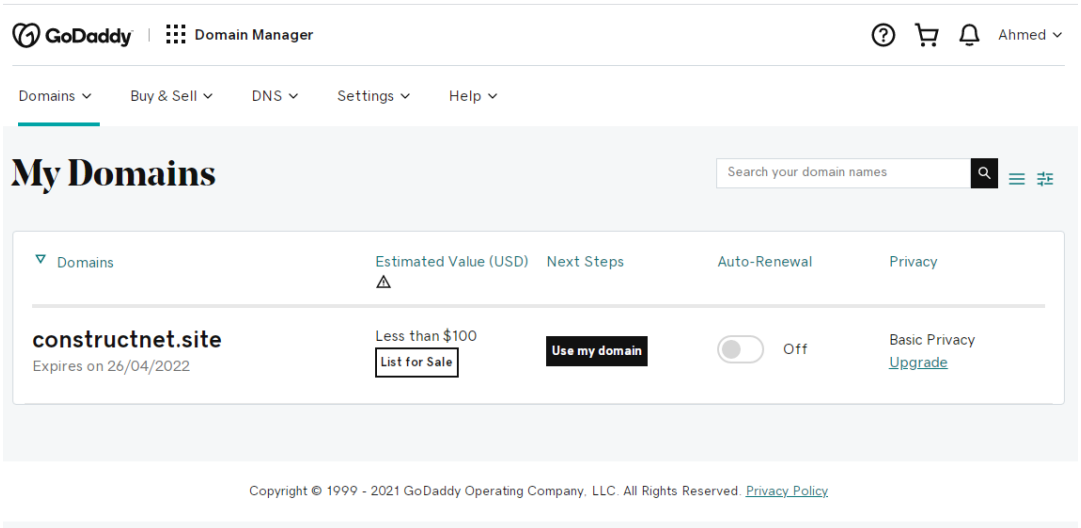

Figure 3: Domain page

Calculations Page:

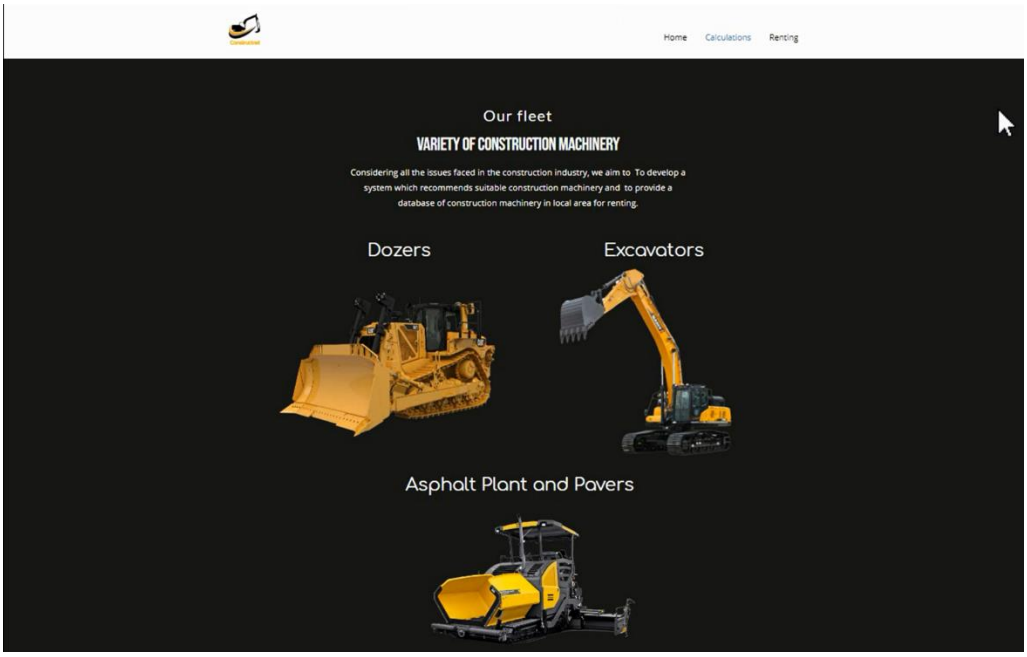

Figure 4: Calculation's page

Dozer Calculations

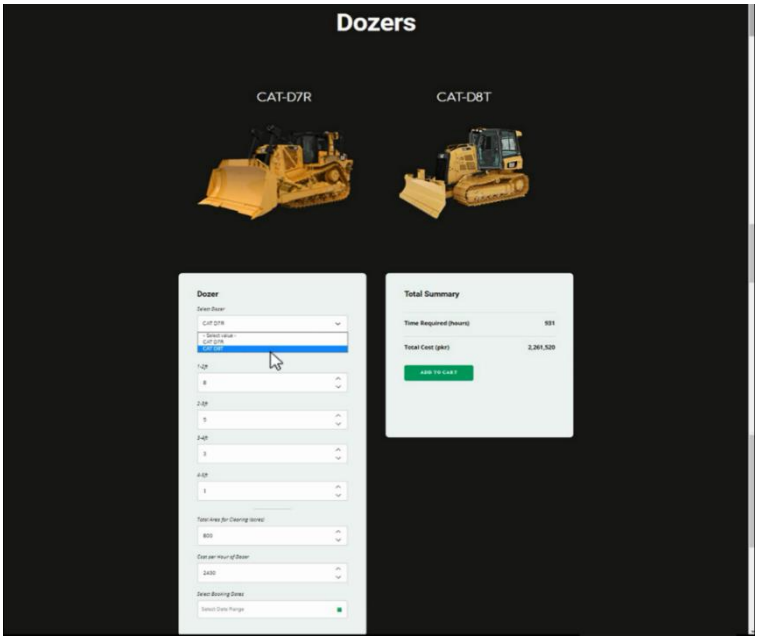

Figure 5: Dozer calculations page

Asphalt Plants and Paver Calculations:

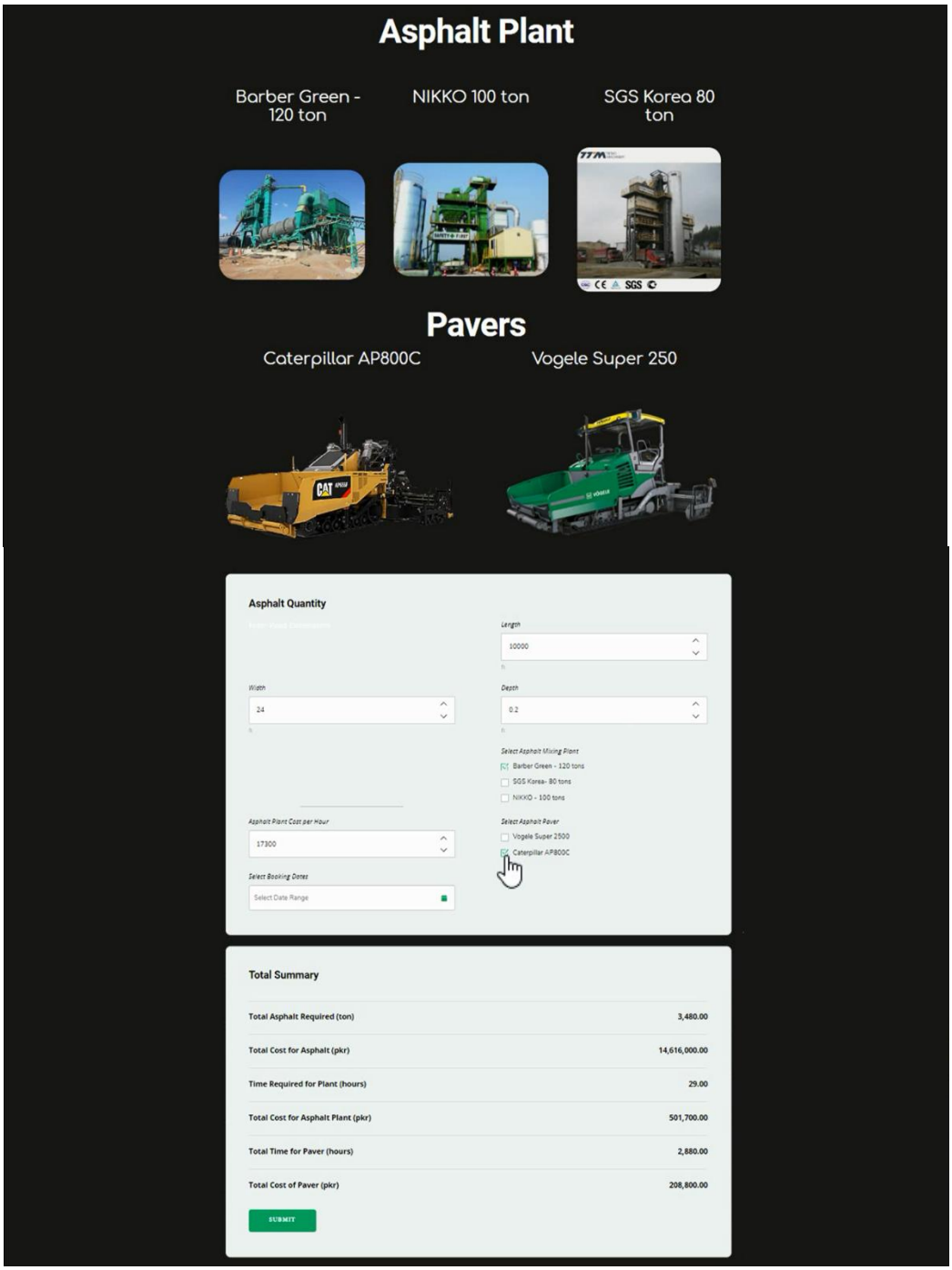

Figure 6: Asphalt plant and pavers calculation page

E-Procurement Catalogue:

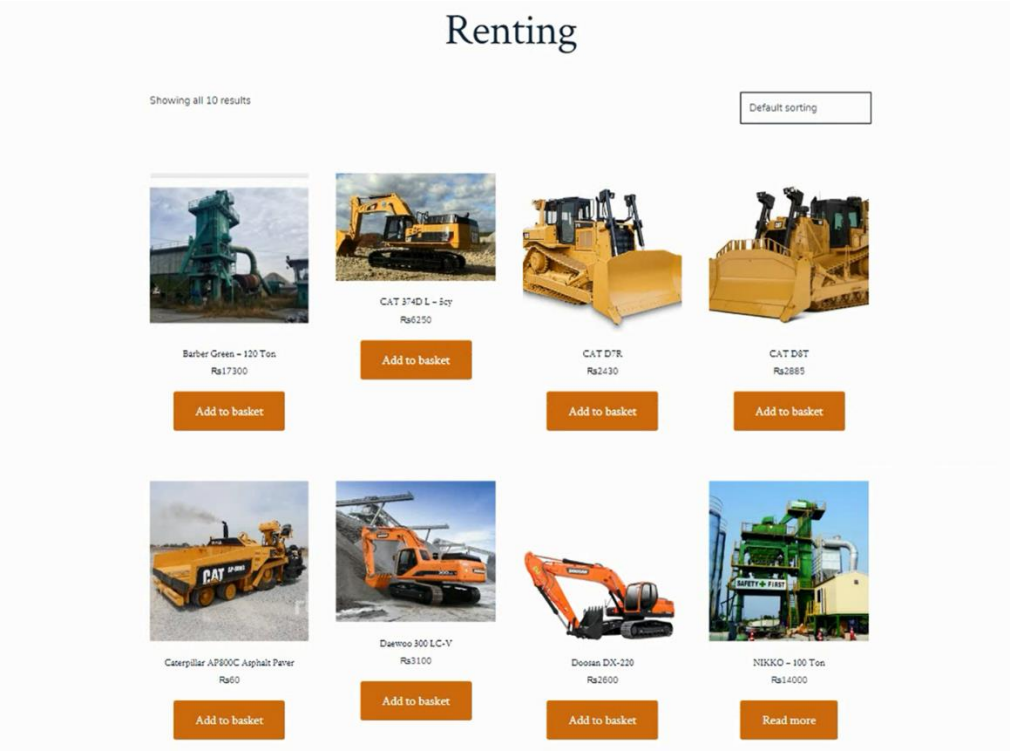

Figure 7: E-procurement catalogue page

CHAPTER 5

CONCLUSION

5.1 Research Conclusions

The conclusions of research-based project were as follows:

1. Constructnet will save a lot of time on the productivity calculations, ultimately making a more efficient workflow.
2. It also eliminates human error involved in these tedious calculations.
3. Gives client freedom of choice when picking the perfect machinery for the job.
4. Provides a centralized database of machinery available for acquisition in locality, saving time and effort for the client.
5. From the problems identified as a part of our research studies, all the necessary features were incorporated that address these issues.
6. Keeping view the entrepreneurial aspect of the project, the web-based platform will be run as a start up in the near future.
7. A huge number of clients and suppliers are very supportive and encouraging of the innovation of such a platform in the industry.
8. The construction industry still relies on old and traditional practices. This causes communication gap between supplier's and clients.
9. The low literacy rate of most suppliers and clients in Pakistan contributes to the reluctance of the industry to lean in the direction of online management.

Pakistan's construction industry holds immense potential to challenge the world on an international scale and revamp with the pace of the progressing world. We have all the right tools and resources that will enable us to compete internationally, what we require is a more streamlined approach by adopting technology.

5.2 Recommendations

Keeping in view the above drawn conclusions, following recommendations are made that can improve the calculation and procurement methods for machinery in the industry:

1. The construction industry needs a medium shift towards a more user friendly and efficient system for machinery procurement.
2. It is a tedious process but with determination and commitment, this system can be implemented.
3. A contact pool of clients and supplier's is of dire need these days so as to remove the communication and access gap between clients and suppliers.
4. Integration of BIM technology in the coming future, which allows project managers to find the best suited machinery based on their BIM drawings.
5. Partnering with multiple firms to maximize efficiency of the overall construction industry.
6. Addition of more complex machinery in the near future such as rollers, cranes, vibrators etc.
7. Expanding to multiple cities
8. Building an artificially intelligent software which automatically assigns clients with the right machinery for their job

As our industry is always progressively moving forward, we should also always be on the lookout for more key areas to research into and incorporate more and more features to assist the clients and the suppliers and the industry as a whole. The transition may be time consuming at first but once the transition is complete, the fruits of our hard work will be evident and the industry will flourish in the years to come

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