

**E-PROCUREMENT OF CONSTRUCTION
MATERIALS
(E-COMMERCE WEBSITE GENERATION)**



FINAL YEAR PROJECT UG 2016

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Final year project titled
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Dedication

We will like to dedicate our work to our beloved parents who made it possible for us to acquire education and our teachers who provided us with education through which we were able to carry out our work.

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 learning as 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.

Acknowledgment

All praises be to Allah, the best Guide and most Merciful. With His Glory, it was possible for us to carry out this research work.

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Abstract

With the increased use of technology in the industry, the procurement methods need to be enhanced too in order to avoid delays which adversely affect the cost and time of the project. However, the use of traditional means of procurement cause problems with record keeping and maintenance related to it. Also with the non-homogenous availability of materials further delays the process of procurement. To overcome the problem, with a proper research and collection of data, which provided information about the local suppliers, a platform is created which is an e-commerce platform from where materials that can be used in construction can easily be bought. Furthermore, an estimate facility is also provided in the platform for four different residential homes of 5, 10, 14 and 20 Marla and estimate provides quantities of the major materials that can be used.

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INTRODUCTION

1.1 General:

E-procurement is the giant jump forward in the development that is long looked for, where the supply chain turns into an uninterrupted and a continuous process stretched out from buyers through the partners that are selling. The technology has set some new standards in the way the economy is doing business based on the idea of efficiency through coordination (Essig and Arnold, 2001).

Since the technology has emerged, it has enabled the information to go from one point to another, whether it has been shared or exchanged through a global network. It provides an efficient and low cost environment. Hence it has encouraged many companies to carry out their business using an E-commerce system since it can provide a win-win situation for suppliers and buyers both and also it provides and expanded market place where suppliers and buyers can directly communicate with one another eliminating the middle man involved (Kong *et al.*, 2001).

In construction industry, where planning, design, bidding, budgeting and even construction management are influenced by the estimates specially cost estimates (Cheng, Tsai and Hsieh, 2009). Cost estimation is done by carrying out material quantity take off. Size and quality of the project, which are usually requirements defined by the client and characteristics of the project themselves, can influence the amount of material that is required for the construction (Ibrahim and Sawalhi, 2012). Estimation is the crucial element of any construction project and its accuracy supports the project managers in decision making process.

1.2 Problem Statement:

Currently, Pakistani citizens are facing a problem of buying different products or materials from different locations for construction which means that there is lack of homogeneous facility to carry out purchase and there is less efficient method to procure construction materials. There are also no reviews available so that if a new person buys something for the first time and has no experience related to construction, so there are high chances that the person might end up buying the wrong material. Therefore, a platform like website is created to overcome this problem but in our region not everyone has a proper access to the internet.

Apart from the availability, waste material is also bought by the clients who do not have much knowledge about the construction material estimate such as how many bricks they require? How much volume of concrete is required or even how many cement bags are need to be bought so that the client can make payments accordingly. Such over estimates lead to over budgeted projects after the have been finished keeping rest of the factors apart.

Are the local markets performing as they are expected and playing a positive role towards the supply of material? If not, will E-commerce market will resolve such issue?

With the increase in the construction process and cost, construction industry requires the transport of material along with proper quantity of material, to be quicker and faster so that delays could be avoided and kept to minimum.

1.3 Objectives:

This study aims to develop (design) a platform (website) for the purchase and supply of construction material and other required products such as electrical products so that someone from construction industry or any citizen that is carrying out any construction process. But before delivering any kind of platform, initially the aim is to collect data of the relevant suppliers and evaluate their response related to E-procurement of the materials.

Inside the platform, an option will be provided in which anyone who chooses to can get to know the amount of material that is required to carry out the construction process of four residential houses.

1.4 Advantages:

With the growth of technology over the time, there are many advantages of E-procurement that have been seen. The main advantage of e-procurement can provide high quantity and quality of information processing. One of the benefits of e-procurement is that it saves cost by saving duplicate spending and saves cost with associated paperwork. Electronically conducting the procurement can makes it easier to write and analyze reports on your procurement system. In E procurement records can be saved electronically and it makes it easier to submit tenders that are reusable. It is also known to reduce storage problems since lump sum of paper work is avoided. Not only this, but old tenders can easily be searched instead of going through whole package of paper work. In an e-procurement system, chances of making an error are less and these errors can easily be detected and analyzed. Last but not the least, new orders can be compared with old orders so that it can be ensured that new orders are correct.

LITERATURE REVIEW

2.1 Procurement:

Procurement in construction industry is planned and managed so that the required services, products or results can be obtained. An organization is involved in this process and this can organization can be either buyer or seller of the services or products (Knoepfel and Berger, no date).

In an industry like construction industry, a procurement mechanism can typically include the determination of the participants that will work in the project, selection of strategies for contract and procurement, purchasing of materials and managing the contract(Tang, Ng and Skitmore, 2019). Procurement systems in construction contain subsystems that are interdependent on each other, system itself to be high dynamic and can be complex itself. The system not only contains hard data such as materials, equipment and drawings but along with it, the system also contains soft data such as knowledge, relationships and information (Tang, Ng and Skitmore, 2019).

2.2 Traditional Procurement:

In traditional environment, after the design of the project is completed and it reaches a tendering stage, procurement of materials is done. The main concern is that the right material must reach the right place at right time on the budget that was agreed upon so that the progress of the project remains uninterrupted (Kong *et al.*, 2001).

After the tender documents have been received by the contractor, he starts estimating and sends out enquiries to the selected suppliers. As soon as the supplier sends the quotes, the contractor will select the best quote among them and complete the tendering documents (Kong *et al.*, 2001).

In traditional system where paper based documents are made, the process of procurement is followed in a long way. The site of office prepares two copies among which one is sent to the buying department and another is filed. After that the buying department prepares four copies of the purchase order. From these four copies, one of the copy is sent to the supplier that is selected and the site office, the accounts office and the rest of the copies are kept by the buying department themselves. Later on the site office will receive an invoice issued by the supplier when the material will reach on the site and an advice note. The invoice is then compared by the buying department against the purchase order that was issued earlier and after the invoice has been cleared, the accounts department will issue the payment of the purchase made (Kong *et al.*, 2001).

2.2.1 Limitation of Traditional procurement:

Traditional procurement method has many limitations in the process. Firstly, it is sure that this method cannot work all long and has specific business hours during which it can work. Apart from business hours, it only works in regions which are geographically defined regions. This process also contains limited amount of information regarding the suppliers and the products that they deliver. Also, the physical catalogues are difficult to handle and use and they also take away a large storage area (Kong *et al.*, 2001)(Kong *et al.*, 2004).

The traditional method is also time consuming and the chances of errors are increased when the data is transferred from one document to another document. In this method it is made sure that all relevant departments get the relevant copies of their data in order to do their jobs but if these copies are lost or misplaced, there is a big chance that a gap will be generated in the system and orders can go incomplete (Kong *et al.*, 2004).

2.3 E-Procurement:

E-procurement is the use of web technology to link consumers, manufacturers and service providers using a computer network so that they can carry out their business activities. The buyers and the suppliers can communicate with each transparently with the help of internet. It also enables the contractors and suppliers to trade material required for construction online through which they eliminate errors that existed in the online paper based system and with low cost of transaction (Kong *et al.*, 2001).

Studies related to implementing e-procurement in the construction industry came out as soon as early 2000s. One of the paper indicated that companies needed to shift from traditional methods of sourcing and they should utilize global market place so that they can increase their efficiency, competitiveness and the profits. Some studies also identified the barriers that medium sized organizations were facing among which some were determined as financial, technical, behavioral and organizational (Isikdag, 2019).

An electronic market provides a platform to the suppliers so that they can display their products online along with information. This way buyers can search through wide range of products of the suppliers and can easily compare them with one another (Kong *et al.*, 2001).

2.3.1 E-catalogue Module:

This module provides suppliers to display their products information in the form of a classified material catalogue in which their products can contain information such as price, brand, units, photos, quality standard, name and other relevant information. It allows the buyers to make a judgment on what product is most suitable for them. However, along with materials, this catalogue

can also contain information about the suppliers also such as their company name, email, address, telephone number and other relevant information (Kong *et al.*, 2001).

2.3.2 Barriers to E-procurement:

A research was also done to determine the barriers that E-procurement faces. Umit Isikdag (Isikdag, 2019) in his research categorized the barriers into four categories.

1) Technology related barriers:

There are concern of security on the information that is transferred. There is slow shift to move towards taking digital signatures. There are also difficulties in establishing an environment for e-commerce. There are problems related to bandwidth and internet infrastructure and also there are problems in management of servers such as databases.

2) Strategic Barriers:

There is lack of organizational focus and lack of top management's support to move towards the e-commerce system. There is also inadequacy of legal infrastructure that supports e-commerce. The also lack of bodies that support the shift towards e-commerce.

3) Market related barriers:

The new media is not as strong as the traditional media when it comes to marketing and public communication. There is fear of price transparency in the system of e-commerce and there is also a concern that how many costumers can be targeted on an online platform. There is also lack of pioneering agents or firms.

4) Human and Process Related Barriers:

There is lack of staff that have skills related to IT. A fear exists that there can be unauthorized access to the information of a critical project. A lack of trust exists between the two parties in an e-commerce system. There is also lack of training on how to use and implement the e-commerce system. It is also difficult to re-engineer the system so that the information flow can happen related to e-procurement system.

Paul Hawking and Andrew Stein (Hawking and Stein, 2002) also carried out researched related to barriers that can occur in e-procurement system in which they recognized them as security, technological, cost, internal or external. Some of them were, cooperation of business partners, security, the cost of implementation and culture in which the company was running.

2.3.3 Drivers of E-procurement:

Paul Hawking and Andrew Stein (Hawking and Stein, 2002) in their study along with barriers to e-procurement they also researched drivers that made e-procurement possible. They were identified as:

- There is price reduction in E-procurement
- The decision making gets enhanced
- The market intelligence gets improved
- It improves the visibility of the demands made by the customer
- The procurement cycle time gets shortened
- The management of inventory increases
- There is reduction in operation and inventory cost
- The cost for administration is also reduced

2.4 Materials:

2.4.1 Cement:

It is a kind of material that has both the adhesive and cohesive properties that are necessary to create a bond between inert aggregates so that a solid mass can be made which has adequate durability and strength. It is not necessary that it is a proper cement but also lime, asphalts and tars. The most common raw materials from which it is made are limestone, they mainly provide calcium oxide (CaO) and clay or shales, which help in furnish of SiO₂ and Al₂O₃ (Nilson, Arthur H.; Darwin, David; Dolan, 2009).

If the cement is only mixed with water it is called cement paste, if mixed with water and sand it is called mortar and additionally if large stones are also added then it is called concrete. As concrete the strength is typically 15-40 MPa (2-6 ksi) and it is measured through compression test. Cement is used for production various concrete and mortars, soil stabilization, grouting and waste containment (Claisse).

2.4.2 Aggregates:

Aggregates are classified in to two categories, fine and coarse aggregate. Aggregates that pass through sieve No. 4 are known as fine aggregates while the retained above it can be called as coarse aggregate. They occupy 65 to 75 percent of the volume in a concrete as hardened mass. The better durability and economy of concrete can be achieved if the aggregates are densely packed and this is the reason that gradation of the size of aggregate is carried out (Nilson, Arthur H.; Darwin, David; Dolan, 2009).

However the aggregate can have effect in concrete in several ways. The cost is less than the cement paste and also shrinkage is less compared to the cement paste. They do not generate heat of hydration and neither do they bleed. They control the density in concrete and cement and water are mixed with the help of aggregates (Claisse).

2.4.3 Steel:

Among the most important material used in the construction industry, steel is one of them. Different type of steel are manufactured with different carbon contents in them such as for construction high yield steel is used with has carbon content ranging from 0.04-0.3%. Steel comes in different shapes such W shapes, L shapes and HSS shapes and also they come in different strengths. Grade of a steel usually classifies yield strength of a steel bar such as Grade 60 steel means it has yield strength of 60,000 psi (420 Mpa). Steel is either welded together or bolts are used to join the different steel members together. Steel fails in with a fatigue failure if it is subject to larger number of load cycles (Claisse, no date)(Nilson, Arthur H.; Darwin, David; Dolan, 2009).

2.4.4 Bricks:

Bricks are the part of masonry units that are used in the construction industry. These bricks are made up of clay and they are fired in a kiln at temperature up to 900-1200 °C. Bricks have main shape of a rectangle but they can be made with indentation or frogs and also with perforations according to the need. The strength of the bricks vary according to the type of brick it is. Common bricks have strength of 4 MPa to 180 MPa (0.6 to 26 ksi), Facing have strength of 12 to 120 MPa (1.7 to 17 ksi) and the engineered bricks have strength of 50 to 70 MPa (7 to 10 ksi). Engineered bricks are the ones with high strength and low permeability (Claisse).

Apart from clay bricks there are calcium silicate bricks and concrete bricks. Calcium silicate bricks have properties such as smooth faces along with sharp corners, have fairly high movement of moisture, comes in wide variety of strengths and it's durability is similar to concrete. Whereas concrete bricks are made where there is no availability of clay so that the clay bricks can be made (Claisse).

2.4.5 Concrete:

Concrete is made with the mixture of cement, sand and gravel or any other aggregate. To this mixture, the water is also added to harden it so that it can be made in to desired shape according to the requirements of the structure. It is a universal construction material that has been used for thousands of years, initially with lime mortar from 12,000 to 6000 BC in Greece and Middle East. It is a material that has high resistance to fire and different weather conditions which gives it an advantage over other materials. Except for the cement, the rest of the materials used to make concrete are locally available at a low cost. Concrete has ability to bear a high compressive strength so it makes it suitable for compression members such as columns and arches (Nilson, Arthur H.; Darwin, David; Dolan, 2009).

2.5 Estimation:

Estimation in construction is used to determine the probable cost any construction project can have. There are many items that contribute to the cost of the project so it is necessary to analyze each of the item and quantify them so that later on they are priced. (Dagostino and Peterson, 2011)

Frank R. Dagostino and Steven J. Peterson (Dagostino and Peterson, 2011) in their book have different types in which the estimation can be carried out. They are detailed estimate, assembly

estimate, square foot estimate, parametric estimates, model estimates and project comparison estimates.

Detailed estimates are those in which quantity of everything that is required is computed so that the cost of project is determined. These estimates can include overheads, labor, material, equipment, insurances and bonds. The contractor must have must all sorts of documents so that this type of estimate is carried out.

In assembly estimates, the bid is placed on components in groups which are known as assemblies rather than on individual components. A quick estimate can be prepared for an entire building by using broad assemblies.

In square foot estimation, cost per square foot is multiplied with square footage in order to prepare an estimate. In some cases, number of installments can be used instead of using square footage for example if a parking area is to constructed than number of parking slots can be used to prepare an estimate.

In parametric estimates, equations are used to establish a statistical relationship between the cost and the building parameters. This method is similar to square foot estimate but the equations used in this method can be complex and for an equation to be usable, the parameters should be those that can determined in the early design process.

In model estimate, computer models are used to acquire the estimate of the project and there are several questions that are to be answered by the estimator to obtain an estimate. These questions can be, what is the length of the building? What is floor thickness? And etc. These model can be complex and they may provide a detailed estimate for an entire project.

In project comparison estimate, the project that is proposed is compared with the project that has been completed to get an estimate. The comparable are estimated and adjustments are made according to the need of the project. It is not a detailed method and adjustments can be based on inflation, changes and availability of labor and material and so on.

METHODOLOGY

3.1 Research:

Initially research is carried out in which research papers were used to see the previous works that had been carried out and find the gaps that exists in the society so that something new could be brought up. In the research, the problems were analyzed and solutions to the problems are planned using previous tools and methods. Literature review for the solution designed for the existing problem is also prepared.

3.2 Survey of Suppliers:

For the supply of materials, it is necessary to know who is supplier and what that particular supplier is providing. For that, a survey is carried out through internet using Google maps. Also some information was also provided local residents of Islamabad and Rawalpindi.

3.3 Data Collection:

For more detailed information about the suppliers, the surveyed suppliers were visited and their data was obtained. Not only the data was obtained but also the other materials they were willing to provide were looked into.

3.4 Quality of the materials:

Materials whether they are raw materials or finished products or semi-finished products or components or parts, they vary with type of construction so it is necessary that their quality is assured with the supply. The testing data is acquired from the suppliers and this data is then compared with the standards of the particular material so that the quality is ensured and the material

provided can be safely used for construction. For the procurement of these materials, it is to be ensured that arrangements are made in advance so that the construction schedule is not disturbed.

3.5 Website Making:

In order to develop a website, the initial step would be to purchase a domain name. It should be easy to remember, short and brand-able. After this, the next thing to be done is to purchase a hosting server in which website files can be stored and served through the internet.

3.5.1 Theme:

Theme of website is selected in a way that the information provided in it is easily understandable and readable for the user. WordPress provides variety of themes that can be used for the type of website we want to build.

3.5.2 Plugins:

It is a small piece of software that can help users to add features to their website without the need of programming and WordPress supports the use of such plugins. They are used in the website so that coding is avoided and features required for the website are attained.

3.5.3 Addition of Products:

Products are easily added in the website with the help of Woo-commerce. For addition, just go to Woo-commerce, select product and then select add product. After that Title and product information can easily be entered.

3.5.4 Add to Cart:

Add to cart option is obtained with the help of Woo-commerce. In Woo-commerce you have to look for Add to Cart and choose the options for your custom Woo-Commerce add to cart buttons.

3.5.5 Adding a WordPress page:

To add a new page to the WordPress website, find Pages on the menu and there click on add new option. Then add title of the page for example what that new page is about. After that content should be added to that for the particular reason that page is made. The pages can be ordered through an order box.

3.5.6 Payment Options:

Payments can be accepted through three methods, cash on delivery, Online Transfer and through Debit/Credit Cards.

3.6 Material Availability Check:

As soon the order is made, the supplier of the material is contacted to know if that particular material is available or not. The client will be informed about the status of availability.

3.7 Good Transport Company Contract:

After confirmation about availability of required materials, Shipping to Goods Transport companies will be done. Further transportation of goods will then be done by the respective transportation companies.

3.8 Shipment Tracking:

Package tracking is done because it provided customers information about the route of a package and the anticipated date and time of delivery. Status will updated about an order on the profile.

3.9 Order Completion:

As soon as the order has been delivered to the client, an email will be sent to the client about the confirmation along-with the order details.

3.10 Clients Feedback:

The customer would be asked to review the product on the website.

3.11 Estimation:

Estimation is carried out in two phases for residential structures of 5 Marla, 10 Marla, 14 Marla and 1 Kanal (20 Marla). The first phase is the estimation, namely paper based estimation of material quantities of major elements like number of Bricks, quantity of Steel and quantity of Concrete. Second phase of estimation is based on computer software in which PlanSwift Pro 9 software is used to take off quantities of the same materials as in phase one.

3.11.1 Phase 1:

This is a purely paper based estimate method in which detailed estimates of quantities is done. Initially, the acquired plans are divided in to different sections such as structural and architectural plans. In these plans, sub division is done for different kind of walls, slabs, columns, footings and elements of a structure and these divisions are later named in a way that it is easy to identify for

which element the estimate is carried out. The example of such names is Walls A1, Beam B6, Column C7 and Footing F10.

After this process, estimated quantity take off of these sub divisions that were named is calculated. Calculations were done on a different page of paper and summary is simultaneously written on a separate page. After calculations and writing a summary of all these divisions, a total of each material is calculated and presented in a form of table.

3.11.2 Phase 2:

In this phase, PlanSwift Pro 9 software is used to carry out takeoff of same plans that were used in estimation in phase 1. Pdf generated files of these plans are imported in the software and scaling of these pages is done. Different software features such as area, linear and segment are used for marking of areas, walls, columns and even footings as shown in the figure below. After making these markings, other features such as parts and assemblies are used to get an estimated takeoff of the required material directly.



Figure 1: Markings of takeoff on a 1 Kanal Plan

Name	Description	Qty	Units	Cost Each	Markup %	Price Each	Price Total	Color
+	Ground Floor							
+	First Floor							
+	Excavation							
+	Exterior wall							
+	Concrete Column - Yards of Concrete	21		0	0	0	0	Blue
+	Concrete Column - Yards of Concrete	5		0	0	0	0	Red
+	Spot Footings - Yards of Concrete	26		0	0	0	0	Yellow
+	Roof							
+	Roof Area	2038.41	SQ FT	0	0	0	0	Cyan
+	#4 Rebar (Slab)	202	EACH	0	0	0	0	
+	Subfloor Adhesive 29 OZ.	17	EACH	0	0	0	0	
+	Concrete Slab 4,000.00 PSI	42	CU YD	0	0	0	0	
+	3'x75' Ice and Watershield	4		0	0	0	0	
+	Roof Material	2279.01		0	0	0	0	
+	7/16"x4x8 OSB Roof Sheathing	80	SHEET	0	0	0	0	
+	25 YR Black Shingles	76	BUNDLES	0	0	0	0	
+	7/16" Plywood Clips	2	CARTON	0	0	0	0	
+	15# Felt Underlayment	7	ROLL	0	0	0	0	
+	Roof SQFT	2279.01	SQ FT	0	0	0	0	
+	Roof wall	209.35	FT	0	0	0	0	Green
+	Brick Count	12282	BLOCK	0	0	0	0	

Figure 2: Takeoff using Parts and Assemblies

The figure above shows how the parts and assemblies are dropped down in to the area to the quantity of materials is estimated. However the above quantities shown are for parts and assemblies which uses area as a help to get the estimate. Similarly linear options are used to takeoff other parts and assemblies. An example of this is brick count for the walls.

After this process is completed, the data is exported with all the material taken off. The data from Phase one and the data from Phase 2 are compared among each other for analysis.

RESULTS AND DISCUSSION

4.1 Results and Discussion:

The procurement process was transformed to an online platform which was basically an E-commerce website in which required products could be purchased online. During the process of data collection and development it was seen that barriers exist in the market for proper implementation. Such barriers are mentioned in earlier researches as shown in literature review.

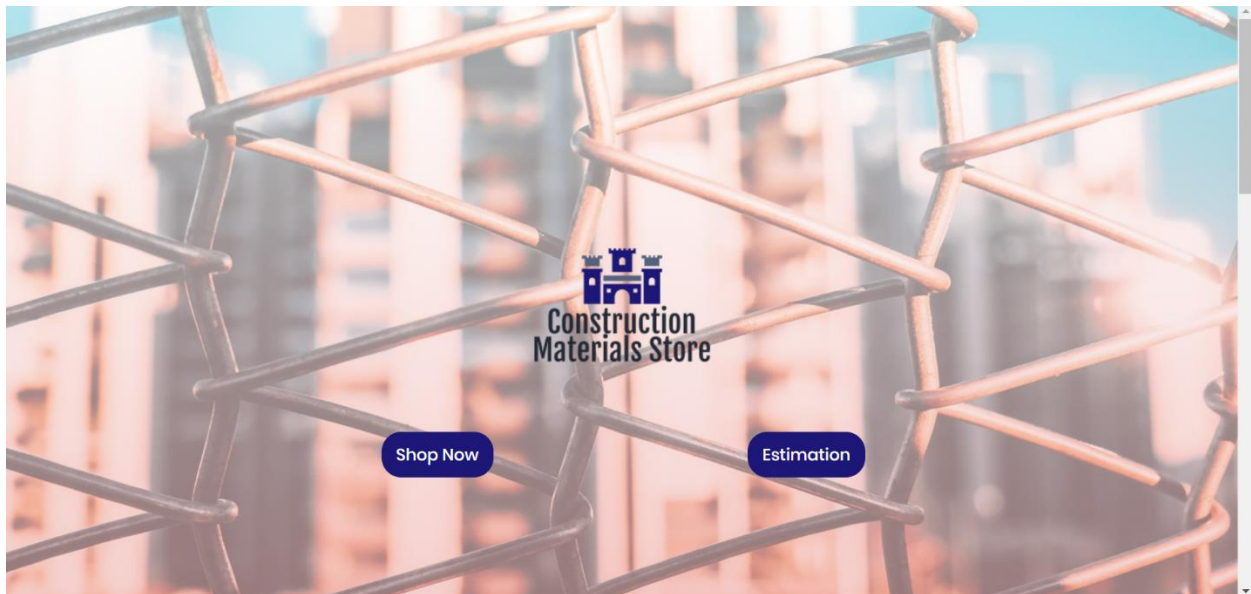


Figure 3: Main Page of the Website

The figure above shows the main page of the website from where the user can navigate to options he wants to utilize. Either the user can use shop now option to buy products or he can go to estimation of the residential homes.

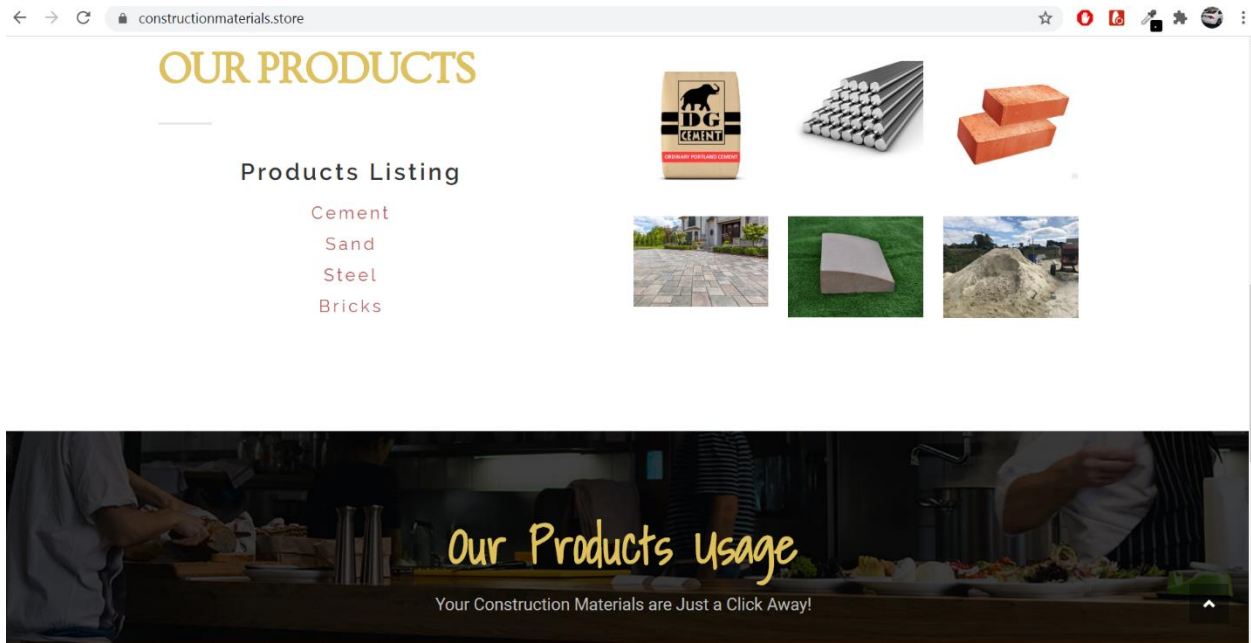


Figure 4: Main page of Website (Part 2)

The figure above again shows the bottom part of main page where the list of products is shown to the user accessing the website so that he can see the product required by him is listed there or not.

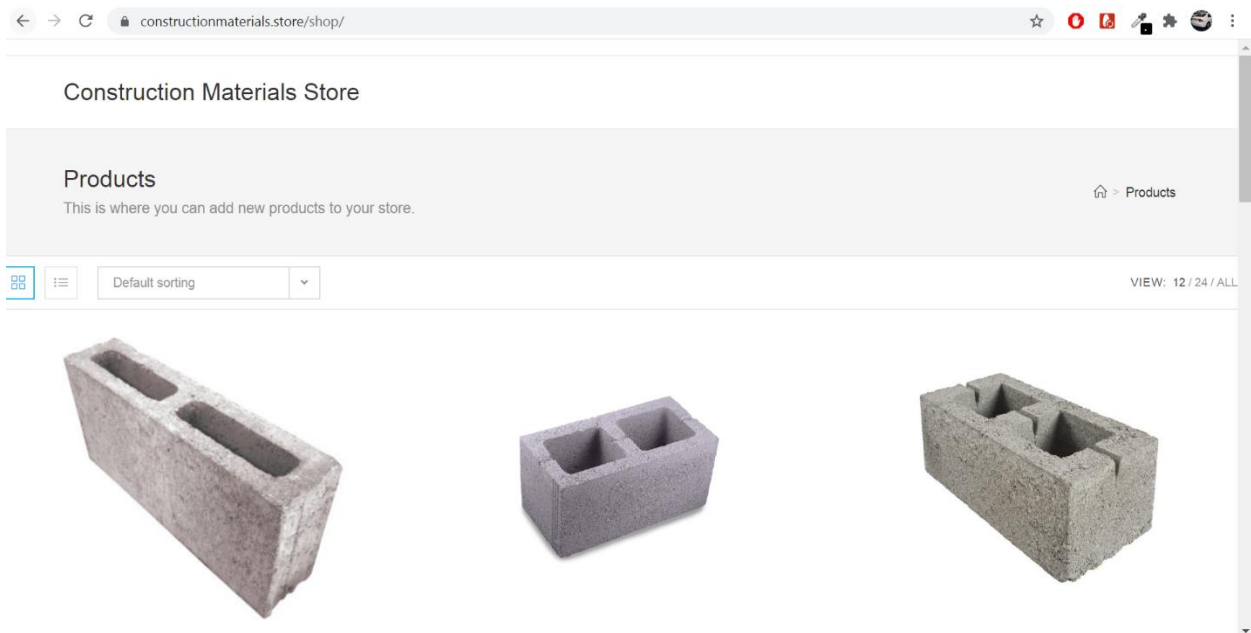


Figure 5: Page of Products along with Prices

Figure 5 shows the main page of shop in the website where products such as bricks are shown along with prices and pictures and other necessary information.

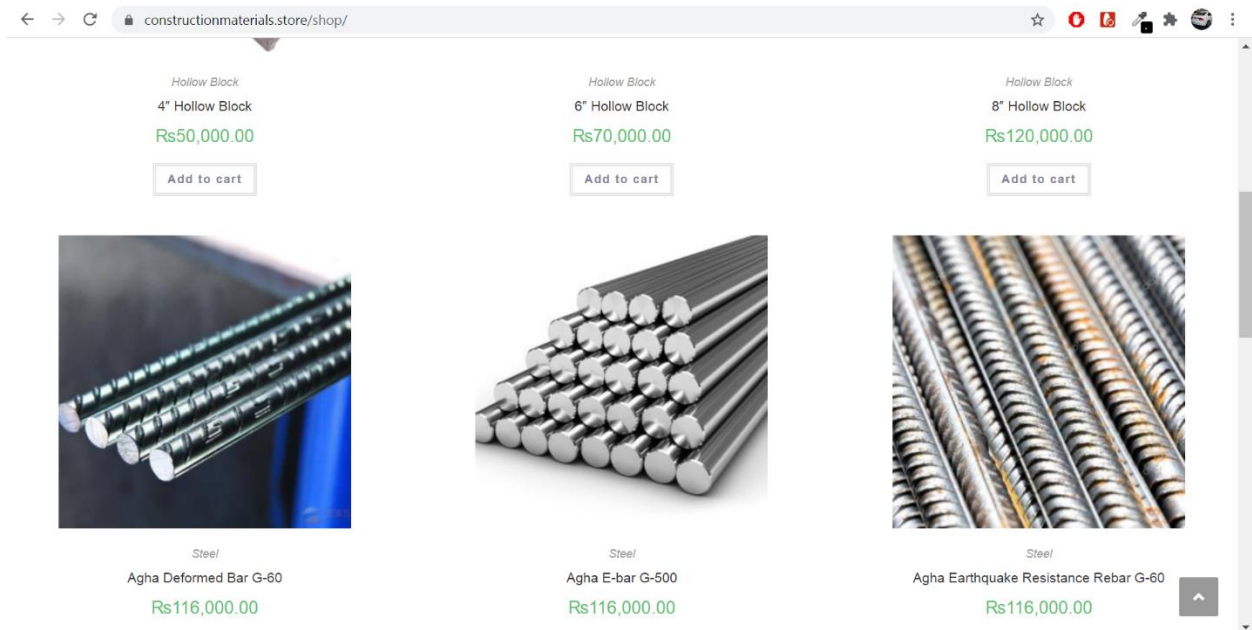


Figure 6: Page of Products with Prices (2)

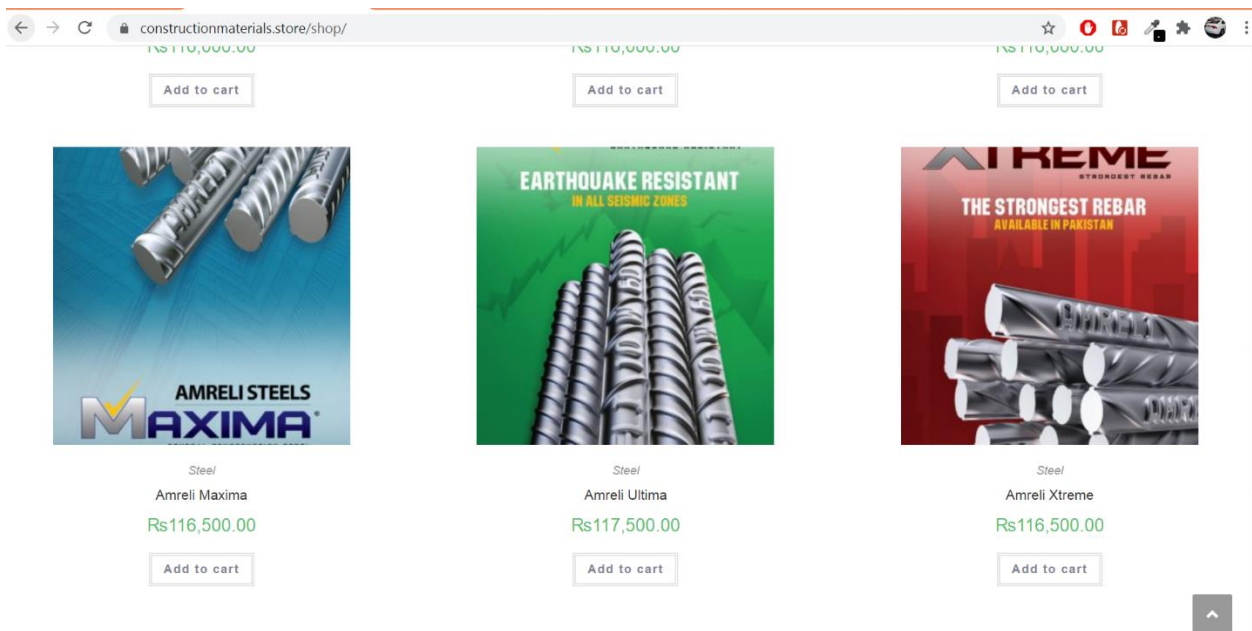


Figure 7: Page of Products with Prices (3)

Figures 6 and 7 show the continuation of figure 5. These two figures show the rate of steel for one ton by different suppliers and distributors. Other necessary details are shown when the a product is selected.

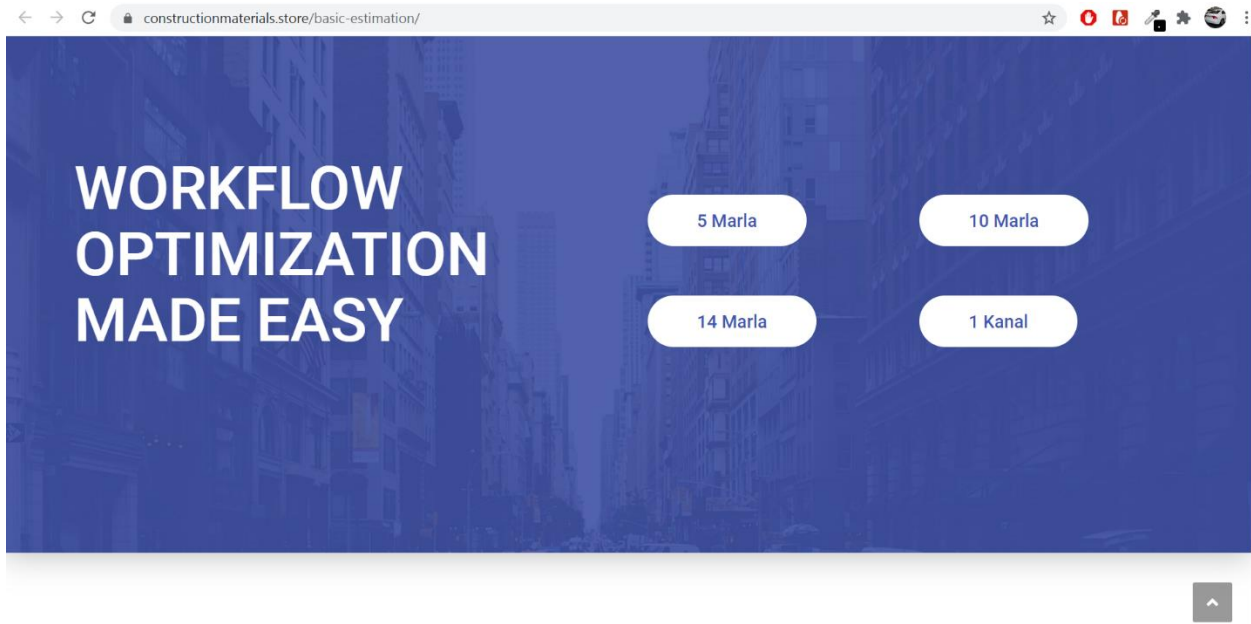


Figure 8: Page of Material Quantity Estimation

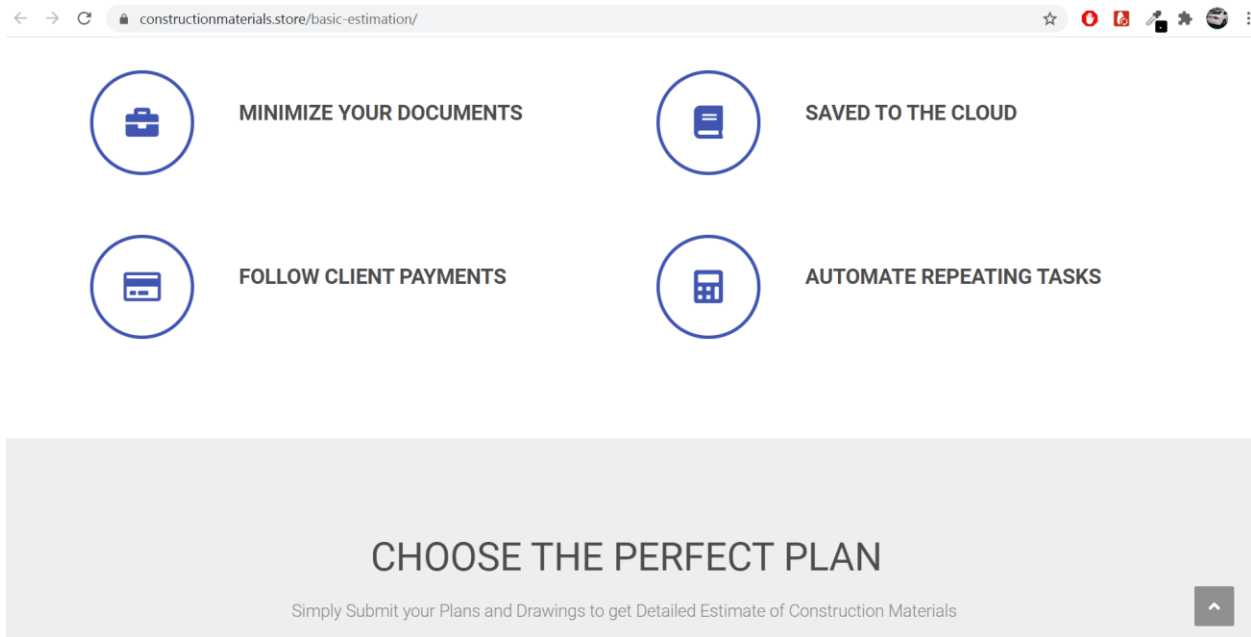


Figure 9: Page of Material Quantity Estimation (2)

Figure 8 and figure 9 show the page of estimation where estimation of four different residential homes are shown. By clicking on one of the options, the user is guided to quantity take off of the particular house. The picture below named figure 10 shows the frequently asked questions which the user if that visits the might have.



Figure 10: Page of Material Quantity Estimation, Frequently Asked Questions

As shown in the figures above, the website is named as Construction Materials Store. It has certain features to facilitate customers as well as suppliers. These features include the data of the product, helpline to contact the owner of the website, data of the suppliers and quantity take off of the materials required for construction.

The basic homepage consist of basic data, exclusive deals and offers that can attract customers or buyers. If someone wants to see full details of a product, that person can click on “Product” tab and reach out to that product for further details. Similarly, other tabs are also provided such as order tracking and material quantity, which based on estimation of four residential houses.

Table 1: Estimated Take off Quantity for 1 Kanal House

	Manual Calculations	Software Results	Difference
Number of Bricks	70,707	80,267	9560
Steel	15.43 Tonnes	19.8 Tonnes	4.37 Tonnes
Concrete	180 Cubic Yards	203.4 Cubic Yards	23.4 Cubic Yards

Table 2: Estimated Take off Quantity for 14 Marla House

	Manual Calculations	Software Results	Difference
Number of Bricks	58,057	61254	3197
Steel	10.5 Tonnes	13.8 Tonnes	3.3 Tonnes
Concretes	151.8 Cubic Yards	164 Cubic Yards	12.2 Cubic Yards

Table 3: Estimated Take off Quantity for 10 Marla House

	Manual Calculations	Software Results	Difference
Number of Bricks	50,800	46375	4425
Steel	9 Tonnes	10 Tonnes	1 Tonne
Concretes	126.5 Cubic Yards	127.75 Cubic Yards	1.25 Cubic Yards

Table 4: Estimated Take Off Quantity for 5 Marla House

	Manual Calculations	Software Results	Difference
Number of Bricks	44,322	30,844	13478
Steel	4.028 Tonnes	4.95 Tonnes	0.922 Tonnes
Concretes	100.88 Cubic Yards	64.82 Cubic Yards	36.06 Cubic Yards

The tables above show difference in the data from software and by manual calculations. In some cases the quantity through software is more and in some cases quantity through manual calculations is more. This occurred due to insufficient data and difference in plans that were used in estimation for each house differently.

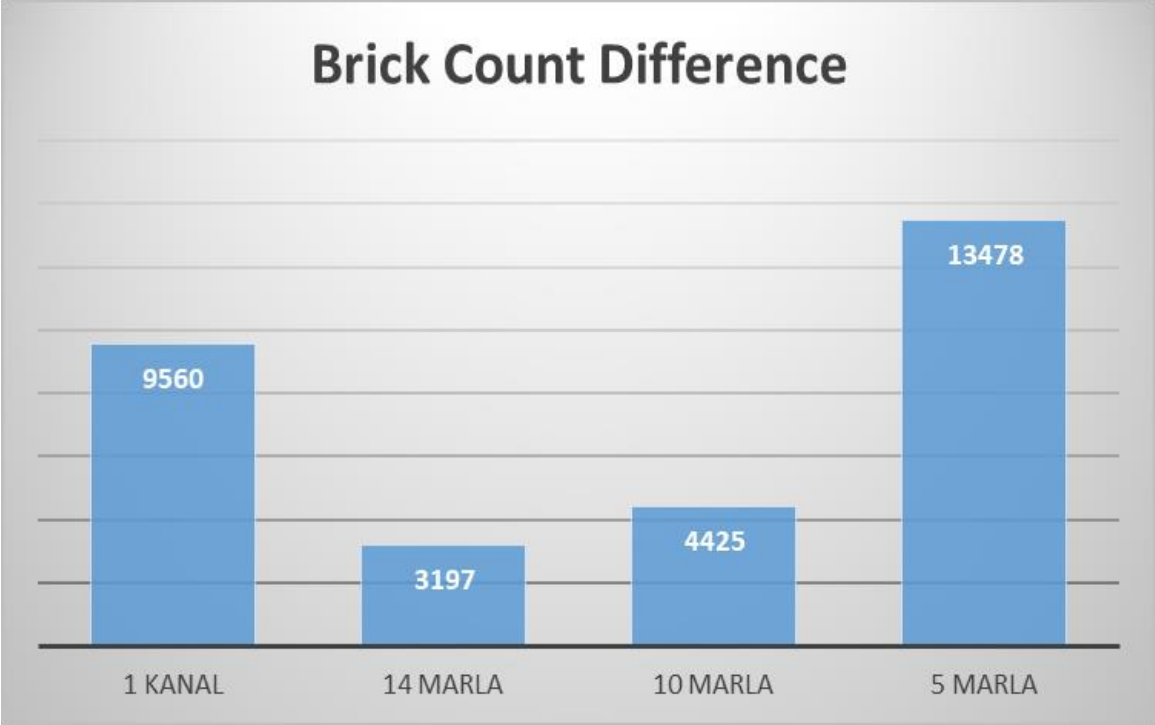


Figure 11: Bar chart Of Difference of Brick Count among different House sizes



Figure 12: Bar chart Of Difference of Steel (Tonnes) among different House sizes

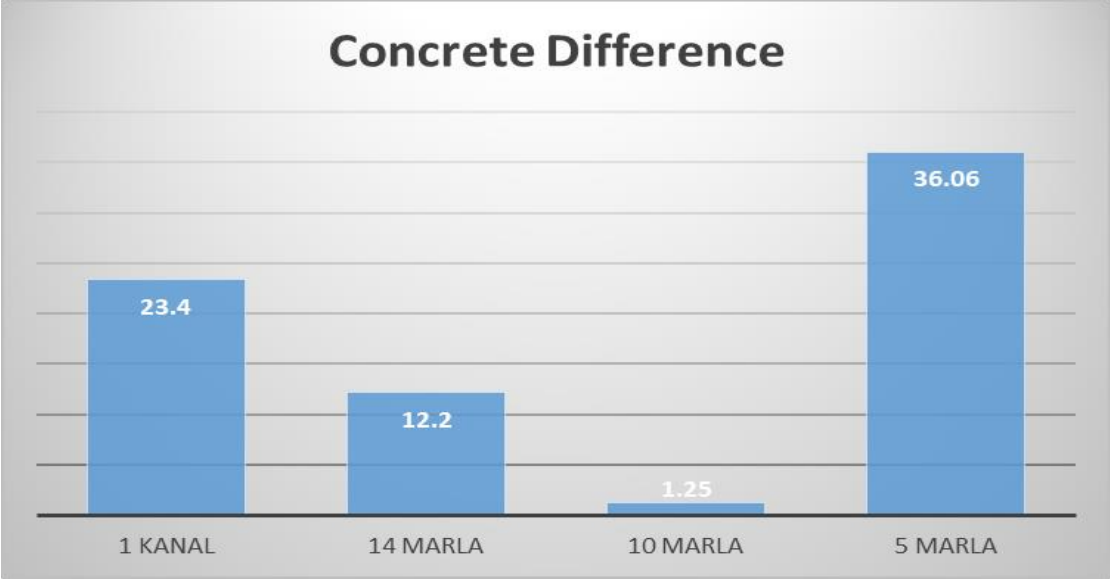


Figure 13: Bar chart Of Difference of Concrete (Cubic Yards) among different House sizes

The above figures, figure 11, figure 12 and figure 13 bar charts show the graphical difference of materials according to the size of the residential structure from the results in the tables above. These bar charts are of steel, concrete and brick count differences among the different sizes of the residential plots.

CONCLUSION

The data collected was not sufficient enough to provide a complete information of all the products that were required hence a it is recommended that complete detailed survey is required to make a more detailed and more efficient platform where more products can be displayed and buyers have more variety of products to look at and compare among them. There was also no set of data for delivery charges at different areas so there was a problem related to setting a base charge for delivery of the products. All these problems occurred because of the prevailing lockdown in the country during the Covid 19 pandemic and since the companies and markets and that point of time were shut down during this period, there was little or no response and proper survey of the market could not be carried out.

Also the plans obtained for quantity estimation were not complete enough so quantities showed difference in various trends so it is recommended to get proper plans for structure of various sizes and use same plan for different methods to obtain a proper difference in quantities of various materials. The country wide lockdown also created problem to obtain proper plans for a single structure in order to obtain a proper data.

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