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Efficient, Cost Effective and Time Saving Home Construction System

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***Abstract*—'Home' or 'House' is where the human beings spend their lives since birth to the death. Since the ancient times and the civilizations, the man has used different places to live with their families. With the improvement of the human beings' intelligent level , range of the imagination skills, hard skills and the soft skills , man have improved the ability to make a home with full of facilities . The impact of the modern technology , the home building process has been modified in numerous ways. Due to the busy life schedule, most of people do not have enough time to pay a proper attention on the home building process. Apart from that the most of the people do not have a enough knowledge on home building process. Without a good comprehension and knowledge , people have to face for many challenges in the home construction process. The major challenges are the budget management and allocation for the home construction process and the difficulty to hiring qualified professionals which related to the construction field. To get avoid those challenges the home building process should maintain and organized in proper manner . The assistance of the modern information technology would be an ideal way to find a solution to face for these challenges in a better way. The modern information technology approach for the home construction process will also be a proper way to interact with most of the people with busy work schedule. This research paper demonstrates about a system developing with information technology which focuses to improve the efficiency, quality, and management of the cost for the home construction process.**

Keywords— Json, Home Building, JWT, vasthu shastra,AI,vedic,socio-cultural factors, DNN,Cost, Cost Estimation, User Profile recommendation

I. INTRODUCTION

The Home building process is a collection of vast range of tasks which takes a lot of amount of cost , time ,labor ,patience. Based on the searched results through resources such as research papers and web sites[15][16][17][18] , we were able to find out the issues in the home building process. The main issues can be represent as issues on budget management in home building process , the lack of knowledge of people regarding to the home building process and the hiring of qualified professionals .

The main objective of this research is to build a efficient and cost effective system to improve the quality and the efficiency of the home building process. The system mainly considered with main four components. Customer component, Architecture Component, Carpenter and Mason Component and Tracking and Bidding Component are the main components which going to be implement in the system . The system mainly implement by using the concepts of machine learning and artificial intelligence technologies.

Customer component handles the interaction between the system and the people(customers) involve with the system. The main functionalities of the customer component is to get the details of the requirements from customers. Those requirements are taking from the customers through AI chat bot process. The requirements are taking as questions(or questionnaire) through the chat bot. The questions are such as 'what is the land size? ', 'what is the land shape?', 'how many family members in the family?', 'what is the home type want?','how many bed rooms want?', 'how many living rooms, bathrooms want? ' etc. The requirements that take by the customers will analyzed by the system and recommend the customer an appropriate home plan(3 dimensional)

Nowadays the vasthu science or vasthu shastra has been popular among the clients.[9]. The origin of the vasthu science in India. According to the [add the reference] vasthu science is "ancient Indian Vedic and Shastra's knowledge for construction area to achieve balance, harmony between gods and nature and people there by paving the way of peace, prosperity, health, happiness and to avoid troubles." Vasthu science relates with the modern architecture. The main objective of the vasthu shastra is to organize the components of a home based on their relations.[10].In vasthu science there are multiple fields have involved with it. These field are Indian philosophy, geography, religion and the environmental factors such as topography, roads, sun-effects, elements of the nature[19]. In the vasthu science , there are main two types of principles. Those principles are vasthu principles and the environmental principles. Socio-cultural and religious factors have influenced in the clients requirements. According to the [20], family structure and the size, safety, privacy and the religion are the main socio-cultural and religious factors that important to the home building process. According to the [20] the good building process defines the socio-cultural and

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religious factors. Under the socio-cultural and religious factors , there are sub-categories which can be discussed further. By researching the article[20] , the sub categories are able to identify as physiological variables ,Physical variables, socio-cultural variables and socio-economic variables. According to the [add the reference] physiological variables are categorized as dwellings' identity, privacy of occupants, territorialize the living environment. [20] mentioned functional requirements, inadequacy of space as physical variables , cultural background ,inhabitants' social norms, their vernacular experience of spaces as socio-cultural variables, economic status of the family as the socio-economic variables respectively.

In the Architecture component, all designs are done using information technology and it has elevated architects' creativity and ease the work of customers in the process. But when a house is built according to the needs and wants of a customer, achieving customer satisfaction and maintaining an architect's professional and business affairs is a definite challenge.For these reasons, from the home construction system that we propose, a customer can get any house design that they prefer, and architects can carry out their professional and business affairs easily. First, details on how their future house should be built are taken from the customer and from that information existing house design models created by professional architects are suggested. Before suggesting a house design model to the customer, the customer collects the flow of the house compartment he wants to build a house and predicts how many square feets the customer will need from that compartment using the machine learning algorithm. Moreover, to maintain the credibility of the system, only professional architects are registered. And based on factors like their certifications and professional skills, they are rewarded with privileges. All architects are rated according to their designs and the system allows every architect to show their designs through a separate profile. Using that, the system allows architects to elevate their income level through skill and creativity.

In the carpenter and mason component, the interaction among the professional personals (carpenter and mason), customers and the system will be handled by this component. The main functionality of this component is to predict the cost for the construction of a house through a Machine Learning model developed using an algorithm. The details required for the model will be gathered from the architecture and the customers such as materials for ceiling, roof, wall and floor…etc. Based on the requirements supplied by the customers and architectures, the system will produce a prediction that helps the customer to get a clear idea about the construction cost for the house and it helps them to manage the cost according to their budget. The other feature is the recommendation system that helps the customers to find professional carpenters and mason for the house construction process. This saves the time and money of the customers'.In the carpenter and mason component, the interaction among the professional personals (carpenter and mason), customers and the system will be handled by this component. The main functionality of this component is to predict the cost for the construction of a house through a Machine Learning model developed using an algorithm. The details required for the model will be gathered from the architecture and the customers such as materials for ceiling, roof, wall and floor…etc. Based on the requirements supplied by the customers and architectures, the system will produce a prediction that helps the customer to get a clear idea about the construction cost for the house and it helps them to manage the cost according to their budget.In the carpenter and mason component, the interaction among the professional personals (carpenter and mason), customers and the system will be handled by this component. The main functionality of this component is to predict the cost for the construction of a house through a Machine Learning model developed using an algorithm. The details required for the model will be gathered from the architecture and the customers such as materials for ceiling, roof, wall and floor…etc. Based on the requirements supplied by the customers and architectures, the system will produce a prediction that helps the customer to get a clear idea about the construction cost for the house and it helps them to manage the cost according to their budget.The other feature is the recommendation system that helps the customers to find professional carpenters and mason for the house construction process. This saves the time and money of the customers'.

The construction process is a relatively complex process that consists of several structures and parts that are interconnected. It is always essential to address the structure of the construction process relative to each other as well as the environmental conditions of the construction. construction time has been pointed out by many researchers as a key parameter of a successful project and is also influenced by factors such as technology, process mechanization, project management, and construction cost. Project overtime is a very common problem in the construction industry in many parts of the world. Occurrence of construction delays is caused by unforeseen factors such as constructor errors, design changes, inclement weather and industrial connection disputes[5]. Accurate estimation of construction time is very important when negotiating contract terms. In practice, the most of the methods of estimation depends on the subjective skills and cognition of the estimators and planners[6].

In the construction industry, constructors usually use previous experience to estimate the duration of new projects[7,8]. Such an assessment is relatively fast but its accuracy is questionable. Determining construction time using construction process modeling software results are accurate but can be time-consuming. Therefore, the main hope is to provide a more accurate assessment to client in a shorter period of time.

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II. METHODOLOGY

A. *System overview*

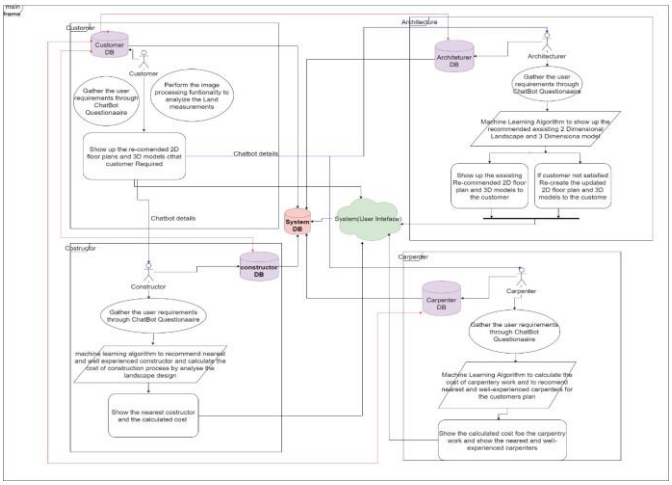

Figure 1 : System overview Diagram

This home construction system considered with mainly four components. The components are the customer component, architecture component, carpenter and mason component and Tracking and bidding system .

B. *Functionalities of the components of the system*

Customer Component of the Home Building Process considered with two main sub-components. The two sub-components are **artificial intelligence-powered chatbot** and **vaasthu concepts recommendation system**.

The chatbot in the customer component implementation doing by using the concepts of machine learning and artificial intelligence. The main functionality of the chatbot is to interact with the registered customer to the system. The chatbot generates responses according to the customers' questions that asking through the chatbot.

The main technology is used to implement the chatbot in python. To establish the functionality in the chatbot , need to train a machine learning model. As the model in the system, use intents. The intents file is always a JSON(Java script object notation) file. The intents considered with mainly tags, patterns and responses. The tags represent the main category that the questions belong to. Patterns are the various types of sentences(or questions). The patterns in a specific tag are similar. The responses considered with suitable answers(or replies) according to the patterns.

By analyzing the customer responses, the chatbot decides which question should ask by the customer. It chooses the relevant tag and go inside the tag and analyze the most suitable pattern and select the relevant and the suitable response and send it to the customer.

The neural networks and machine learning algorithm called regression is used to develop the chatbot. The used neural network called DNN. The neural network which used inside the chat bot has three layers. The neurons inside the neural networks randomly assigned for the different tags in intents file. When the training the model each neurons in the given neural networks make paths (interactions) with each neural layers.The sentences that given in the intents.json file break into the words and the words label in to different ids. The regression algorithms applies for the categorizing the labels and words. In other words the parameters for the regression algorithm are the labels and words. The words represents the x axis(independent variable) and labels represent y axis(dependent variable). The labels also called as directories.For the preparations of the sentences for the patterns and the responses, refereed the data which gathered from a google form. The google form sent through the social medias and through emails.

Below the questionnaire that used to create Sample Sentences for the intents. JSON file of the model.

1)what is the size of the land?

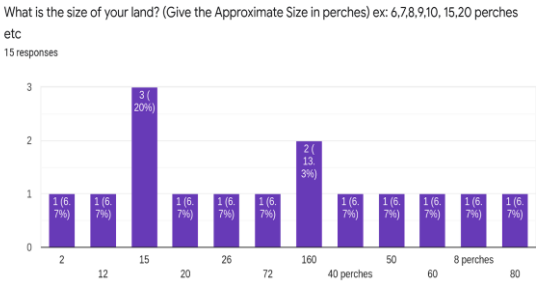

Figure 2 : land size chart

2)what is the shape of the land?

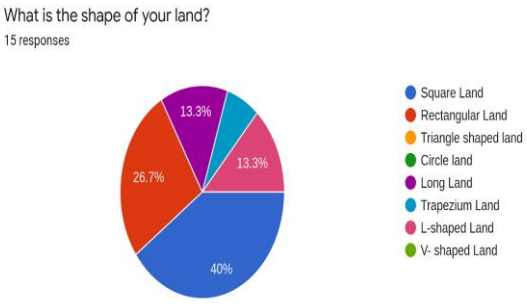

Figure 3: land shape chart

3)what is the home type want?

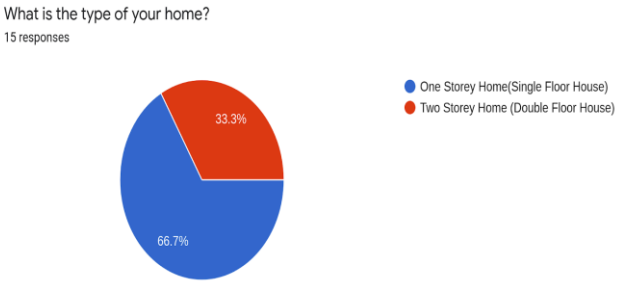

Figure 4:Home Type chart

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4)What is the size of your home?

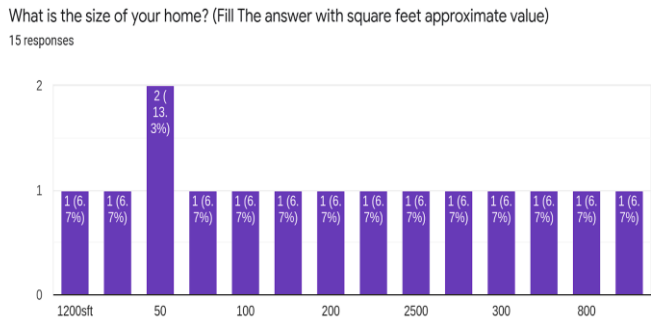

Figure 5: Home Size chart

5)How many total bed rooms in your home?

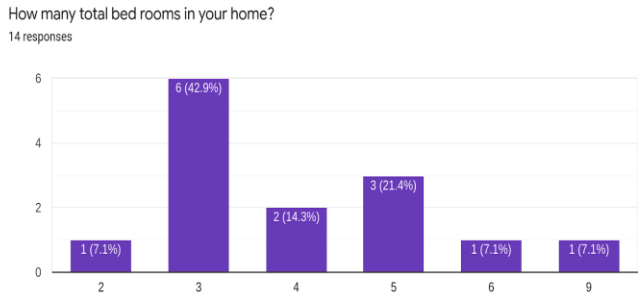

Figure 6 :number of bed rooms chart

Vaasthu Concepts Recommendation System.

The main objective of Vaasthu Concepts Recommendation System is to generate the vaasthu science concepts which helpful and important to build homes with more scientifically and more environmentally friendly. According to [34],[35], vaasthu science is ancient Indian architectural science used to build constructions such as homes, massive buildings, monuments, etc. Vaasthu Science has multiple principles to follow through to get the best outcome for your dream home from Vaasthu Science.

The main input for the Vassthu Concepts Recommendation System is a 2-Dimensional(2D) floor plan. The 2-Dimensional floor plan describes the internal structure of a home. The internal structure of the home mainly shows the interior rooms such as the living room, bedrooms, dining area(s), bathrooms, kitchen, and other specific areas. According to the theories of Vaasthu Science, there are specified approved vaasthu direction for each room in a 2-Dimensional Floor Plan. Vaasthu Approved direction is always a cardinal direction. There is eight number of cardinal directions such as 'North', 'North-East', 'East',' South-East', 'South', 'South-West', 'West', 'North-West'. Among the eight number of cardinal directions, the specified cardinal direction approved as Vaasthu Direction for each room in a 2-Dimensional Floor Plan.

The Image Processing techniques used to implement the Vaasthu Recommendation System. The open-source software called OpenCV used to perform the image processing techniques.

The main functionality of the Vaasthu Concepts Recommendation System, divided into three steps. The main three steps are -

i) Analyze the 2-Dimensional Floor Plan and separate each room.

ii) Find the center-point of each separated room

iii) Find the Cardinal Direction for each room

i) Analyze the 2-Dimensional Floor Plan and separate each room

The main step to perform before analyzing and separate rooms in a 2-Dimensional Floor Plan was to add an image processing technique called 'image thresholding'. The image thresholding process used to convert the 2D Floor Plan into a binary image. A binary image always consists of two colors such as white and black. The binary image represents value '0' for black color and value '1' for white color. To performing the thresholding process, it's essential to add a fixed pixel value which stands between 0 to 255. The image thresholding process analyzes each and every pixel value of the 2D floor plan and compare it with the fixed pixel value. If the random pixel value less than the fixed pixel value, that random pixel value shows as black color, and also if the random pixel value greater than the fixed pixel value, the random pixel shows as white color.

For the perfect analysis, it is necessary to clean (or reduce the noise of the image) the thresholded image. There are image processing techniques called dilation and erosion to remove the unnecessary particles from the 2D Floor Plan Image. Dilation used to remove the unnecessary pixels in the foreground of the image and Erosion used to remove the unnecessary particles in the background of the image.

After a successful thresholding process, image processing techniques used to separate the rooms in the 2D Floor plan. There are multiple functions that have already implemented in the image processing to detect the various 2D shapes such as circles, square, rectangle, triangle, etc. The majority of the room shapes belong to either a rectangle shape or a square shape. By adding the shape detector methods is allowed to separate the rooms according to the shape.

The final outcome of the conclusion of this step was a thresholded floor plan with separated rooms.

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ii) Find the center-point of each separated room

The outcome image of the above step 'Analyze the 2-Dimensional Floor Plan and separate each room' direct to this step. The main objective of this step to identify the central points also known as centroids of each room. The centroid values of each room essential to find the cardinal direction of each room.

The centroids' values represent as x-axis and y-axis values. To get the central values(or centroids) of each room, using a specific image processing function called moments. The moments in image processing identify the center points of a given shape. The shapes are the separated rooms from step 1. Moments produces all the center points of the rooms. Moments produces centroids values as x-axis and y-axis values.

The centroids' values of each room store in a python array called coordinates for use the centroids values in the next steps. The x-axis and y-axis centroids values of each room keep as separate pairs inside the coordinates array.

iii) Find the Cardinal Direction for each room.

To find the cardinal direction, essential to implement a function using python. The function called cardinal direction finder. The coordinates array from the previous step, passing as the parameter for the function.

Inside the function, there is a section to take the x-axis values for each room and also a separate section to take the y-axis values for each room. Those sections need to get the values from the coordinates array mentioned in the above step. Each x-axis values and y-axis values store in separate variables.

The next section in the function responsible for calculating the value of the degrees by referring to the separate centroid values for each room. The variables which keep the separate x-axis and y-axis values passing to the section for calculating the value of degrees.

The next section gets the final degree value by dividing the value of degrees by 45. Then the final value compared with the cardinal directions' degrees values and finally generate the relevant cardinal direction for the centroid values from each room.

After completion of the above steps, the Vaasthu Concepts Recommendation System generates the cardinal direction for each room in the 2-Dimensional Floor Plan.

In today's architecture, it enhances the relationship between clients and architects, giving all stakeholders maximum satisfaction with their work.

This research component is an architecture design plan which is to suggest the most suitable house plan to customers according to their requirements.

There are four methods in this component.

- Architect Recruitment system
- Prediction of the best suitable plan using Machine learning algorithm
- Re-designing the suggested plan

- Architect recommendation system

Architect Recruitment system - The system can register a valid architect to the system and each architect can create, maintain their profiles and can upload their house plan designs and details to their profile which will be shown to the customer. Then every plan record is saved to the database and will retrieve by the system when needed.

When a customer requests for a design plan, the system will generate a House design compartment section. Then the customer can fill the desired requirements needed to build his or her house in the compartment section.

In this section technologies used in prediction modules are briefly introduced. As mentioned in the previous section, this system prediction module was developed using Linear Regression algorithm.

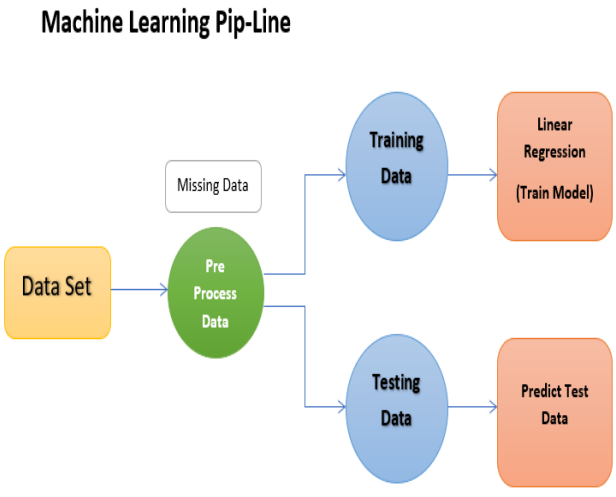
Firstly we consider the two groups of customers.

1. Customers who have knowledge of architecture and customers who do not have knowledge of architecture.

2. Customers who have land to design a house plan and customers who do not currently have land but are willing to design a house plan.

As the first step, in order to construct the house using the architecture component, the amount of house compartments will be noted through customers. Here the house compartment is taken as a sum and the number of house compartments related to the house required by the customer is predicted using a machine learning pip-line. This model uses data from at least 30 currently designed homes.

The prediction made is as shown below.



The number of square feet and the number of house compartments related to the data set collected before predicting the result are imported here.

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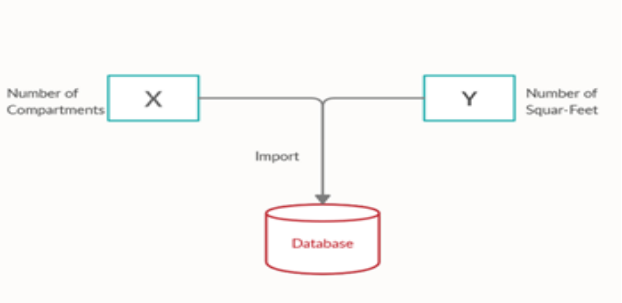
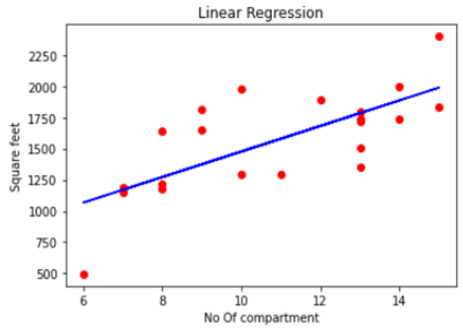


Figure 7 : import data set

compartment	Squair feet
15	1834
13	1718
17	2687
7	1184
6	495
14	1733
13	1350
11	1295
13	1504

Figure 9:Machine Learning pip line

If there are any missing data in that data set then all data will be preprocessed, after that dataset is divided into two as Training set and Test set (0.25 for testing data and 0.75 data for training data) then a new shape is given to the array without changing its data (reshape 1D Array to 2D Array).Then build the model in Linear Regression and fitting simple Linear Regression to the Training data set and training the Algorithm. Next Predicting the test data set result and visualizing the training result. Finally calculate R-squared and take the result of value.



r-squared_LR = 0.6773181723610744

Figure 8: Prediction result of square feet

This result shows that a customer needs this number of square feet for this number of compartments as it displays the number of square feet predicted by the system so they can know the amount of land required and if they have a land, customer will be able to conclude as to whether the size of the land is sufficient for the predicted number of square feet. If the customer agrees with the predicted square feet number, system will provide with suitable house design models currently on the system database corresponding to the predicted square feet allowing the customer to choose a house design plan that satisfies him.

Re-Designing the suggested plan

If a customer wants to redesign further the house design plan suggested by the system, it will be possible to redesign the house design plan through the architect of the suggested house design plan.

Architect recommendation system

Each architect is grouped to the system according to their talents and strengths and through customer review ratings a customer can select an architect with total satisfaction. Even if a customer is not satisfied with the redesigned house design plan also, the architecture recommendation system allows the customer to create a house design plan that suits him most as per his wish.

Finally, all information related to that selected home will then be passed on to the remaining decision makers.

Carpenter and Mason - Methodology

Since most people don't have enough knowledge, they will face challenges during their house construction process. Most of the people are very concerned about the cost that they will have to bear or spend on the construction of their dream house and finding professional, reliable and trustworthy personals for their house construction. Normally people will have to find personnel by themselves. That takes a lot of time and also they will have to spend a lot of money for that.

With the help of modern technology, the above issues can be addressed. This methodology demonstrates a cost prediction system that can predict the cost of the house construction. It will help the customers to get a clear idea how much they will have to spend. Also a recommendation System that helps the customers to find trustworthy, reliable and professional personals.

Following are the two subcomponents that address the challenges mentioned earlier.

1. House construction initial cost forecast system using a Machine Learning Model
2. Carpenter and mason recommendation System

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01. House Construction initial Cost Forecast System using Machine Learning Model

In the construction field, the cost is the most important factor that helps to ease the decision-making process for the customers. In order to forecast the cost for the house construction, the random forest regressor gives more accurate results compared to the multivariate linear regression, and as the programming environment, the "Python" language is used.

Once the information is given by the customer, the information provided by the customer will be inserted into a machine learning model. Since the system needs to forecast a real value based on multiple variables, the model is developed using a random forest algorithm.

The forecast system is developed using random forest algorithm inorder to keep the quality called "code reusability". For the forecast system, a dataset is used. The dataset contains the information about construction of 112 houses. Once the dataset is imported to the algorithm, it needs to be preprocessed in order to give quality forecasts otherwise it will give a negative impact for the results. So for that, the dataset needs to be checked whether there are any null or NaN type values. In the dataset used for forecasting cost, it does not contain any of those values. Then the dataset will be separated into two groups. They are,

1. Training data
2. Testing data

The dataset is separated based on 80% for the training purpose and 20% for the testing purpose criteria. Then the data is fitted into the random forest regressor. Using that the forecasts will be done. In order to evaluate the forecast quality using the score method of the random forest algorithm. In this case the accuracy score is 0.95. This indicates the accuracy of the forecast of cost.

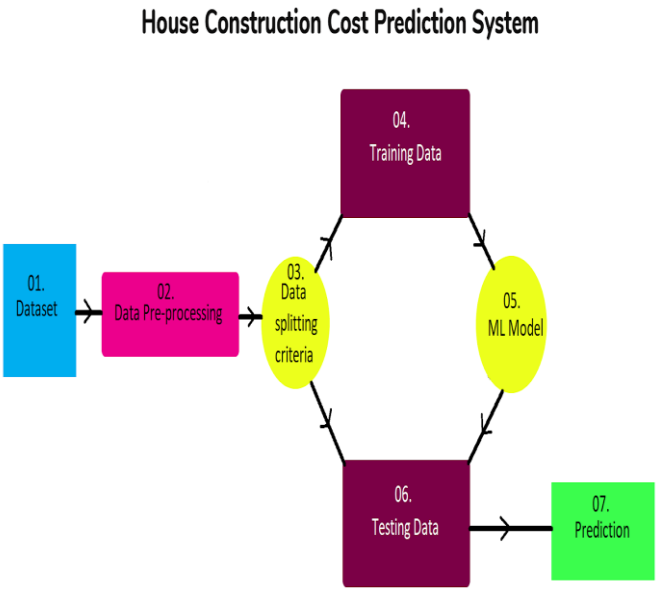

Figure 10: Cost prediction process

02. Carpenter and Mason Recommendation System

When the customers need professional carpenters and mason, the system will recommend some of the best professional carpenters and mason. The customer can select a professional carpenter and mason from the recommendation list. If the customer is not satisfied with the recommendation of the system, they can filter carpenters and mason using the carpenter and mason search filter functionality which is implemented. It allows the customers to enter some information such as address or region, name of the person, job specification of the personal, and the service cost rate.

The results of the above functionality help the customer to save time and money without wasting and also it helps them to find professional personals in time. The methodology is as follows.

First the implemented system will supply how much meters the carpenters and masons have to work. The carpenters and masons are allowed to add previous jobs they have done to the system implemented. Using the recognized cost for carpentry and masonry, the previous projects will be filtered out and displayed for the customers as recommendations. So the customers can view their previous works and based on the quality of them they can hire a carpenter and a mason.

area	no_floors	no_rooms	no_bathrc	no_doors	no_windo	wall_mate	celing_ma	floor_mat	roof_mate	total_costings
1838.83	2	2	2	7	2	Cement B	Tiles	Cement	Asbestos	6506842
3155.03	5	2	3	7	7	Bricks	Tiles	Cement	Iron Plate	6911907
2469.32	6	7	6	8	6	Bricks	Wood	Cement	Asbestos	6846783
5677.61	3	8	3	8	2	Cement B	Tiles	Tiles	Asbestos	6738230
4962.82	9	4	9	4	4	Bricks	Tiles	Cement	Asbestos	6880985
2080.85	3	4	8	8	2	Cement B	Wood	Cement	Iron Plate	6996197
3486.17	7	9	3	9	8	Cement B	Wood	Cement	Iron Plate	6747287
4030.78	4	9	6	5	5	Cement B	Tiles	Cement	Iron Plate	6798121

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Figure 11: Snapshot of dataset

The creation of a mathematical model begins with the definition of variables. First, it was necessary to identify the parameters of the construction process that can significantly affect the construction process and choose the inputs that will be modeled. An electronic survey per questionnaire was used as one of the most widely used research instruments. This method of collecting information from respondents is very simple and relevant and the interlocutor does not have to spend a lot of time asking personal questions. The questionnaire was divided into several parts. The first part focused on general information about the respondent and the construction company where the respondent works. Other parties focused on the interactions of the parameters of the construction process. As one of the results of the questionnaire survey, variables were defined for the prediction model (for construction time estimation). Respondents answered questions about the interaction of construction parameters at construction time based on their own practical experience and had to comment on the possible impacts of construction parameters on construction time. They also had to select among the various alternatives, construction parameters according to which it would be appropriate to estimate the duration of construction. The objective of the survey presented was to define the variables for the construction time by estimating a model of construction projects in the construction market.

Since the system deals with customers, predictions need to be more accurate. One of the most important factors that need to be considered for the accuracy of the predictions is the quality of the data used to produce predictions. When the data quality is high the predictions become more accurate. If there are any null/ Nan values used for the predictions, there is an adverse effect on the prediction.

In this case, there are no null or missing values. If there are, the dataset needs to be pre-processed. After the data pre-processing step, the data set will be split into two partitions as “training data” and “testing data”. The dataset splitting criteria is 20% of the data will be used for testing and 80% of the data will be used for training. The next step is to fit the data into the model and make a prediction based on the test data and test the prediction by giving data manually. In order to check the accuracy of the prediction, a metric called “r2_score”[2] is used. In this case, the r2_score is 0.94.

This result will make customers’ decision-making process so easy. Using this result, customers can get a clear idea about how much cost they will have to bear for the construction and it will help them to manage the cost according to their budget.

Tracking And Bidding System Component

Bidding system

When the customer does not satisfy the designs provided in the architecture component, the customer must be able to create a job opportunity and publish it. Then all registered architects must be notified about the opportunity and the architects can see the job opportunity. After notifying the architects about the created project, the timer will start. The system must provide the architect with the customer's requirements that were collected at the beginning. After that, the architects can estimate the cost of the design and the offer for the project before the time has exceeded. All bidders and their prices will be displayed to the customer on their dashboard. The most suitable architect selection process is, all offers are added and averaged, and the bidder that is closest to this average number receives the job. This process is done by the system. After awarding the project to the appropriate architect, the timer has begun. The architect must create the design according to the period of time. If they want to extend the duration, they will be given the opportunity.

Progress Tracking system

The supervisor of the construction project should be registered to the application by providing a valid username, mobile number, and password. Once who registers to the application, he can simply log in to the application. After logging in to the application successfully, the supervisor can create a site. To create a site, the supervisor should provide the site name, location of the construction site, and date. In this step, let the supervisor view all sites that have been created previously. The supervisor can report daily progress. In this case, the application lets the supervisor upload the photos of the daily works to the database. And also the supervisor can add which of the tasks completed on that day and any special notices consider the work done on that day. Also, the supervisor can record the amount of raw material used to complete the day-to-day tasks and track labor attendance.

III. RESULTS AND DISCUSSIONS

A. *Results*

For all the component in the system are shown as follows.

Customer component

The main sub-components of the customer component are chatbot and Vaasthu Concepts recommendation system. When the customers successfully logging into their own profile in the Home Construction Application, they have to choose the option called ‘chatbot’. After clicking on the chatbot, the chatbot starts the questionnaire process. The questionnaire-based on the requirements based on the home construction process and the questionnaire can fill out by any customer with an initial knowledge level of the home construction process. The questionnaire mainly based on the characteristics of the land in which the home is going to be built in the future and about the internal structure of the home.

The characteristics of the land such as land size , land shape, and other important geographically facts of the land, etc. The internal structure of home can be described as the number of bedrooms, living areas, dining areas, bathrooms, kitchens, and storey types(one floor or two floors) that required by the customers.

The chatbot takes all the responses relevant to the customer requirements and stores inside the respective database model.

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After the system generates a 2-Dimensional Floor plan by analyzing the customer responses given through the questionnaire. Customers are able to download the generated 2-Dimensional Floor plan by making a payment.

Then customers are able to take an option called vaasthu recommendation for the house. After selecting that option, the system asks for the 2-Dimensional Floor Plan image. Customers have to put the generated 2-Dimensional Floor Plan and after that the system process the 2D image and generate the vaasthu science approved directions and tips for each room in the floor plan.Then customer can get the Vaasthu recommendations and add those recommendations to the home.

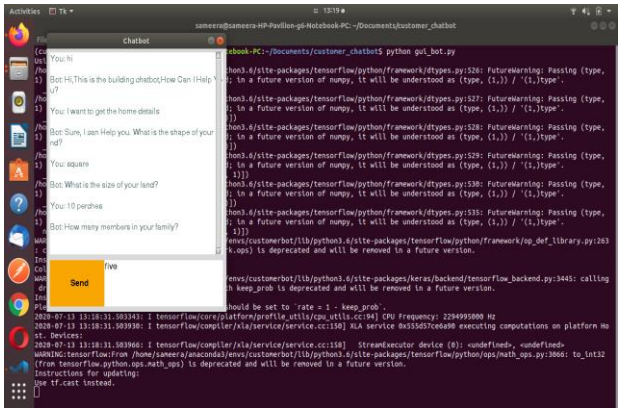


Figure 12:chatbot

Architecture Component

The starting point here is to use a linear regression algorithm to provide the customer with a more accurate housing plan and determine the number of square feet per customer number of house compartments required.Depending on the requirements provided by the customer, the data model provided here is trained using a linear regression algorithm and the required number of square feet is given to the customer.

The house plans provided by the existing cave architects are then provided to the customer according to the number of square feets quantity obtained. There, customers can choose the most suitable housing plan for themselves and see the details.The customer will then be able to recreate the design of the house of his choice .The customer will be provided information to create the design through an existing architect.

The system also categorizes existing road architects based on their experience rating value and creates an architecture recommendation system to select an architect to provide the highest quality service to the customer

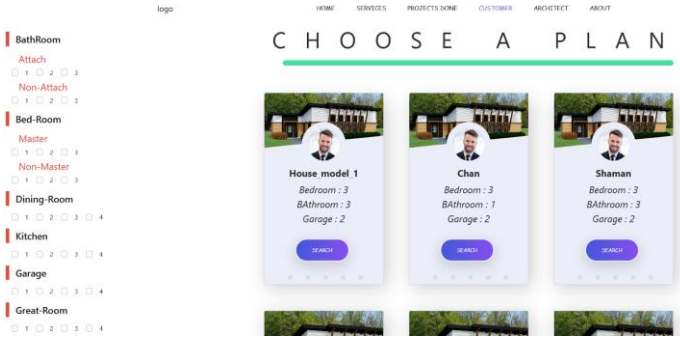


Figure 13: Customer Fill the house compartment list

compartment	S.F.	Bedroom	BathRoor	Garage	Lundry	LivingRoor	Desk	Dining	Kitchen	Veranda	MudRoom	Ensuit	GreatRoor	Den	Flover
15	1834	3	3	2	1	1	1	1	1	1	1	0	0	0	0
13	1718	3	3	2	0	0	0	1	1	0	1	1	1	0	0
17	2687	3	3	3	1	0	0	1	1	0	1	1	1	1	1
7	1184	3	1	0	0	0	0	0	1	0	0	0	1	0	1
6	495	1	1	0	0	1	1	0	1	0	0	0	0	0	1
14	1733	3	2	2	1	1	0	1	1	0	1	1	0	1	0
13	1350	2	2	2	0	1	0	1	1	0	1	1	0	1	1
11	1295	2	2	2	0	1	0	1	1	0	0	1	0	0	1
13	1504	2	2	2	0	1	1	1	1	0	1	1	0	0	1
12	1890	3	2	0	0	1	1	1	0	0	1	1	1	0	1
13	1740	3	2	0	1	1	1	1	1	0	0	1	1	0	1
15	1509	3	2	3	0	1	1	1	1	0	1	1	1	0	0
10	1294	2	2	1	0	1	0	1	1	0	0	1	1	0	0
13	1668	2	2	2	1	0	1	1	1	0	0	1	0	1	1
9	1648	3	1	0	1	1	0	1	1	0	1	0	0	0	0
9	1812	3	2	0	1	1	0	1	0	1	0	0	0	0	0
7	1145	3	0	0	0	1	1	1	0	1	0	0	0	0	0
8	1181	3	1	0	1	1	0	1	1	0	1	0	0	0	0
8	1213	3	1	0	0	1	0	1	1	1	0	0	0	0	0
14	2000	4	2	0	1	1	1	1	1	1	0	1	1	0	0
16	2500	5	3	1	1	1	1	1	1	1	0	0	1	0	0
15	2400	6	2	0	0	2	0	1	1	1	0	0	1	0	1
13	1800	3	2	0	1	1	1	1	1	1	0	1	1	0	0
16	2100	4	2	1	1	1	1	1	1	1	1	0	1	0	1
8	1640	3	1	0	0	1	0	1	1	1	0	0	0	0	0
7	866	2	1	0	0	1	1	1	1	0	0	0	0	0	0
9	1560	3	2	0	0	1	0	1	1	1	0	0	0	0	0

Figure 14: data set

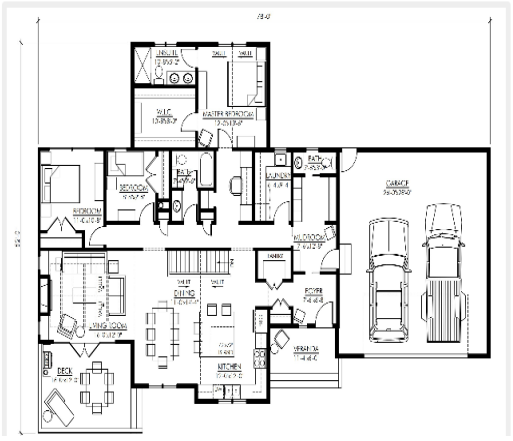
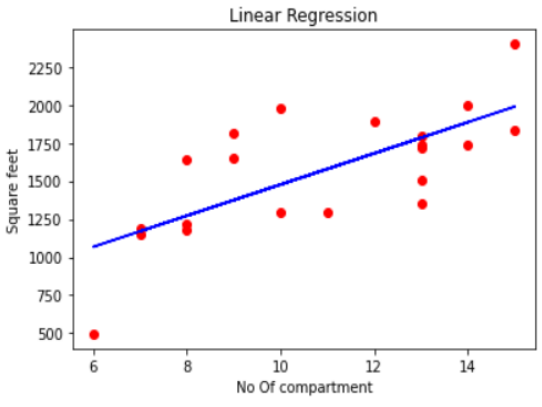


Figure 15: Collected Dataset abouthouse compartments



r-squared_LR = 0.6773181723610744

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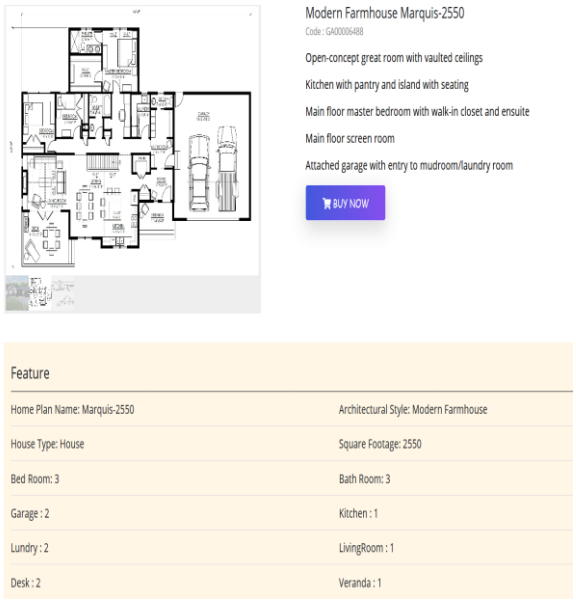

Figure 16: Predicted Home plans

Carpenter and Mason Component

In order to produce a prediction from the model, there should be a proper way to send the data to the model and retrieve the result or the prediction produced by the model. For the above functionality, an application called “flask”[2] is used. Flask is a python language based framework. In order to run the prediction system, the flask application should be running too.

All the interfaces (front-end) related to the carpenter and mason component are implemented using React[3] technology and use Laravel framework [4] as the backend. The back-end is developed using API (Application Programming Interface) technology.

In the carpenter and mason component, it includes two sub components. They are as follows.

1. House construction initial cost forecast system using a Machine Learning Model
2. Carpenter and mason recommendation System

Above two sub-component address the two major challenges found during the research.

Once a carpenter or a mason log into the system, they will be able to manage their profile and add previous projects they have done. As an additional information, carpenter and mason is allowed to add the following information.

1. Bio
2. Service Price Rate
3. Service Price Type etc...

Once the customer logs in to the system, they can create construction projects. In construction projects, the customer will have to provide some information. Such as name for the construction project, timber type for ceiling, timber type for carpentry, wall material, floor material etc. The information provided by the system and the customer will be used for forecasting the initial cost and it will be displayed to the customer. So that the customer can make easy decisions with high accuracy. Once the customer goes to the next web page, they are given two options to select suitable carpenter and mason. The options are,

1. Carpenter and mason recommendation system
2. Search Filter Functionality

Based on the information provided by the customer, the previous projects done by carpenter and mason will be displayed as recommendations based on the cost for carpentry and masonry costs. If the customer is not satisfied with the recommendations provided by the system, they can use the search filter functionality to find a suitable carpenter and mason for their house plan. Then all of the information will be stored in the database. Customers are allowed to manage their construction projects as well as they are allowed to add reviews on the carpenter and the mason they have selected for their construction project using a star based rating system. The ability to manage the reviews is given to customers.

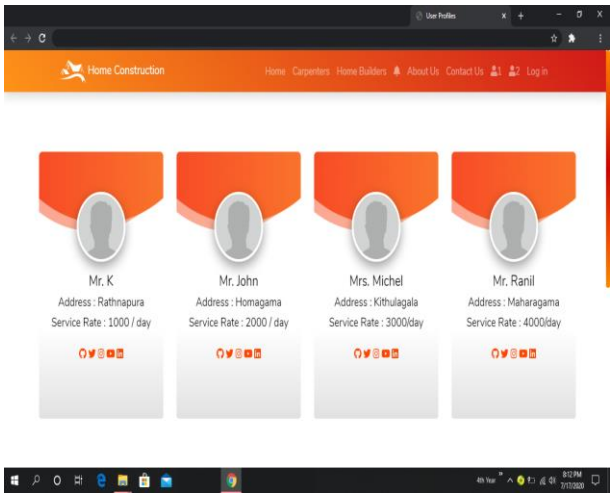

Figure 17: User List

Progress Tracking and Bidding System Component

The main functionality of the Progress Tracking System is to provide daily updates to the customers about his/her home construction project’s progress. The supervisor updates the daily progress via the mobile application. After downloading the mobile app to the smartphone, the supervisor can simply sign up for the application. By providing the site name, location of the site, and the date, the supervisor can create a new site. The supervisor can upload daily tasks, title, date, progress of the task, special notes about the daily works and upload the images of the daily works. Also, the supervisor can

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track the labor attendance and the supervisor can record the amount of raw material used to complete the day-to-day tasks.

B. Discussions

The components which are mentioned in this paper , have used the main machine learning methods and the artificial intelligence techniques to implement them. There are a lot of ways to implement those techniques inside the components, which need a lot of data to train the certain algorithms . Due to the unavailability and the time consuming those techniques will not give the proposed output at the given time.

Implementation of the chat bot in the customer component could be done with the seq2 seq technology. But to implement a chat bot with the seq2seq technology , it needed a large dataset to be train . Due to the less availability of the large dataset for the home construction field, it was hard to implement that kind of chat bot and the process is complex and time consuming.

The Vaasthu Recommendation system of the Customer Component used the fundamentals of Vaasthu Science. Vaasthu Science is a traditional and has a long history which originated from India. The main objective of the Vaasthu Science is to build home, buildings according to the more environmental friendly and energy saving manner.According to the [36], there are multiple comparisons between vaasthu science and modern science attributions towards home construction process. Technically the influence of the vaasthu science has not been approved 100% scientifically. But the main focus of the Vaasthu Science is to give the assistance to build a home that people can live in a more harmony.

In the implementation of the architecture component, It is clear from the softwares [12][13]14] used for architecture today that not everyone has the knowledge and ability to achieve their goals and this research will help them to meet their needs more accurately. This system will enable customers of all levels of knowledge and all professional architects to easily set the backdrop for their home. The number of Square Feet in a house will be determined by the number of house components taken. Consumers may have different and variable opinions about the predicted number of square feet, but since we obtain factual information, the size of the predicted square feet can be stated to be very accurate from the vast amount of data obtained from these homes. Here the customer will be able to easily determine how many square feet he wants based on the details provided. Also, the service provided by the skilled people is superior in the accuracy and quality of the designs that they create using their own house design softwares.

In the carpenter and mason component,beginning of this research, there were few parts found that have functionality to help the carpenters and masons job such as object measurement apps, To-Do apps for task management. However, they do not quite match with the outcome of this research. With the help of surveys' results and other research methods, two sub-components could be identified that can be developed uniquely and can be contributed to the construction field. They are,

1. House construction cost prediction system
2. Professional Personals (Carpenters and Masons) recommendation system.

By integrating these two sub-components, the system will be able to help the customers to make their life much easier. It will help them to reduce the wastage of time and money.

With rapid technological development and rapid environmental development, people are getting busy with their work. The busyness is a big obstacle in making the dream of building one's own house a reality. In this busy lifestyle, it is difficult to go to the construction site and observe the progress of the day to day construction activities and gain a comprehensive understanding. For these reasons, there is a need for a good tracking system. This tracking system should help people keep track of what is important to reach the final stage once they start building their dream home. And also provide an overview of the time it takes to build a home.

The bidding system that is described in this paper allows a highly qualified architect to design a home by creating a job opportunity that meets their requirements.

IV. CONCLUSIONS

In this research , the components in this system are partialy implemented. The main objective regarding to the research , is to implement the entire functionality of each component and create a efficient Home construction system that will useful for everyone who insterest on the home construction field. We suppose to improve the efficieny of each component to implemenr this system as a unique one.

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