APPLICATIONS OF AI AND BLOCKCHAIN IN CONSTRUCTION MANAGEMENT

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Content

CHAPTER ONE
INTRODUCTION

INTRODUCTION

SYNOPSIS

In this chapter a brief introduction about artificial intelligent and its history and how its applied in construction management as its study the following :

-Overview of AI and optimization in the construction industry

-Importance and impact of AI on construction management

- Objectives and scope of the study

1.1 Overview of AI and optimization in the construction industry

The building industry has several problems that have slowed its expansion and resulted in exceptionally inadequate efficiency in comparison to other industries such as manufacturing [1]. In reality, the construction sector is one of the least digital in the globe, and numerous stakeholders recognize the age-long tradition of resistance to change [2].The industry's absence of automation and too manual nature complicates and prolongs project management[3]. The construction industry's lack of proper digital knowledge and technology adoption has also been connected to cost inefficiencies, project delays, poor quality performance, misinformed making decisions, and poor efficiency, well-being, and security performance .[4] In the past few years, it has been evident that the building sector has to accept digitization and rapidly expand technical capability, particularly with regard to the problems of present shortages in labor.

Artificial intelligence (AI), a leading digital technology, has helped to significantly enhance corporate operations, service procedures, and industrial efficiency in recent years [1]. The use of AI techniques has helped to improve automation and create more business advantages when compared to traditional methods [5]. AI subfields include deep learning, natural language processing, artificial intelligence, computer vision, optimization, autonomous organizing,

and sequencing. [6], They have been used to address complicated challenges and help make choices in situations that are real. For example, in the production sector, the 4th industrial revolution, referred to as Industry 4.0, is a movement that focuses on automation, data-driven technology, and the use of sophisticated AI methods [7]. It is clear that this change has led to major advances in savings, reduced manufacturing times, increased safety, and helped enterprises meet their objectives for sustainable development [8]. Despite its current issues, the construction sector has yet to enjoy any meaningful benefits from artificial intelligence.

In recent decades, scholars have written articles on how to use AI and related subfields to address construction-specific difficulties. Machine learning has been used to monitor health and safety, estimate costs, optimize supply chain and logistics processes, and identify risks, among other things. Nonetheless, manufacturing remain one of the most digitized sectors in the entire globe and continues to struggle with the positive uptake of AI along with other technological innovations.. A few studies have linked the lack of AI acceptance to a variety of factors, including cultural hurdles, high initial costs of adopting solutions based on AI, confidence, safety, insufficient processing power, and access to the internet. However, it is obvious that there are plenty of grey topics related to the growing field of AI applications, as well as potential prospects and impediments to acceptance in the building sector.

Intelligence emerges as a major force in construction, capable of overcoming long-standing challenges while carving new paths for efficiency and creativity. AI's disruptive ability throughout the construction sector stems from its capacity to provide data-driven insights, automate complex activities, and improve the way decisions are made.

With implementing AI, building contractors may anticipate and avoid hazards, refine the distribution of resources, and improve project execution tactics, lowering the likelihood of budget and timetable overruns. Furthermore, AI significantly improves worker safety by allowing for continuous monitoring of building sites, detecting possible hazards, and maintaining safety standards. As a result, AI in construction acts as both a solution to current difficulties and a catalyst for advancement, guiding the construction sector toward better, more secure and profitable building processes.

This trend toward AI in building not just aims to expedite the execution of projects and administration, but it also creates opportunities for sustainability and creativity, altering the construction industry. For example, the use of AI in the preconstruction phase may transform project design and planning by utilizing sophisticated algorithms, machine learning, and other AI foundation models, assuring optimal resource use and reducing the carbon footprint. Furthermore, AI in the construction industry brings a new degree of accuracy to scheduling, budgeting, and manpower allocation, resulting in considerably improved completion rates.

In addition, the future of AI in construction is bright, with emerging innovations such as generative artificial intelligence having an opportunity to alter traditional procedures even further. These developments might result in more fluid and adaptable building methods, with AI-powered systems constantly learning and improving, opening up possibilities for more robust and environmentally conscious buildings.

Despite the achievement of AI in other sectors, there is huge opportunity for using AI techniques in the construction business. AI can assist to automate operations, increase managing projects, strengthen safety measures, and optimize resource allocation. Construction organizations may examine massive

datasets using machine learning algorithms to acquire important insights for informed decision-making and maintenance forecasting. Artificial intelligence (AI) may help with quality supervision and surveillance on building sites, guaranteeing compliance with design requirements and spotting possible safety issues. based on artificial intelligence algorithms for optimization can help to shorten building timelines, reduce delays, and increase the entire project's effectiveness. Nevertheless, various hurdles must be overcome in order to successfully integrate AI in the construction business. These difficulties include improving data availability and quality, integrating with current systems, ensuring legal AI usage, and addressing industry resistance to change. Additionally, there is a need to upskill the workforce in order to take on and successfully use artificial intelligence (AI) techniques.

1.2 Importance and impact of AI on construction management

Artificial intelligence, also known as AI, is a broad term for when a computer replicates human cognitive processes such as problem solving, recognizing patterns, and learning. The science of machine learning is an aspect of artificial intelligence. Artificial learning is a branch of machine intelligence that use statistical methods to enable machines to "learn" on information despite having programmed in any way. As more data is fed into a computer, it improves its comprehension and ability to provide ideas.

Several artificial intelligence approaches have been created to help robots resemble human mental operations such as acquiring knowledge, deductive reasoning, and self-correcting. The established AI approaches are divided into four primary categories: expert systems, fuzzy logic, machine learning, and optimization algorithms. To be more exact, a system for experts is a basic and accessible technique of sophisticated , which incorporates relevant specialist information and logic to solve complex situations. Fuzzy logic converts unclear,

unreliable unclear, and incomplete input data into computer intelligible forms before generating replies according to a collection of fuzzy guidelines. Using machine learning is a big step in AI to teach robots how to uncover patterns buried in massive data sets and make statistical forecasts about future activities. Deep learning and reinforcement learning are emerging as higher-level trends in machine learning. The goal of an optimization algorithm is to find the best results from a collection of accessible options, whether locally or worldwide. Furthermore, process analysis is a relatively new subject that aims to bridge the division across process administration and data sciences. Whereas process mining fully utilizes event logs with the goal of tracking, identifying, examining, and enhancing the real process, it has not gotten adequate attention. We also regard methods for processing mining to be a significant branch of artificial intelligence. It is well recognized that AI's field of application may be quite broad.

whereas the possible advantages of using AI in the management of construction are undeniable, challenges remain in translating research findings into practical applications. Key barriers to widespread AI adoption in the construction industry include data quality issues, limited access to domain-specific expertise, and organizational resistance to technological change. Furthermore, the scattered structure of the construction industry offers hurdles for integrating information and compatibility, limiting the scale and efficacy of powered by AI solutions. Tackling these difficulties needs a multidimensional strategy that includes technical innovation, change in organizations, and stakeholder collaboration. Efforts to harness AI in development management have resulted in the creation of advanced analytical instruments for prediction and systems for decision support that are suited to the industry's specific demands. For example, a hybrid AI framework integrating artificial intelligence technologies with professional expertise can foresee overruns in project costs and improve the

allocation of resources. By combining human experience with algorithms, the structure improves the understanding and resilience of prediction models, allowing managers of construction to make informed choices in complicated and unpredictable contexts. This hybrid method offers an important change in the management of construction, spanning the gap across data-driven analytics and domain- particular expertise to produce more exacting and actionable results.

1-3 Objectives and scope of the Book

The main objective of this book is to provide a guide how to use the AI in each area or field in the construction management . this book the following :

1) Project integration management: This area focuses on coordinating all aspects of a construction project, ensuring that each part of the project works together smoothly and efficiently.

2) Scope management: This area involves defining the scope of the project, identifying the specific work that needs to be done, and ensuring that the project stays within the defined scope.

3) Time management: This area is all about scheduling the project, ensuring that each task is completed on time, and monitoring progress to ensure that the project stays on schedule.

4) Cost management: This area involves budgeting and managing the project costs, tracking expenses, and ensuring that the project stays within budget.

5) Quality management: This area focuses on ensuring that the construction project meets the required quality standards, and that the result is of high quality.

6) Human resource management :entails recruiting, instructing, and overseeing individuals participating in the building project.

7) Communication management: This area is all about ensuring effective communication between all stakeholders in the construction project, including clients, contractors, and workers.

8) Risk management: This area involves identifying potential risks to the project, assessing their impact, and developing strategies to minimize or mitigate them..

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CHAPTER TWO

AI in Project Integration Management

AI in Project Integration Management

SYNOPSIS

In this chapter we will provide the use of AI in Project integration management with some practical case studies with different language and include the following

-AI-driven project Corporation tools and techniques

-Case studies: AI applications in complex Project integration management

2-1 AI-driven project Corporation tools and techniques

Intelligent computing (AI) is now a buzzword throughout sectors, including the management of projects. AI is the replication of human intellect in robots engineered to entertain ideas and develop like humanity. In the administration of projects, artificial intelligence may be utilized to simplify and automate numerous activities, improve decision-making, and increase overall project performance. The advantages of employing AI in the execution of projects are multiple, including higher efficiency, greater precision, lower costs, and better cooperation.

Project planning is an important phase in the management of projects since it establishes the framework for the whole project. artificial intelligence-powered project organizing solutions can help to simplify the procedures by automation functions like scheduling, resource allocation, and risk assessment. These technologies utilize mathematics and machine learning to evaluate past data, discover trends, and forecast future results. This enables administrators of projects to develop more precise and realistic project plans, distribute resources more smoothly, and anticipate potential dangers.

The advantages of utilizing AI in the planning of projects are enormous. First, it minimizes time and effort by simplifying repetitive operations and eliminating the need for human data entry. This enables administrators of projects to concentrate on the more strategic parts of preparing and making decisions. In addition, AI-powered technologies can rapidly and reliably evaluate vast volumes of data, delivering useful insights to help with decision-making. This results in better informed, data-driven project strategies. Finally, AI may assist in resource allocation by determining the most effective use of scarce assets based on previous data as well as predictive analysis.

A- Improving Project Managing through AI

Task management is another crucial aspect of project management that can be greatly enhanced with the use of AI. AI-powered task management tools can automate the assignment of tasks, track progress in real-time, and provide intelligent recommendations for task prioritization. These tools use machine learning algorithms to analyze historical data and learn from past performance to optimize task allocation and scheduling.

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2- Improving Resource Allocation with AI

allocating resources is an important part of the management of projects that may significantly effect project success. powered by artificial intelligence allocate resources technologies may evaluate past data, detect resource usage trends, and forecast future resource requirements. This enables project supervisors to better distribute assets maximize the use of assets, and minimize overallocation of resources or inadequate use.

The advantages of utilizing AI in distributing resources are enormous. For starters, it increases resource usage by determining what is the most effective use of resources using historical information alongside machine learning. This ensures that finances are deployed to the correct projects at the right time, resulting in increased productivity and lower costs. Furthermore, AI-powered systems may predict possible delays and disputes regarding resources, permitting administrators of projects to take proactive steps to address them. Finally, AI may assist improve the allocation of resources by taking into account elements like accessibility to resources, expertise, and workloads when rendering judgments. This results in evenly distributed duties and higher the efficiency of the team.

3- Predictive Analytics and AI in Project Management

The use of predictive analytics is a strong tool that may assist project managers in making accurate estimates and projections for potential project events. AI-powered predictive analytics solutions employ neural network methods to examine past data, discover patterns, and forecast future trends. This enables project managers to foresee possible hazards, discover chances, and center choices on data-driven insights.

The advantages of utilizing AI in predictive analytics are numerous. For starters, it enhances forecasting and prediction accuracy by rapidly and precisely evaluating vast volumes of data. This enables project supervisors to make more informed decisions and lowers the likelihood of unexpected results. Second, powered by artificial intelligence technologies can predict possible hazards and risks in advance, allowing leaders of projects to take proactive steps to reduce them. This helps to reduce project delays and interruptions. Finally, predictive modeling may discover areas for enhancement or optimization using previous data and patterns. This enables project managers to make decisions based upon data, potentially leading to enhanced effectiveness and financial advantages.

4- Real-time Monitoring and Reporting with AI

Real-time monitoring and reporting are critical for successful execution of projects. powered by artificial intelligence monitoring and reporting solutions may collect and interpret real-time information from a variety of sources, including software for project management, sensors, and Internet of Things devices. This enables managers of projects monitor project progress, spot concerns throughout the time, and produce automatic reports with useful insights.

The advantages of implementing AI in real-time tracking and reporting are enormous. For starters, it gives project managers with real-time information on the progress of each work, allowing for improved monitoring and faster interventions if problems emerge. This ensures the projects stay on pace and allows for proactive issue solutions. Second, AI-powered technologies may evaluate real-time data from a variety of sources to detect trends or abnormalities that could point to possible threats or opportunities. This enables project managers to make educated decisions using current information. Finally,

software for reporting minimizes time and work by automatically creating reports based on established templates or specific needs. This allows administrators of projects to focus on data analysis rather than laborious report preparation.

5- Boosting Team Collaboration with AI

Efficient collaboration among teams is critical to project completion. AI-powered collaboration applications can help increase communication among teams, sharing of knowledge, and general cooperation. These technologies utilize the processing of natural languages and machine learning algorithms to assess communication patterns, detect possible problems, and make intelligent proposals for enhancing cooperation.

The advantages of implementing AI in team cooperation are numerous. First, it enhances communication by studying conversation patterns and making intelligent recommendations for greater cooperation. This ensures that every team member are on the same page and decreases the likelihood of miscommunication or misunderstandings. Second, AI-powered technologies may help with knowledge sharing by evaluating project documentation, recognizing important material, and recommending ways to share or reuse knowledge. This improves overall project efficiency while lowering the danger of recreating the wheel. Finally, AI may aid in the identification of possible challenges or disputes within the team by studying communication patterns and detecting potential causes of tension or disagreement. This enables leaders of projects to initiate proactive steps to settle problems and enhance team chemistry.

4- AI-powered Decision Making in Project Management

Making intelligent choices is critical for predicting success. artificial intelligence-powered decision-making technologies can evaluate enormous

volumes of data, detect trends, and give thoughtful recommendations for decisions. These technologies utilize neural network systems to evaluate past data, find trends, and forecast future results.

The advantages of utilizing AI when making choices are numerous. For starters, it increases decision-making efficiency by processing vast volumes of data rapidly and accurately. This enables team members to make more educated choices and lowers the likelihood of unforeseen outcomes. Second, powered by artificial intelligence technologies can offer intelligent proposals for making decisions based on past information and forecasting. This enables project managers to analyze all important elements and make more objective judgments. Finally, artificial intelligence may aid simplify making decisions by giving real-time insights and suggestions. This saves time and effort and enables administrators of projects to make fast choices based on current facts.

2-2 Case studies: AI applications Planning

One of the most important stages in the construction projects is planning , as the main decisions are made in this stage.

Planning is critical to the success of any building project. This procedure may be tough due to the complexities of the building industry and the numerous factors to consider, such as finances, supplies, employment, and schedules. AI can accelerate and enhance planning. Generative AI may suggest action items and create agendas for subsequent sessions. These features not only boost the productivity of teams working together but also enable them to stay on schedule. Borders stated:.

A- Enhancing Task Management with AI

On the most important use of AI in enhancing tasks management by using several methods and software

Python language one of the most important languages that every engineering should consider and learn. This book assume the reader know the basic of using the python. MATLAB also very powerful tool that can be used in the engineering problems. Both of them will be used in this book.

In AI there are two type of modeling , predictive modeling , descriptive and optimization modeling one must know the different between them before use them

Predictive modeling is the model that the user want to predict in future with unknown output , in other word assume that an engineer has a historical data about ten project with certain cost , time and the problems that occur and the performance of the project fail to meet the requirements , and wish to know the about the future projects whether they will fail or sauces with specific time , cost and others input . here the role of AI to predict that failure as show in table (2.1) as example

Table (2.1) Predictive model Example

Year	Time	Cost	Chang ordered	Performance
2019	X	X	X	Y
2020	X	X	X	Y
2021	X	X	X	Y
2022	X	X	X	Y
2023	X	X	X	Y
2024	X	X	X	?
2025	X	X	X	?

The AI will take theses input s and predict the unknown output. This will be explain more briefly in the next chapters.

Descriptive modeling differ from the first one as its main aim is classify if the output is in or out . for example for the same previous example but all the output is known and just classify if the project is in or out performance as in table (2.2).

Table (2.2) Descriptive model Example

Year	Time	Cost	Chang ordered	Performance
2019	X	X	X	Y1
2020	X	X	X	Y2
2021	X	X	X	Y1
2022	X	X	X	Y1
2023	X	X	X	Y1
2024	X	X	X	Y2
2025	X	X	X	Y2

As in table (2.2) the role of AI is classify if the output Y1 or Y2.

Optimization model different from the first two as it require to build an equations that relate to the problems to find a solution , for example if the engineer has cost problem and need to minimize the amount of the cost in the projects but it affect by certain factors as time , quality , workers and others.

The model should be built as

Min cost . (called objective function) '

Time (constrain 1)

cost (constrain 2)

workers (constrain 3)

so in order to minimize the cost , the constrains must be fulfilled (see the optimization basics)

now our first case study is how to manage the tasks without exceeding the time limit or cost lime and keep the work smoothly.

The data set that use is the work progress schedule of different projects with their tasks allocation

	Task Name	Constructi preiod	Start Date	Completion Date	Predecessors	Resource Na
1	**1 Design and implementation project**	**545 days**	**Sun 09/07/23**	**Sat 04/01/25**		
2	**1.1 Commence date of this project / start milestone**	**0 days**	**Sun 09/07/23**	**Sun 09/07/23**		
3	**1.2 Mobilization and Preparation**	**268 days**	**Sun 09/07/23**	**Tue 02/04/24**		
4	1.2.1 Topography/Soil Investigation,etc	30 days	Sun 09/07/23	Tue 08/08/23	2SS	
5	1.2.2 Temporary Land Permissions	90 days	Sun 09/07/23	Sat 07/10/23	2SS	
6	1.2.3 Mobilization of managerial staff, first batch	20 days	Sun 09/07/23	Sat 29/07/23	2SS	
7	1.2.4 Mobilization of managerial staff, second batch	20 days	Sun 30/07/23	Sat 19/08/23	6FS+1 day	
8	1.2.5 Mobilization of Manpower, 1st batch	10 days	Mon 10/07/23	Thu 20/07/23	2FS+1 day	
9	1.2.6 Mobilization of Manpower, 2nd batch	30 days	Wed 09/08/23	Fri 08/09/23	8FS+20 days	
10	1.2.7 Mobilization of Manpower, 3td batch	50 days	Sun 08/10/23	Mon 27/11/23	9FS+30 days	
11	1.2.8 Mobilization of Manpower, 4th batch	30 days	Tue 28/11/23	Thu 28/12/23	10FS+1 day	
12	1.2.9 Mobilization of Manpower, 5th batch	30 days	Thu 01/02/24	Sat 02/03/24	11FS+35 days	
13	1.2.10 Mobilization of Manpower, 6th batch	30 days	Sun 03/03/24	Tue 02/04/24	12FS+1 day	
14	1.2.11 Mobilization of Materials from China, 1st batch	50 days	Mon 10/07/23	Tue 29/08/23	2FS+1 day	
15	1.2.12 Mobilization of Materials from China, 2nd batch	50 days	Thu 20/07/23	Fri 08/09/23	14SS+10 days	
16	1.2.13 Mobilization of Materials from China, 3td batch	50 days	Sun 30/07/23	Mon 18/09/23	15SS+10 days	
17	1.2.14 Mobilization of Materials from China, 4th batch	50 days	Sat 19/08/23	Sun 08/10/23	16SS+20 days	

Figure (2.1) MS PROJECTS Example

23 projects were collected with their completion rate , tasks relationship and other information.

One of the main problems in the AI is to build the data set and provide the requirements in order the algorithms work. First we will decide the type of modeling , if predictive modeling used then we will need the input and out for certain time to predict and manage the tasks allocation in the future .

The input require is the type of the program used to organize the tasks management (MS projects, excel , primavera, by hand) , the second input is the

daily update of the task management , the third input is the relationship between the tasks if its available or not such as start to finish and other , the type of the projects .

The output would be if there is critical tasks failed to be manage or not.

After deciding the input and the output , now the data set is built as in table (2.3)

Table (2.3) Building Data Set

No	Year	Type of software	Relationship	Type of the projects	Daily update	Tasks management
1	2018	By hand	Exist	Building	No	Not Effective
2	2018	excel	Exist	Building	Yes	Effective
3	2019	excel	Exist	Building	Yes	Effective
4	2019	MS projects	Exist	Building	Yes	Effective
5	2020	MS projects	Exist	Building	Yes	Effective
6	2020	MS projects	Exist	Roads	Yes	Effective
7	2021	MS projects	Not	Roads	Yes	Effective
8	2021	primavera	Not	Roads	No	Not Effective
9	2022	primavera	Exist	Building	No	Not Effective
10	2022	MS projects	Not	Roads	No	Not Effective
11	2023	MS projects	Exist	Building	Yes	Effective

12	2023	MS projects	Not	Road	No	Not Effective
13	2024	MS projects	Not	Road	No	?
14	2025	MS projects	Exist	Building	No	?
15	2026	primavera	Exist	Building	Yes	?
16	2027	primavera	Exist	Building	Yes	?

After building data set , its necessary to decide the type of algorithm to be work with. The algorithms are divided into several type and its require to understand each type as the data set depend on its.

There are four types of machine learning algorithms

1. Supervised Learning

A. Classification

- Logistic Regression
- Support Vector Machines (SVM)
- k-Nearest Neighbors (k-NN)
- Naive Bayes
- Decision Trees
- Random Forest
- Gradient Boosting (e.g., XGBoost, LightGBM, CatBoost)
- Neural Networks (e.g., Multilayer Perceptron)

B. Regression

- Linear Regression
- Ridge Regression
- Lasso Regression
- Support Vector Regression (SVR)
- Decision Trees Regression
- Random Forest Regression
- Gradient Boosting Regression
- Neural Networks Regression

2. Unsupervised Learning

A. Clustering

- k-Means
- Hierarchical Clustering
- DBSCAN (Density-Based Spatial Clustering of Applications with Noise)
- Gaussian Mixture Models (GMM)

B. Dimensionality Reduction

- Principal Component Analysis (PCA)
- t-Distributed Stochastic Neighbor Embedding (t-SNE)
- Linear Discriminant Analysis (LDA)
- Independent Component Analysis (ICA)

- UMAP (Uniform Manifold Approximation and Projection)

C. Association

- Apriori Algorithm
- Eclat Algorithm

3. Reinforcement Learning

- A. Model-Free Methods
- Q-Learning
- Deep Q-Network (DQN)
- SARSA (State-Action-Reward-State-Action)
- Policy Gradient Methods (e.g., REINFORCE)

B. Model-Based Methods

- Deep Deterministic Policy Gradient (DDPG)
- Proximal Policy Optimization (PPO)
- Trust Region Policy Optimization (TRPO)

C. Value-Based Methods

- Monte Carlo Methods
- Temporal Difference (TD) Learning

4. Ensemble Learning

- Bagging (e.g., Random Forest)
- Boosting (e.g., AdaBoost, Gradient Boosting)

- Stacking

In this book we will take the first two type and see how its effect on the data set some of the supervised learning algorithms require the data set to be process before entering to the algorithms.

Supervised Learning for type of classification is used for type of descriptive classification with all input and output are known , for same previous example in table (2.3) if we assume the output is known the procedure will be as follow :

First decide the type of the algorithm that will be used , in our case different algorithms will be used with python language. Logistic Regression will the first algorithm to be used with python language that need environment to be implemented , we could use the online environment such as Google colab or offline such as VS code,

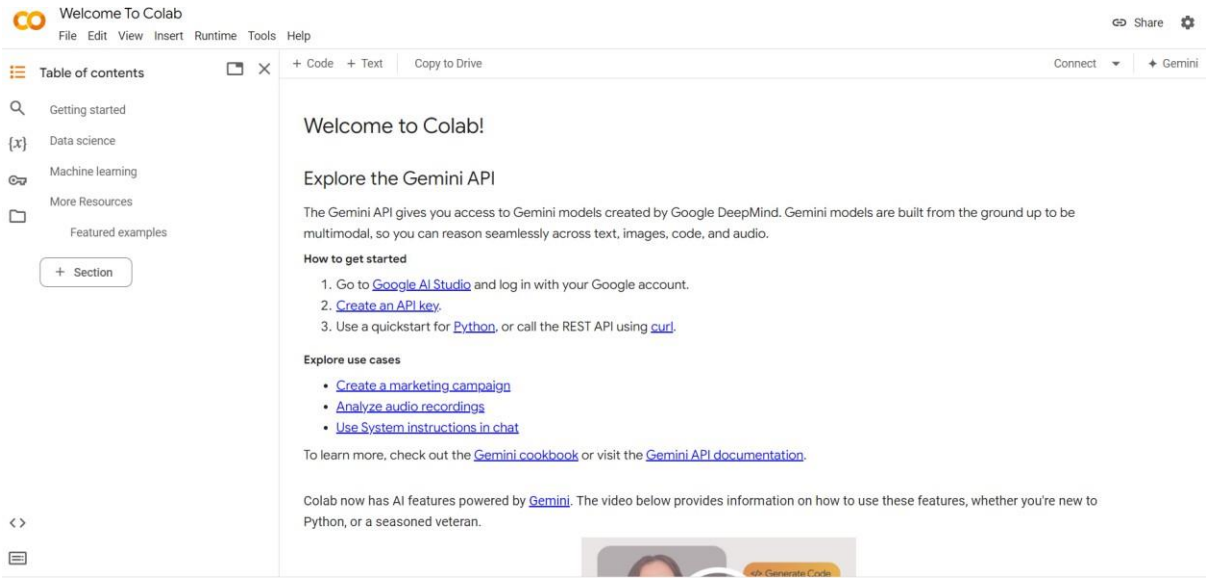


Figure (2.2) Google colab

Google Colaboratory (a.k.a. Colab) is a cloud service based on Jupyter Noteboo ks for disseminating machine learning education and research. It provides a runt ime fully configured for deep learning and freecharge access to a robust GPU.

First we need to upload the required library that we will need during the classification process.

```
# imoprt library
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

Each library refer to purpose as Importing pandas as pd: an essential Python library for data scientists. Once you import it, you can take your data analysis to a whole new level. As a general purpose programming language, Python has all the features necessary to analyze and gain insights from data.

NumPy is a Python library used for working with arrays. It also has functions for working in domain of linear algebra, fourier transform, and matrices. NumPy was created in 2005 by Travis Oliphant. It is an open source project and you can use it freely. matplotlib. pyplot is a collection of command style functions that make matplotlib work like MATLAB. Each pyplot function makes some change to a figure: e.g., creates a figure, creates a plotting area in a figure, plots some lines in a plotting area, decorates the plot with labels, etc. In matplotlib.

Seaborn is a Python data visualization library based on matplotlib. It provides a high-level interface for drawing attractive and informative statistical graphics.

Each library is required before every programming and other library also will be needed and will be mentioned.

The next step is to upload the data by using the command upload file

```
uploaded = files.upload()
df=pd.read_csv('nn1.csv')
```

as the first line indicate the upload and the seconds line the name and type of the data file.

There is a lot of operation that could be done on the data before the classification begin such as correlation to find what is the most important input that effect on the output and we can use the command

```
df.iloc[:,column 1: column last].corr
```

this line will give the correlation between the input and the output.

The next step is to dived the data into training and testing in order to begin the classification by using the following command

```
x=df.iloc[:,input 1:last input ].values
y=df.iloc[:,output].values
from sklearn.model_selection import  train_test_split
x_train , x_test , y_train , y_test=
train_test_split(x,y,test_size=0.7,random_state=0)
```

First we begin by deciding the input and the output and matching it with excel file that we uploaded and then upload the library for training and testing.

Then the next step is to call the algorithm to perform the work

```
from  sklearn.linear_model import LogisticRegression
regressor=LogisticRegression()
regressor.fit(x_train,y_train)
```

after uploading the library for the classification the following error occur

```
ValueError: could not convert string to float: 'MS projects'
```

That's mean the algorithm handle only numerical value nor string , in this situation the user has transfer all the input to numerical.

In this situation the algorithm work and the training and the testing work.

The next step , preform the classification process and see the accuracy of the algorithm .

```
y_predict1=regressor.predict(x_test)
print ('[0 logistic regression :', regressor.score(x_train, y_train))
regressor.score(x_test,y_test
```

the accuracy about 58% and return to many reasons such as the type of data or type algorithm , let's try different algorithm and see the different such as decision tree.

```
from  sklearn.tree import DecisionTreeClassifier
tree= DecisionTreeClassifier (criterion ='entropy',random_state=0)
tree.fit(x train, y train)
```

the same process repeat but the library of decision tree will be called and the accuracy reach 99% with same data that used and that return to many reasons

The main distinction between logistic regression analysis and decision tree analysis is that logistic regression models the interaction between the variables used for prediction and the outcome variable as a function of distance, whereas decision trees use a structure of hierarchical trees to model the associations between each of the variables.

Decision trees segment the feature space based on data. This reduces risks on single data points. Pruning: Pruning methods can be used to eliminate branches that are overly affected by outliers or noisy data.

Decision trees are used to answer questions about classification and group items based on their learning characteristics. They may also be used to solve regression issues or forecast ongoing results based on unknown data.For second type and if we use regression as linear regression

```
from  sklearn.linear_model import LinearRegression
regressor=LinearRegression()
regressor.fit(x train,y train)
```

the lines used to call the algorithm and then it can be used for the prediction

```
y_predict3=regressor.predict(y_test)
```

```
Reshape your data either using array.reshape(-1, 1) if your data has a
single feature or array.reshape(1, -1) if it contains a single sample.
```

This error occur which mean the output should be in numerical as the prediction require the output should be number to be predicted . after changing the output to number to prediction as follow:

Array = ([0.60802469, 0.60185185, 0.97530864, 0.41666667, -0.2345679 ,
0.78395062, 0.39197531, 0.14197531, 0.18209877, 1.20987654,
-0.07407407, 0.21604938])

This indicate the output for 12 years as the positive number to effective and negative number as not effective.

A different algorithm can be used in the same way for this purpose. As conclude the different between algorithms as follow :

Classification				Regression			
Logistic Regression	Support Vector Machines (SVM)	Naive Bayes	Decision Trees	Linear Regression	Support Vector Regression	Decision Trees regression	Neural Networks Regression
Descriptive	Descriptive	Descriptive	Descriptive	Predictive	Predictive	Predictive	Predictive
Input numeric	Input numeric	Input numeric	Input numeric	Input and output numeric	Input and output numeric	Input and output numeric	Input and output numeric
Medium data	Large data	Large data	Small	Small	Medium	Small	Large

Float data	Float data	Float data	Integer	Float data	Float data	Float data	Binary

Summery

- AI is powerful tool in task management
- Predictive algorithm can give the output as the same as number of input
- Descriptive classification required he input in numerical type
- Predictive algorithm require the output in numerical type

CHAPTER THREE
AI in Time Management

AI in Time Management

SYNOPSIS

In this chapter we will provide the use of AI in time management with some practical case studies with different language and include the following:

- Role of AI in construction time Management
- Case studies: AI in time management

3-1 Role of AI in construction time Management

Time management entails properly planning your personal time for optimal efficiency; AI tools can assist you in better optimizing your time. To make the most out of every moment, make sure your goals and priorities match those of your job.

AI can automate repeated processes and determine the most effective sequence for them, drastically lowering time to completion. chat bots because recognition of faces, automated scheduling, and predictive task sequencing are all elements that may be used to minimize the amount of time required to complete tasks while

Following are some of the more general advantages of AI regarding time management:

- Automates tasks such as reaching organizing, emailing, and the years tracking.
- Analyzes large amounts of data to provide insights into business metrics.
- Recommends personalized workflows based on task history and behavior.
- Reduces stress from neglected time frames and uncontrollable tasks.
- Ensures work and life posture by allowing you to get more done in less time
- Lowers overhead costs and increases ROI.

AI capabilities provide several opportunities for managing time, which might be daunting if you have no idea where to begin. Let's look at some of the most common use scenarios where AI may help you spend your time more effectively.

Organizing the procedure might be challenging since it incorporates several time management applications and task management tools. AI time administration software may streamline this procedure by centralizing the entire scheduling process under one roof, with capabilities that allow the following:

- Applying work histories along with information to maximize schedules.
- Taking account of considerations including personnel access, work precedence, financial restrictions, due dates, along with time regions.
- Automate discussions and inquiries.
- Creating personalized schedules for every worker depending on their timetables and tastes.
- Creating immediate scheduling modifications

An driven by AI solution could automatically sort, tag, as well as prioritize emails, saving time and effort. It additionally automate the entry of information from emails and generates task signals, decreasing mistakes. You may also employ artificial intelligence to create emails based on suggestions, allowing you to communicate more efficiently in less time.

By implementing machine learning (AI), the Architectural Design, Engineers, and Construction industries may benefit immensely from ideation to construction. So it's hardly surprising that the industry is expanding. News and Data predicts that the sector will spend $4.51 billion by 2026.

With huge building endeavors frequently running late and over budget, AI provides optimism that on-time projects will become more commonplace. And,

as previously mentioned, timing seems ripe for change.
AI is a game changer for industrial scheduling. Historically, just one or two schedules were developed for huge projects. However this was challenging since creating timetables takes time. Using AI, hundreds of thousands of fully resource-loaded schedules may be created in hours, having a clear price and duration effect for all of them.

AI may influence the huge number of different aspects that have an impact on builder, such as staff, machinery and supply of materials, or construction methodologies. This quick data modification is only possible with parameterized software.

3-2 Case studies: AI in time management

AI in time management can be used by two different way , either build a software that track the progress of the project in time and report when there is a problem to take an immediate action or by using AI algorithm to predict the time delay of the projects and how to handle it.

In the first case we will build a software step by step by using MATLAB software and see how to control time in construction projects.

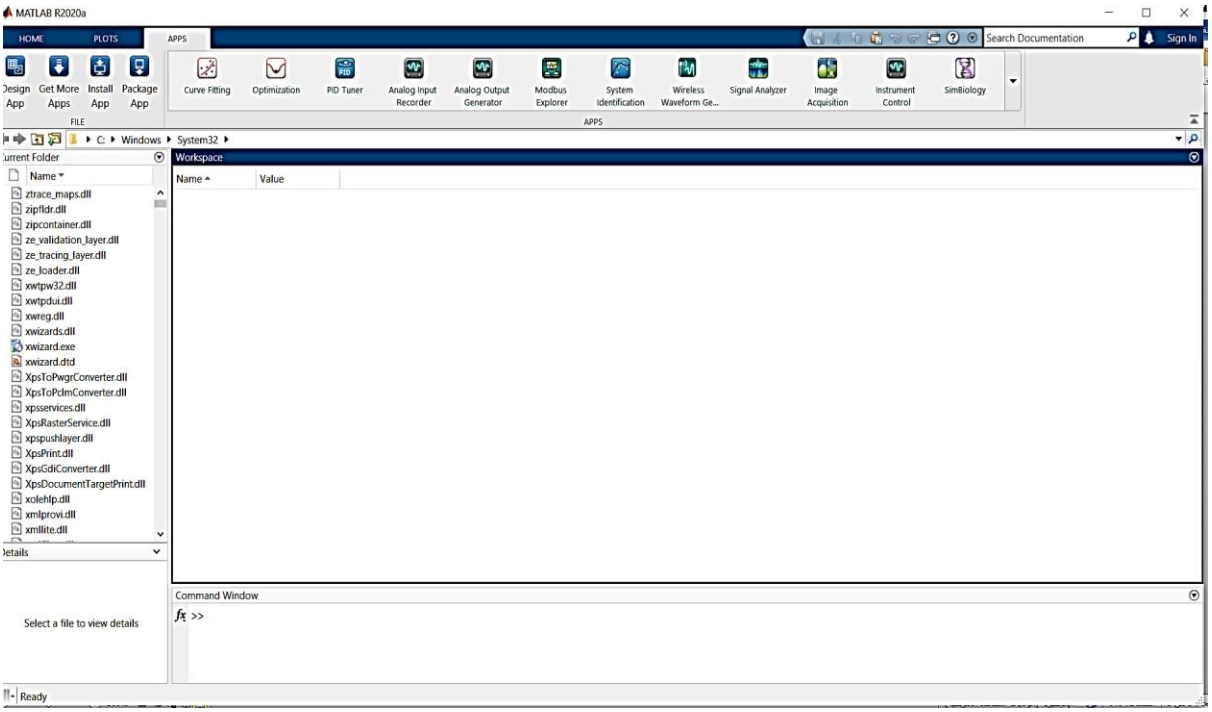


Figure (3.1) MATLAB software

To develop software a design app will be used which available in 2018 and up versions.

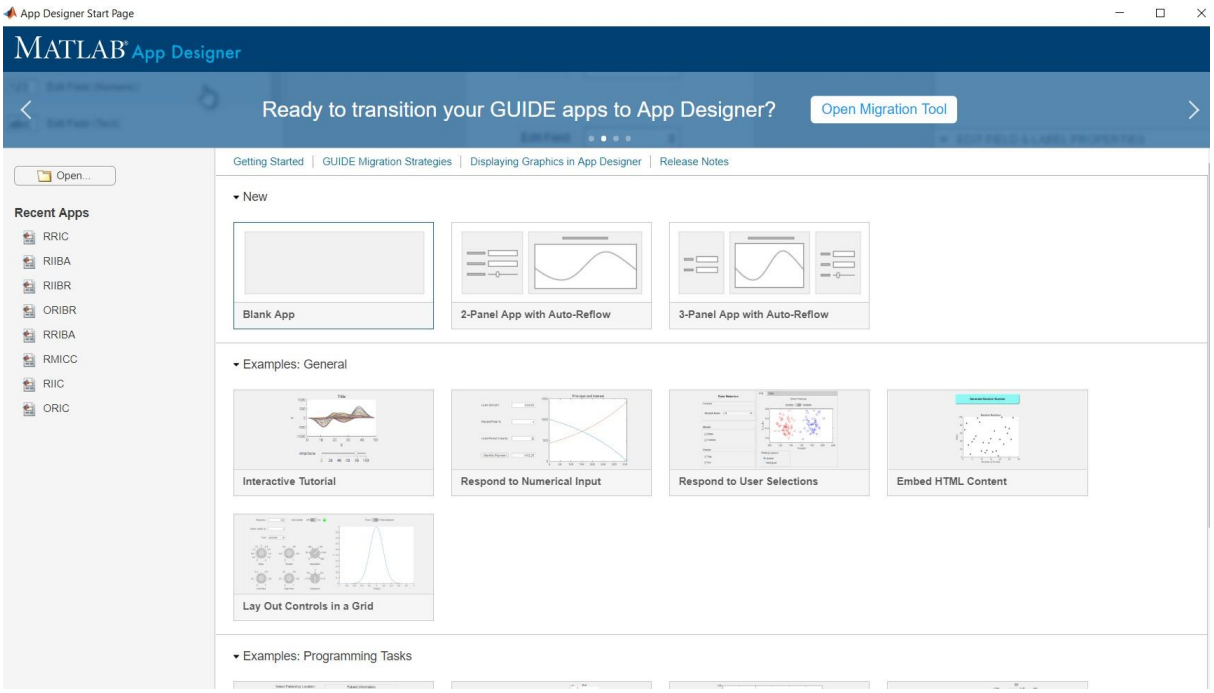


Figure (3.2) APP Designer

App Designer allows you to design great apps without needing to be an expert software developer. Drag-and-drop design elements to construct your graphical user interface (GUI), then use the embedded editor to swiftly write its functionality.

.

The first step is to create user interface that indicate the purpose of the software and what is used for.

Figure (3.2) Building System

As in figure (3.2) each bottom has a purpose as the first one indicate that user use string value and the second one is number value . after building all the type of the filed we required the following will be build.

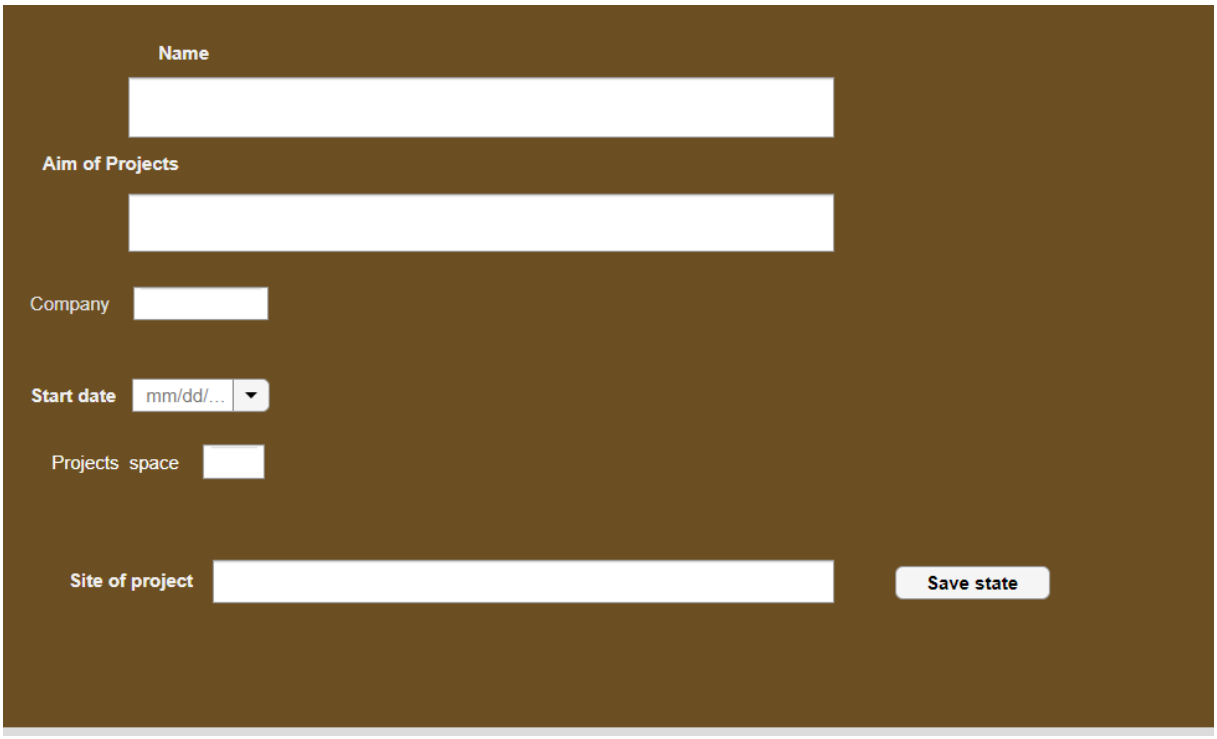


Figure (3.3) User Interface

After that the next step is to build to enter the time of each tasks and the percentage of complete and the worker that responsible of the tasks as in figure (3.4)

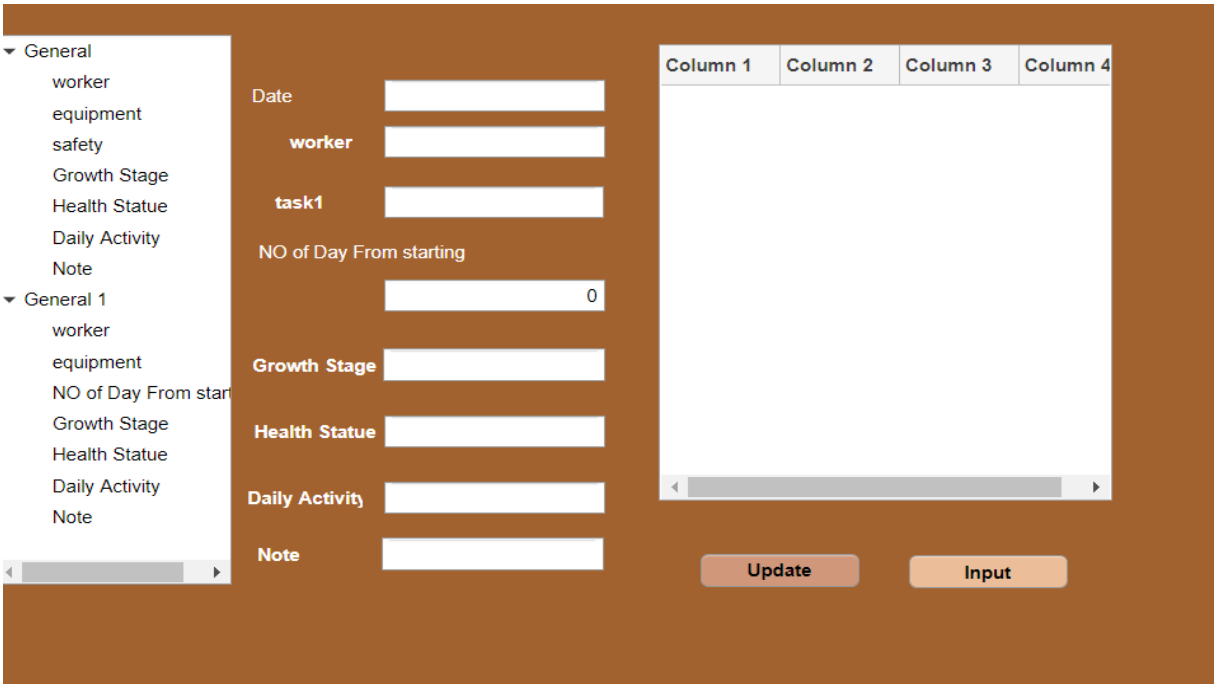


figure (3.4) Time Planning of the projects

The right side of the interface can be built by using the following command

```
app.Node4 = uitreenode(app.Node);
            app.Node4.Text = 'Node4';
```

and the linking between the tree of item and the boxes to be filled as using the following command

```
selectedNodes = app.Tree_4.SelectedNodes;
            contractors = {'General', 'General1'};
            if ~isempty(find(strcmp(selectedNodes.Text,contractors),1))
            app.workerEditField.Visible = 'on';

            else
           app.workerEditField.Value='';
           app.task1EditField.Value='';
            app.NOofDayFromstartingEditField.Value = 0;
            app.HealthStatueEditField_2.Value = '' ;
            app.GrowthStageEditField_2.Value = '';
            app.DailyActivityEditField_2.Value = '';
            app.NoteEditField.Value = '';
            app.DateEditField.Value='';
```

After the link , another link will be required with table in order to be download as excel file by using the following command

```
value = app.DateEditField.Value;
                            app.UITable3.Data(row+1,column number )={value};
```

and this command is repeated for each node to be filled for each row and column.

The third step is to address if there is any problem in the schedule of the projects and send it for solution

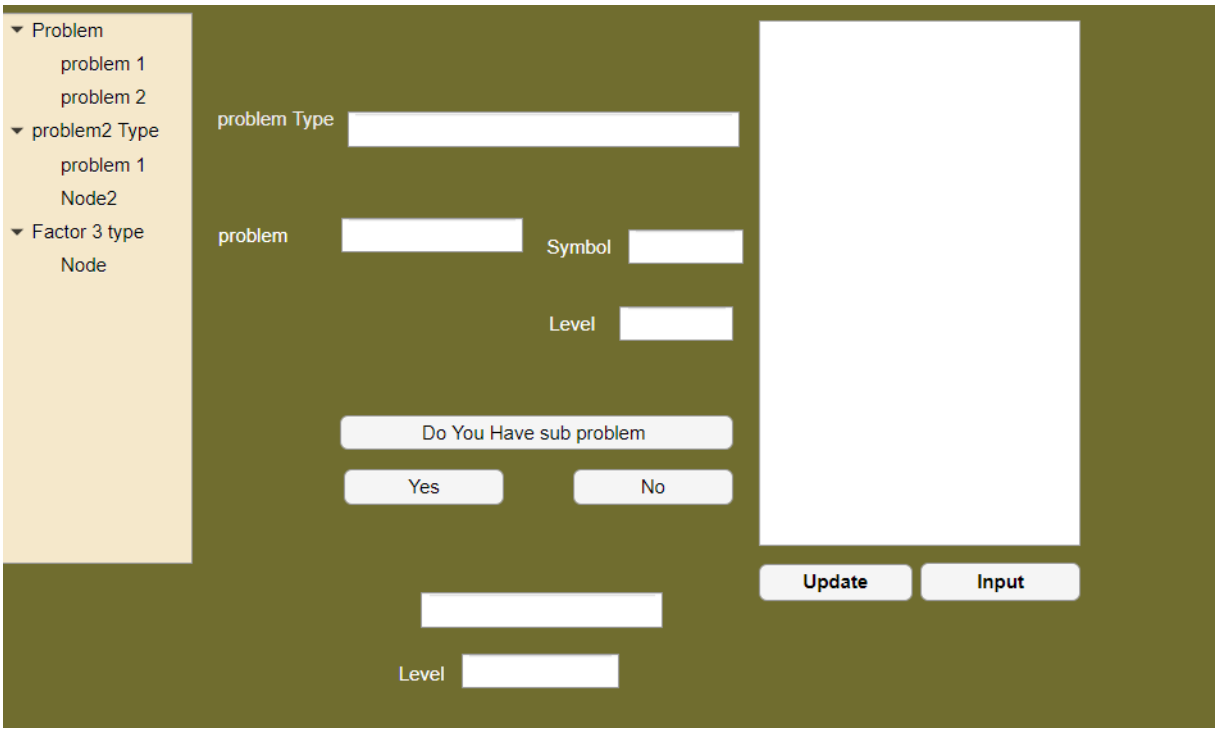


Figure (3.5) Recording Problems In Time Management

The last step is the Automated emailing about all the problem in scheduling and give report to the higher authorities.

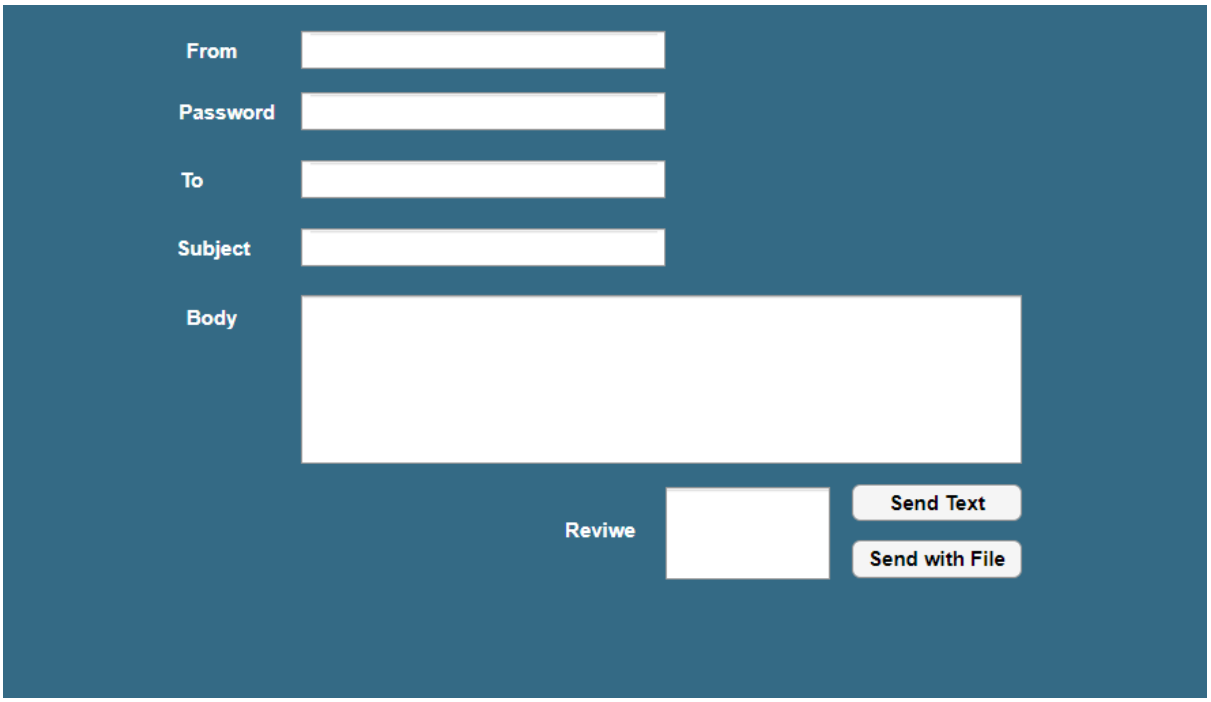


Figure (3.6) Emailing the Report

The code that used for emailing as follow:

```
UserName = app.FromEditField.Value;
passWord = app.PasswordEditField.Value;
setpref('Internet','E_mail',UserName);
setpref('Internet','SMTP_Server','smtp.gmail.com');
setpref('Internet','SMTP_Username',UserName);
setpref('Internet','SMTP_Password',passWord);
setpref('Internet','SMTP_Server','smtp.gmail.com');
props = java.lang.System.getProperties;
props.setProperty('mail.smtp.auth','true');
props.setProperty('mail.smtp.socketFactory.class', ...
                  'javax.net.ssl.SSLSocketFactory');
props.setProperty('mail.smtp.socketFactory.port','465');
sendmail(app.ToEditField.Value,app.SubjectEditField.Value,app.BodyTextArea.Val
ue);
        end
```

thus the software was build and the last step is to extract the software out of MATLAB so it can be used by different users .

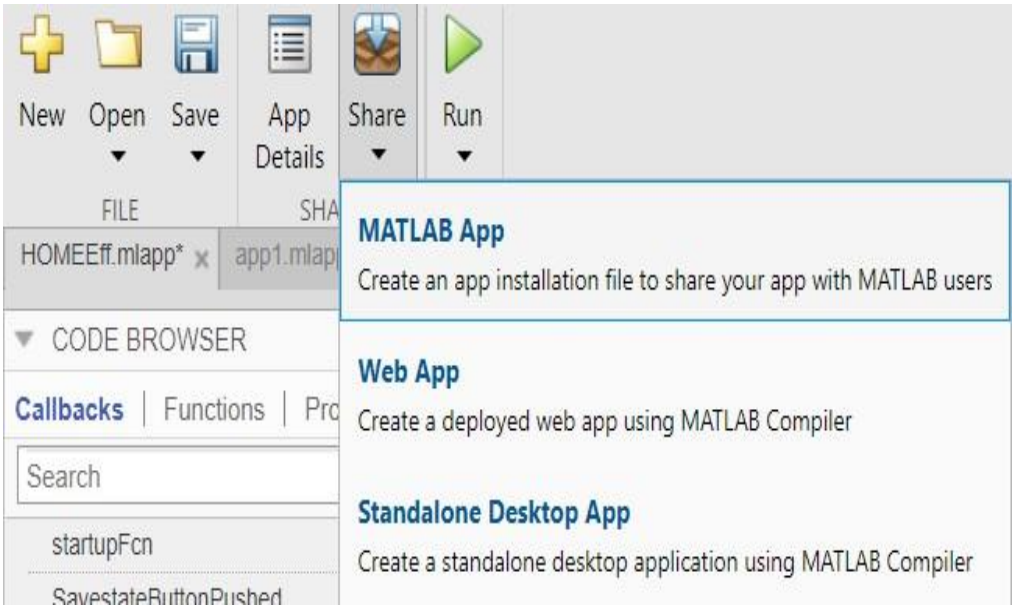


Figure (3.7) Build Standalone App

After clicking the last choice the software will start to be build

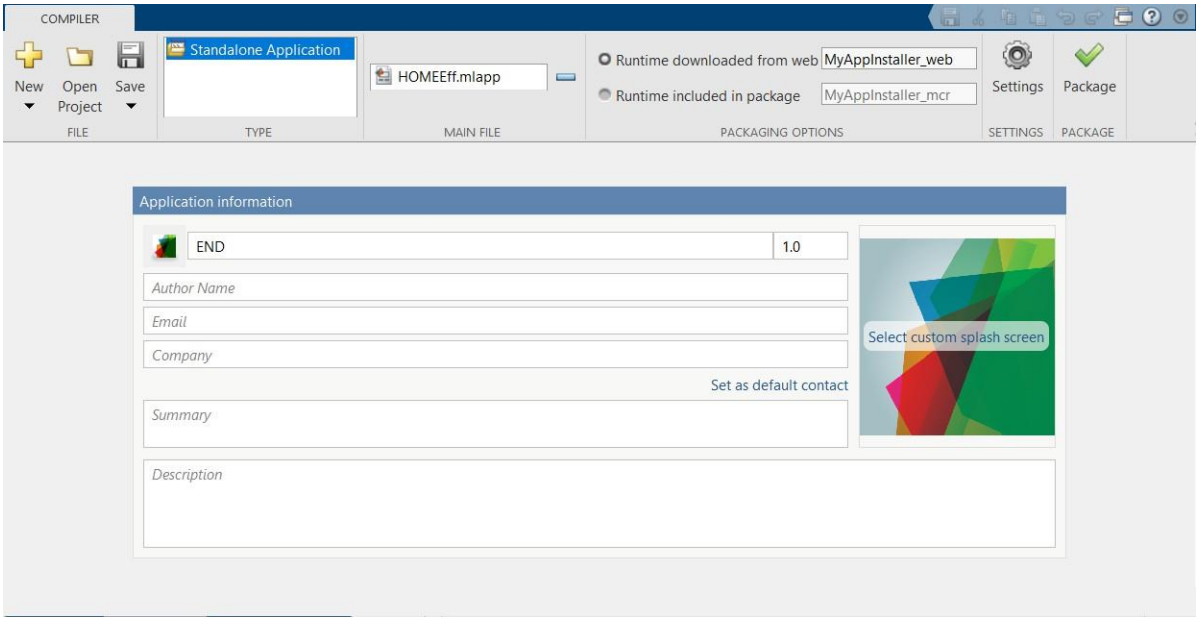


Figure (3.8) Software Information

This consider the last step in building an automated scheduling reporting for the projects .

The second use of AI in time management is to use algorithms that mentioned in chapter two, first we have to provide a data set for the projects that contain time problems.

Table (3.1) Data Set for Time Management

Project	Performance	Complete	Estimate	Actual	Add time
1	In	مستمرة	0%	0%	0
2	Out	82%	100%	82%	231
3	Out	10%	75%	10%	284
4	In	100%	100%	100%	91
5	Out	75%	85%	75%	323
6	Out	15%	100%	15%	162
7	Out	59%	85%	59%	376
8	In	0%	50%	0%	0

9	In	100%	100%	100%	188
10	Out	0%	100%	0%	0
11	Out	65%	80%	65%	405
12	In	100%		100%	213
13	Out	0%	100%	0%	0
14	out	100%	100%	100%	215
15	in	0%	20%	0%	0
16	out	100%	100%	100%	36
17	In	0%	40%	0%	0
18	In	0%	30%	0%	0
19	In	0%	30%	0%	0
20	In	0%	0%	0%	0
21	In	100%	100%	100%	0
22	Out	45%	100%	45%	330
23	Out	17%	100%	17%	174
24	Out	64%	89%	64%	461
25	Out	100%	100%	100%	29

The algorithms will be test on two languages , MATLAB and Python . MATLAB has several ready tool for algorithms to be used without any programming . in app the user can select the algorithm that wish to work with as seen in figure (3.9).

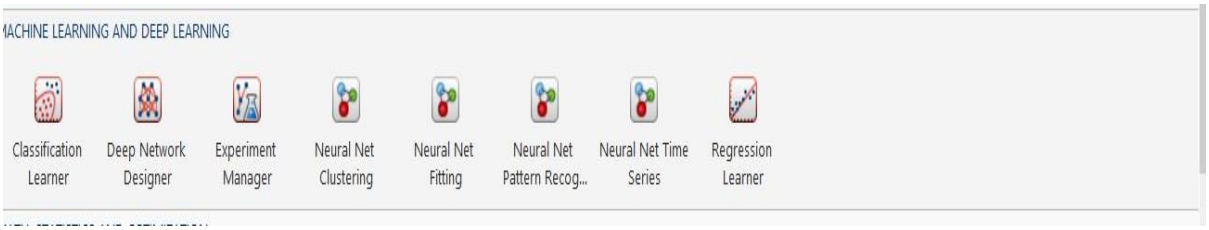


Figure (3.9) Machine Learning in MATLAB

First we will make comparison with linear regression in both language and see the deferent in accuracy. First we have to download the data required as seen in figure (3.10)

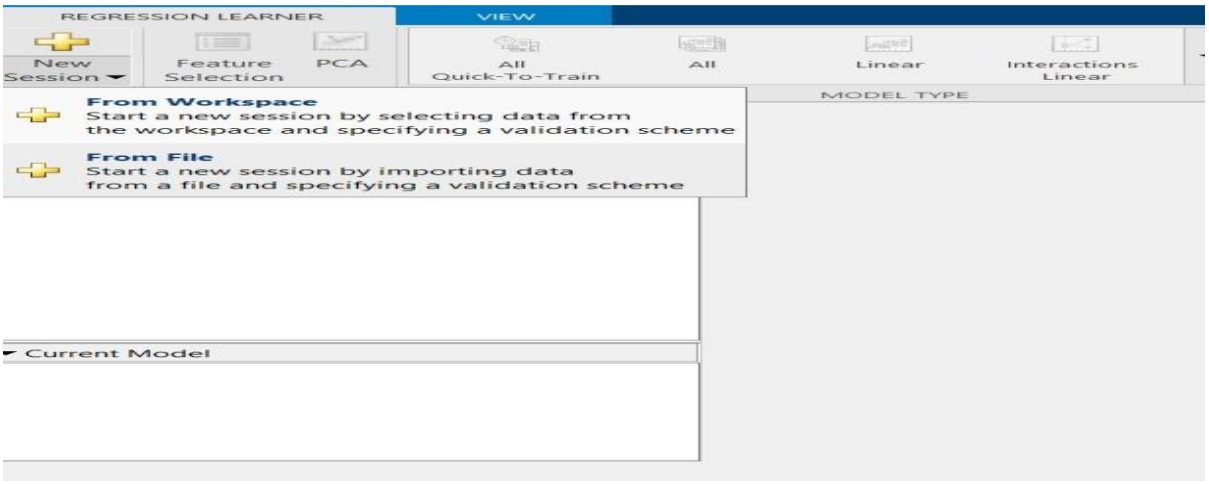


Figure (3.10) Adding Data set to MATLAB

Second we decide the input and type of cross validation that can be used as seen in figure (3.11)

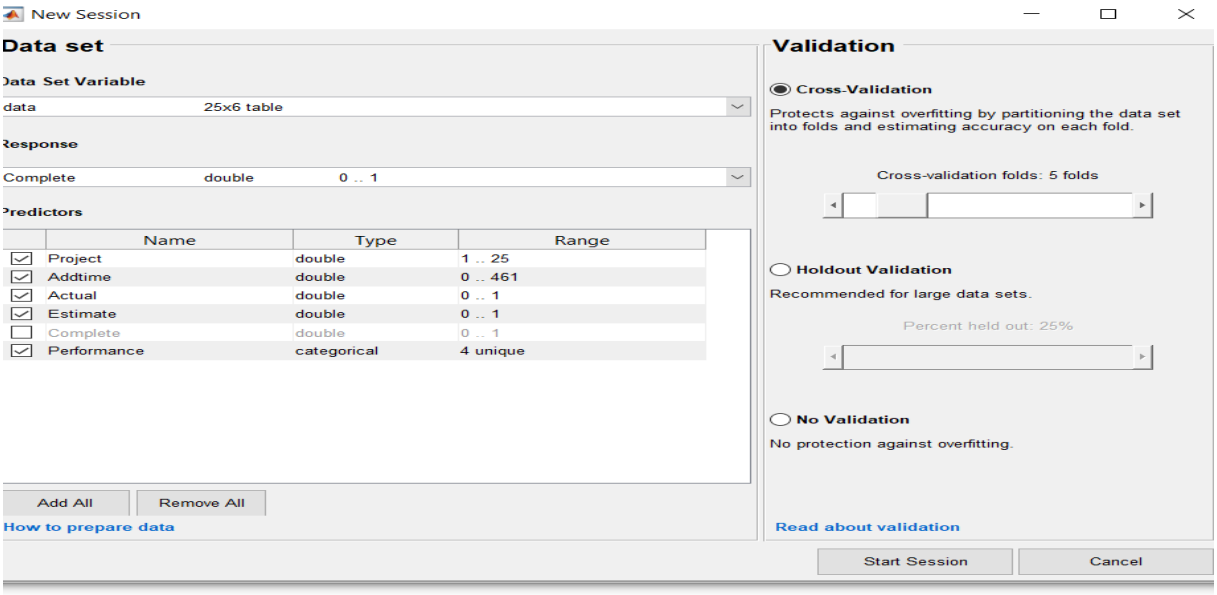


Figure (3.11) Cross Validation

The last step is getting the accuracy of the algorithm as in figure (3.12)

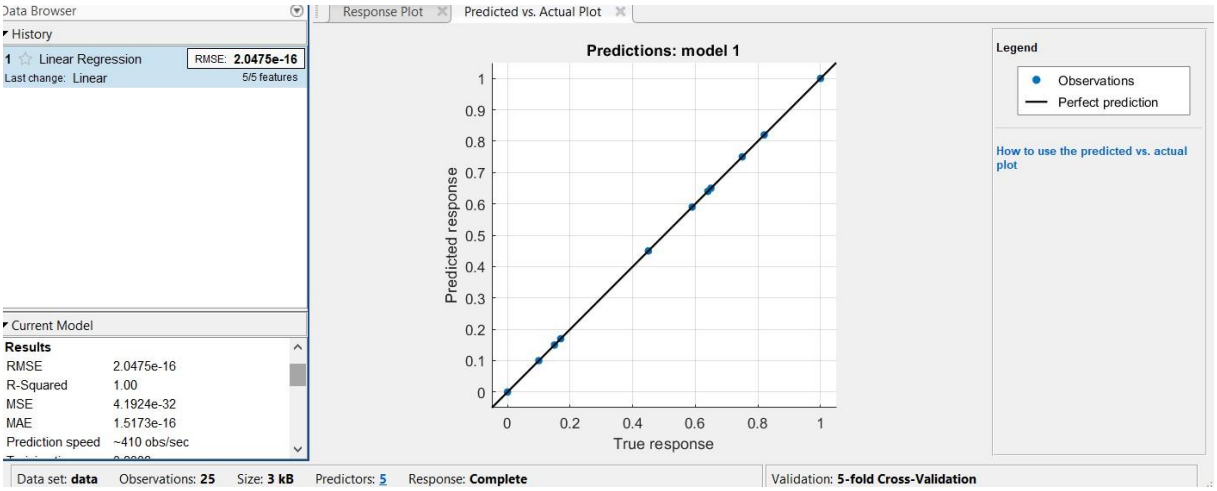


Figure (3.12) Algorithm accuracy

The accuracy is almost 100% while if we use python it will give me 70% which consider very big different ,MATLAB defaults to storing all numerical information as double-precision floating- point integers. On the contrary, Python defaults to storing some numbers in integers. Because of this distinction, you may give numbers as input parameters to MATLAB functions that need double-precision values.

CHAPTER FOUR
BlockChain in Construction Projects

BlockChain in Construction Projects

SYNOPSIS

This chapter include the application of blockchain in construction projects

4-1 Blockchain

The blockchain was first launched by (Nakamoto, 2009) as Bitcoin's foundational technology, a decentralized cash sharing scheme for individuals (peer-to-peer). The distributed ledger technology (DLT) is a community oriented and transparent technology that transfers data between network users and tracks the transaction in the system (Muthuraman et al., 2019). The technology works with a network of computers focused on a wide range of individuals or peers. Blockchain can also be called a block chain containing information or transaction records for each block; (Fortney, 2019) It is chronologically sealed and protected by cryptography, coding and decoding science, for information and correspondence protection and securing respectively. In accordance with the consensus of the majority (more than percent 50) and organizations known as network knots, each transaction is checked and performed directly on Internet via computers (Crosby et al., 2016). Blockchain as a value sharing network that can decentralize the storage and transmission of data. Smart contracts are one of the most applications. (Mougayar, 2016)

The contracts constitute the cornerstone of every business. These contracts must then be effectively handled. Companies are often subject to regulatory threats in the delivery and logistical stages of their contracts, apart from financial pressures of reliable contract life cycle management. As a consequence, a technological solution is best suited for each of these

contracts. Project automation is a promising solution for addressing ever-expanding contract management problems. Suppose a self-executing agreement: for example, once the distribution is complete, the payment begins immediately. This contract is much more functional in principle than tradition Intelligent contracts are the main emerging uses of technology blockchain (Efanov & Roschin, 2018). Transfers cannot be identified in the first wave of blockchain; bitcoin. In other words, the ability of the Bitcoin blockchain to use it for some other purpose than moving bitcoins from one account to another is quite restricted. However, in the definition of terms and clauses (smart contracts) between the parties, well-known blockchains can be defined (Wood, 2014). The main aim of Ethereum creation was thus to create a blockchain programming network (Buterin, 2014). Ether is a smart contractual network and a decentralized platform which makes smart blockchain contracts; (Nagpal, 2017).

4-2 How Smart Contracts Work In the Ethereum blockchain network

There are accounts which share or have some significance amongst them. The Ethereum blockchain monitors and registers the status of each account and transaction as other blockchains like Bitcoin. The two types of accounts on Ethereum blockchain are externally own account (EOA) and contract account. EOAs delegated to users have no personal code and are managed by private keys. Contract accounts, on the other hand, are managed by their contract codes and are kept in blockchain by intelligent contracts. The terms and rules of the contract account shall ensure that the transactions are properly done (Aung & Tantidham, 2017). Value transfers are only available between EOAs and from an EOA to a contract account by creating and cryptographically signing a 35 transaction with their private key. As a result, contract accounts are unable to initiate new transactions. A transaction

from EOAs to contract accounts, on the other hand, unlocks the codes within the contract accounts, which then execute various coded functions including payment transfers, calculations, and so on (Savelyev, 2017). When a transaction is sent by the EOA to a contract account, the transaction data payload is used to provide information to the contract function (Bahga & Madisetti, 2016). Contracts on the blockchain will communicate with one another. Contracts will actually send messages to one another. The letter is sent with the receiver's and sender's addresses, the transmitting value, and a data field containing the recipient contract data entry (Bahga & Madisetti, 2016). The transaction and message are generated by an EOA and a contract, as seen in Figure 6.1.

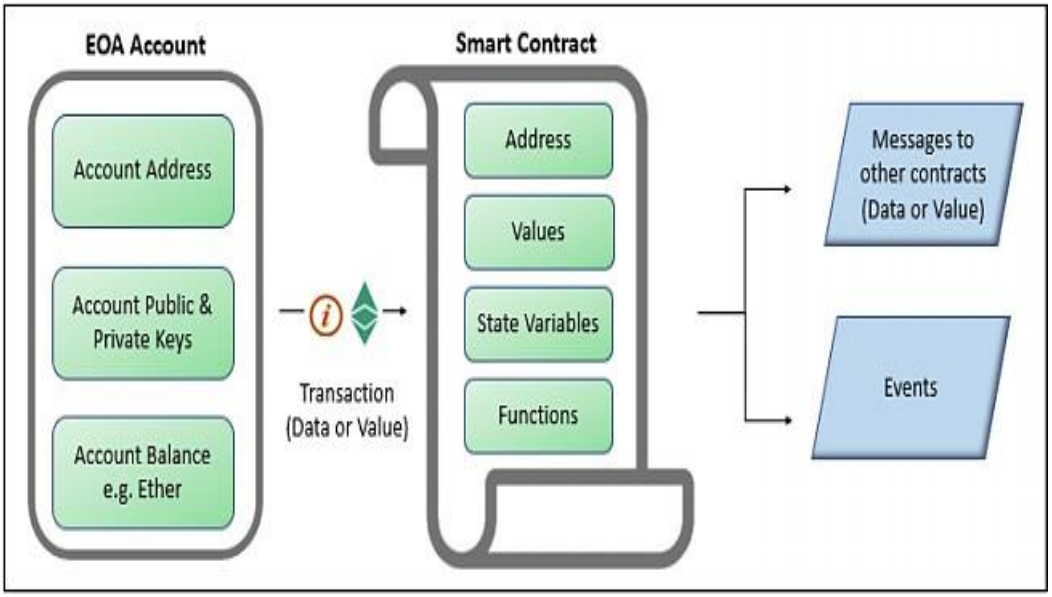


Figure (4-1) Smart Contract Accounts(Bahga & Madisetti, 2016)

In order to conclude an intelligent contract, parties should first and foremost identify and set the required conditions for the trade. Conditions, external activities or milestones can be caused by the parties themselves. Both agreements are then written in programmatic fashion by using programming languages such as Solidity for smart contracts in the form of

codes. Then the coded intelligent agreement is implemented in the blockchain, where self-execution is carried out until the conditions are fulfilled.

In order to execute financial contracts on blockchain Marlowe is a domain specific language (DSL): Cardano is the initial goal but it can be deployed on several distributed ledgers (DLT platforms) including Ethereum (Bartoletti & Zunino, 2018). (Bartoletti & Zunino, 2018). In order to allow users to express contracts with Haskell elements that are normally a meaning of the constants and simple functions, Marlowe is integrated into Haskell. In a number of cases, we can use Marlowe as a reference semantic in the Haskell language. We can read Marlowe's contracts ourselves in Haskel but can use this realization compiled for Plutus to translate Marlowe on the Blockchain particular.ain Cardano (Margaria & Steffen, 2018).

Model Marlowe Contracts are designed by creating a limited number of buildings that may describe several various financial contracts in combination. The contracting parties, also referred to as the partners, may partake in different actions: money can be deposited or various alternatives have to be chosen. In such circumstances, any party may cause the contract only to warn it that certain conditions have become valid (e.g., a timeout has occurred). In certain disjoint accounts, the Marlowe model requires a money management contract: this allows more precise control over how the money comes into the contract. Each account is held by a single contracting party, and after the deal is closed it will collect a reimbursement of the outstanding funds in the account. Marlowe contracts specify a number of steps in conjunction with a second (under) contract outlining whether to do the next step, usually in the first step. The contract Pay a p v cont states, for instance "paid v Lovelace from the account a to a party and then observe the contents of the contract." The extension of the contract is requested. We need to keep

track of the contract in the execution of a contract: the new contract would be cont after a phase in the example above. We must also keep track of some other facts, including how much is included in each account, which is usually changing at each point. A phase could also see action, such as depositing money, or producing an impact, e.g. a payment. Users can communicate on the blockchain with Marlowe contracts, make deposits and receive payment through their wallets. Move by step, Marlowe We name these contracts structures Marlowe has five ways to construct contracts. In exchange, contract structures can include beliefs, observations and behaviors as well. Values, assumptions and activities are used to provide external information and inputs to an operating contract to monitor its growth. (Margaria & Steffen, 2018)

Values include such amounts, such as the actual slot size, the account's current balance, as well as any choices made previously. Addition, subtraction and denial should be used to merge values. Boolean expressions comparing and can be mixed using regular boolean operators are observed. You should also check if a decision has been made (for a particular identified choice). At each stage of performance, observations would have a meaning. Actions occur at some stages and may be carried out

I cash deposits.

(ii) make a decision of different options, or (iii) inform the contract of the truth of a certain observation.

Contract structures form the core contract building block, with five of them: four – Pay, Let, If and When – create a complicated contract out of simple contracts, and the five, Near, is a simple contract. We will have a new contract at any stage of the execution and it is likely in certain cases to have consequences, such as fees and alerts. The table overview The (6-1)

Table (4-1) Marlowe contracts Items

Item	Description
Pay	A payment contract. Pay a p v cont will transfer value v from bank a to recipient p, which might be a single of the contract's parties or an additional account in the terms of the agreement. Advice will be issued if the value v cannot be positive, or if there is insufficient funds in the bank account to cover the whole payment. In the initial scenario, nothing is sent; in the second case, a partial payment (of all available funds) is made. The deal will remain as is.
Close	A contract Close allows the agreement to be ended (or ended). The sole action taken is to reimburse the value of all accounts to its individual owners. That involves repaying with one account per step, however all accounts are repaid through a single transaction. Each agreement eventually lead to Close.
If	The conditional If obs cont1, cont2 will continue as either cont1 or cont2, based on the Boolean value of obs on performance.
When	It's an extremely sophisticated agreement its constructor to, having a structure After occurrences time out. It is an arrangement that is triggered by events which may or may not occur at any precise slot: Cases outline the permissible actions and their consequences.
The list	comprises a collection of instances of the type Case ac co, where ac is an action and co is a continuation (a different

cases	contract). When action ac is executed, the state is updated, and the contract continues as defined by co. To ensure that the deal finally moves forward, When cases timeout, cont will remain as cont as soon as any valid transaction is issued after the timeout (slot number) is reached. When cases timeout, cont will continue as cont as soon as any valid transaction is submitted after the expiration date (a slot value is achieved).

The Model Contracts from Marlowe were used to model the contracts for the buildings schemes, but the present situation will first be assessed and the term and condition will be improved.

4-3 Evaluate The Current Contract Condition

Before implementing the smart contract , the current that used was evaluated in two way , first a questionnaire was made to know the current evaluation by the expert , and second a collection from different ministries about the problems that arise from the contract and their influence on the subsequent stage of the project.

A case study was taken , and it contract was study with details in order to compile and add enhancement on the conditions of the contract.

After reviewing the contract of the case study , and also reviewing many contract with different type of project , it can be notice the same conditions are repeated in all projects whether is building , infrastructure or other type , also not taking into consideration the complexity of the project , whether small , medium or large and other aspects. furthermore some contract only comprise from two papers with little obligation for both side ,

as many of the owner and contractor neglect the contract and consider it not an important part of the projects , a survey made on the ministries in order to know the projects that have been stopped due to the contract , it has been found more than 40% of the projects due to lack of the condition of the contract.

After reviewing the contract condition according to NEC and other standard format contract it can notice the contract comprise of the following :

1- Risk management plan along with contract , in order to comply the contract a risk management procedure must exist to manage all the type of the risk occurs.

2- The scope of work is clearly describe as the first part of the contract.

3- The contract is divide into several subcontract , one for safety, quality , interim payment , subcontractor obligation and others.

4- There is different scenario for occurring the uncertainty or risk and method of sharing compile with type and complexity of the projects.

The contract of the case study did not include all of these that mentioned in spite of their important and subsequent effect on the project. As the project started on 20 October 2019 and suppose to end with December 2020 , however the project undergo several unexpected conditions which first the owner wrong drawing as in the cad drawing the project contain appendix however , the site didn't have enough space to be built there for a change order was made and a third floor was added , the second issue the owner was not able to pay for the contractor in the four invoice as to finical problems and the second was due to covid 19 , the project has to stooped more than it scheduled , which lead to delay the project for one year and the deliver postpone to July 2021.

As solutions for the problems , the first one a change order was made for adding the third floor and quantity for the appendix transfer for the third floor but this change order lead to add time to the project.

The second issue was not solved and the contractor has to wait until the owner has the cash flow in order to pay , but the contractor stooped the work as to delay for the payment of the invoice , in spit there is a condition in the contract that state the contractor has no right to claim or stoop the project in case the owner could not pay for the invoice.

The third issue was manage with decision of the Prime Minister give the project a time about 300 days an addition to the original project duration regard the type of the project or original duration or any other aspect , the project schedule is shown in appendix .

Not only in this contract , but many contract its terms are not enforced , even if they are stated , hence the methodology of the chapter include two part ; the first one propose the optimal contract condition based on the international contract with adjustment with the risky environment to accommodate with Iraqi projects and their continuity risks.

Proposed Contract Frame work

This section include the main items that should be included in the construction contract as follow :

1- The scope of the work : The job is a description of the work that the contractor is going to complete under the building contract. It provides an overview of the following:

a- Work to be performed in a contract (or by its sub-contractors)

b- summary of the operations involved in the performance and deliverables at each point of work

c- phased works (for instance, demolition of the works, site monitoring, frame construction, lock-up stage and completion).All these should be include in the contract in order to that both contractor and owner right perceived without any damage.

2- The project progress with invoice must be early determine in the contract , for example , the contractor must provide an invoice every thirty days with 10% progress in order to that both parties can guarantee their rights.

3- Risk management plane must clearly and with details must be stated with unexpected risks that occur during the project lifecycle. The NEC contracts are the first that deal clearly and successfully with the management of the inherent risks and difficulties that are experienced at least in part on each undertaking.

Table (4-2) Contract Proposal

Contract name
First party :
Second party :
The cost of the project:
The duration of the project (should include all the holidays both formal and the informal):
Location and size of the project :
The name of the design consulter with fee

The name of the supervisor consulter with fee

Scope of the project: the contract include all the work that required to be implemented and with maintenance and the contractor has to admit that he had seen all the condition , design , drawing and all contract documents and give his approve , also the contractor has to admit that he had already visit the site in order to compile the drawing with it and all price of material have been evaluated.

The contractor obligation : this item should include all the contractor obligation according to the project type and complexity such as for building

- The Contractor provides access to work and materials for the Project Manager, Supervisor, and others as informed by the manager of the project.
- The Contractor follows instructions from the Project Manager or Supervisor that are in compliance with the contract.
- The Contractor follows the health and safety criteria specified in the Works Information.
- The contractor is accountable for examining and testing materials. Whether or not the Supervisor tells him, the Contractor corrects the Defect. A contractor corrects a detected defect within the issue's repair time expires. The issue's remedy time begins at Finish for flaws that were informed prior to Finalization, and when the defect is notified for other defects.

- The contractor is responsible to provide a project progress with every (

.....) and percentage about (…) .

- The contractor is responsible to provide a risk management plane for each stage of the work. The risks should include all the significant and most repeatedly and the risks that not expected.
- The contractor has to take the consulter instruction in the implementation of the work an provide a details report of the wok progress in which type of equipment that he use and other using photograph and different method of reporting.
- The contractor must provide the strategy or plan for safety management , including the safety against accidents and disease.
- The contractor must provide an insurance against the subcontractor mistakes and other defect work.

Owner obligations

- The owner should provide the payment on time without any delay and if there is a delay the owner has to pay to the contractor to compensate for his lost .
- If the delay was due to circumstance that outside the control , this consider a risk ,therefore the owner must also provide a risk management plan for unexpected event.
- The owner has to provide bonus for good performance or completing before schedule.
- The owner must provide his requirements with details in oder to tb implemented by the contractor to avoid change order and claims.
- The owner must provide a details feasibility study with all aspect.

This contract include only the items that should be foced on not all the contract items.

One of the main contract problem is it execution , as the contract most of the time is not been executed by both party , hence a smart contract was design using Marlowe blockchain so that the owner and the contractor both has obligate with the contract . the contract was coded with the part that include the payment and inspect the completed part of the project so the payment is made without any problems.

Smart Contract

This section include designing a smart contract to ensure that the payment is made on time without any loss for both owner and contractor , however there some condition that the both owner and contractor agree on period with progress percentage to make the payment , in addition the owner has to agree if he failed to pay the first invoice , either the contractor stoop the work or take the second invoice with profit from the contractor or proceeding to the second invoice without any action to be made.

The smart contract was design using Marlowe block chain as the following steps:

1- The condition should be write in a step before make it a code this is called pseudo code , the steps for the construction code as shown in table (4-3)

Table (4-3) Code step for smart contract

Input: conditions and term

Output: Smart contract code

Begin

define the condition

if the owner accept the invoice

then

when the owner inspect the building

if the part is not damage

then the owner will transfer the money to the contractor

else

if the property damage

the contractor will transfer the amount of the damage to the owner

else

if

the owner late in the payment to the contractor

then

the owner will pay for the both invoice plus percentage () decide by the contractor

END

Table (4-3) show a simple pseudo code for the payment process , the interface of the program is shown in figure (4-2).

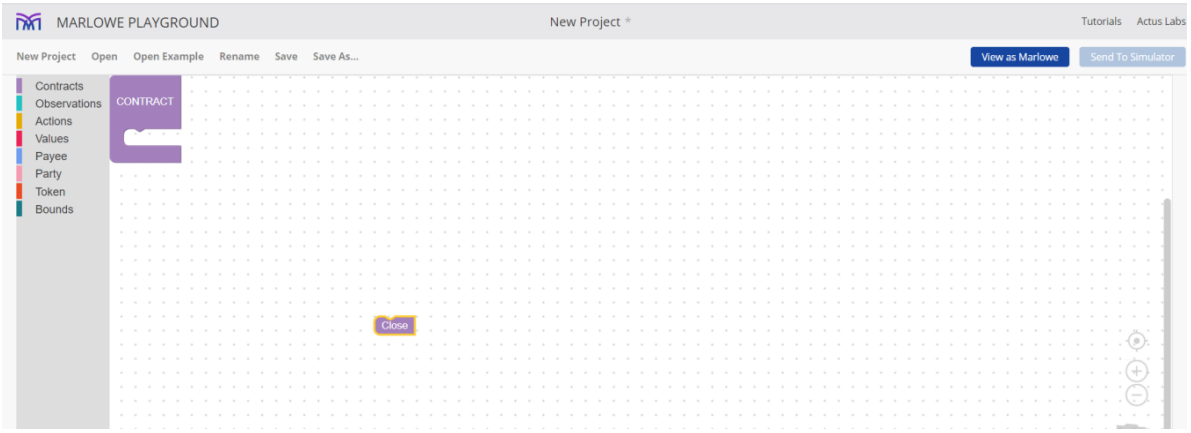


Figure (4-2) Marlowe Playground

The step for creating the smart contract is by combining different block together to form the code , the first step as shown in figure (4-3).

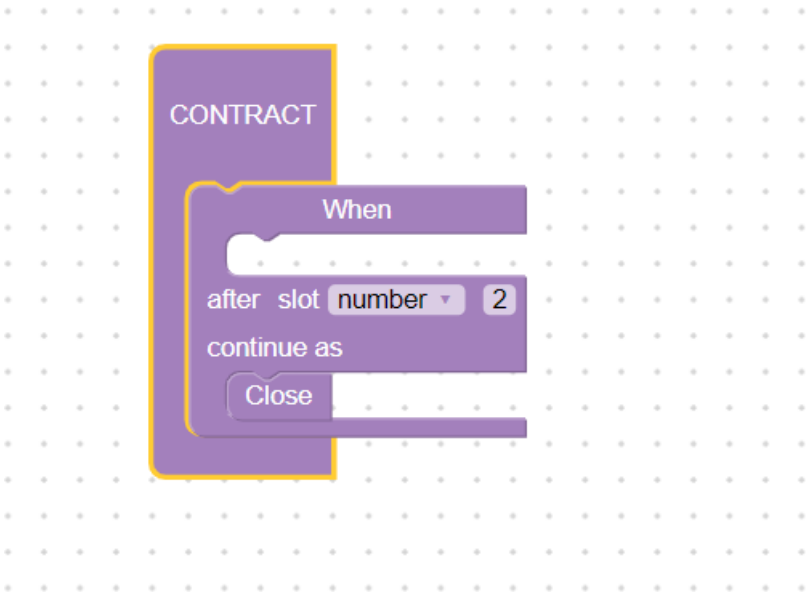


Figure (4-3) Marlowe Playground Contract Starting

Figure (4-3) sate the first part of creating the smart contact , as this block represent the contract start with its first period , in this example it assumed to be the invoice will be proposed after two month.

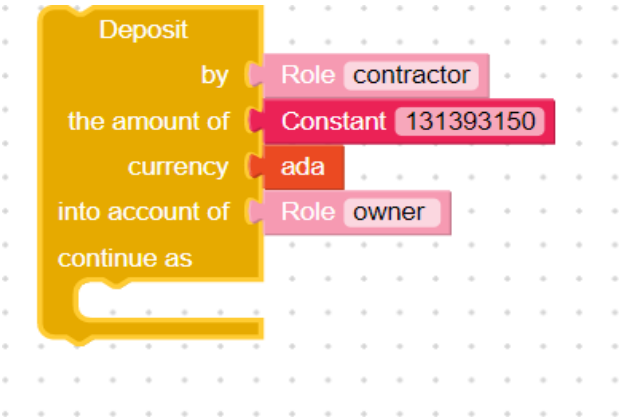


Figure (4-4) Smart Contract Deposit

Figure (4-4) represent the initial deposit of the project , which is the legal insurance that the contractor offer to the owner in the start of the project and if the project terminate these should be return to the contractor.

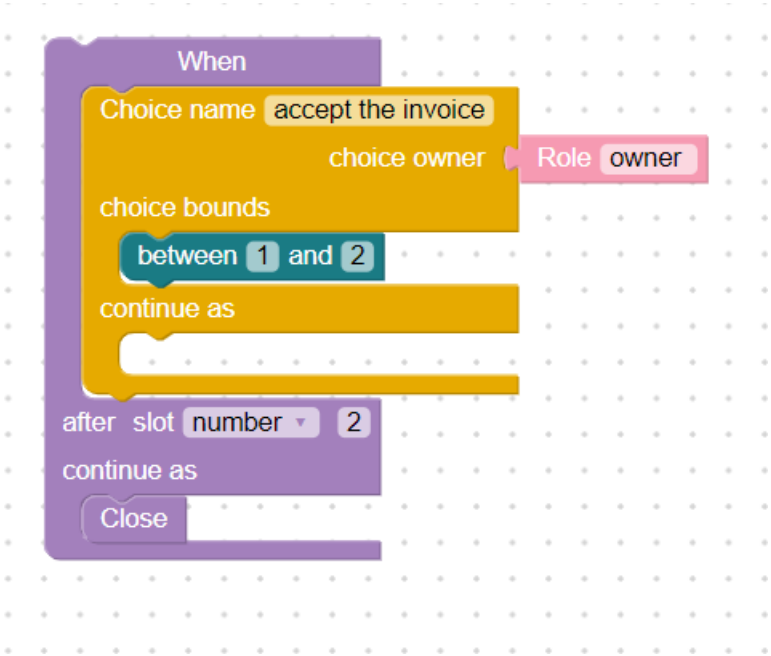


Figure (4-5) Smart Contract Start the Payment

Figure (4-5) indicate the start of the payment and that payment is subject to two condition as stated by the bound that stated as two bound.

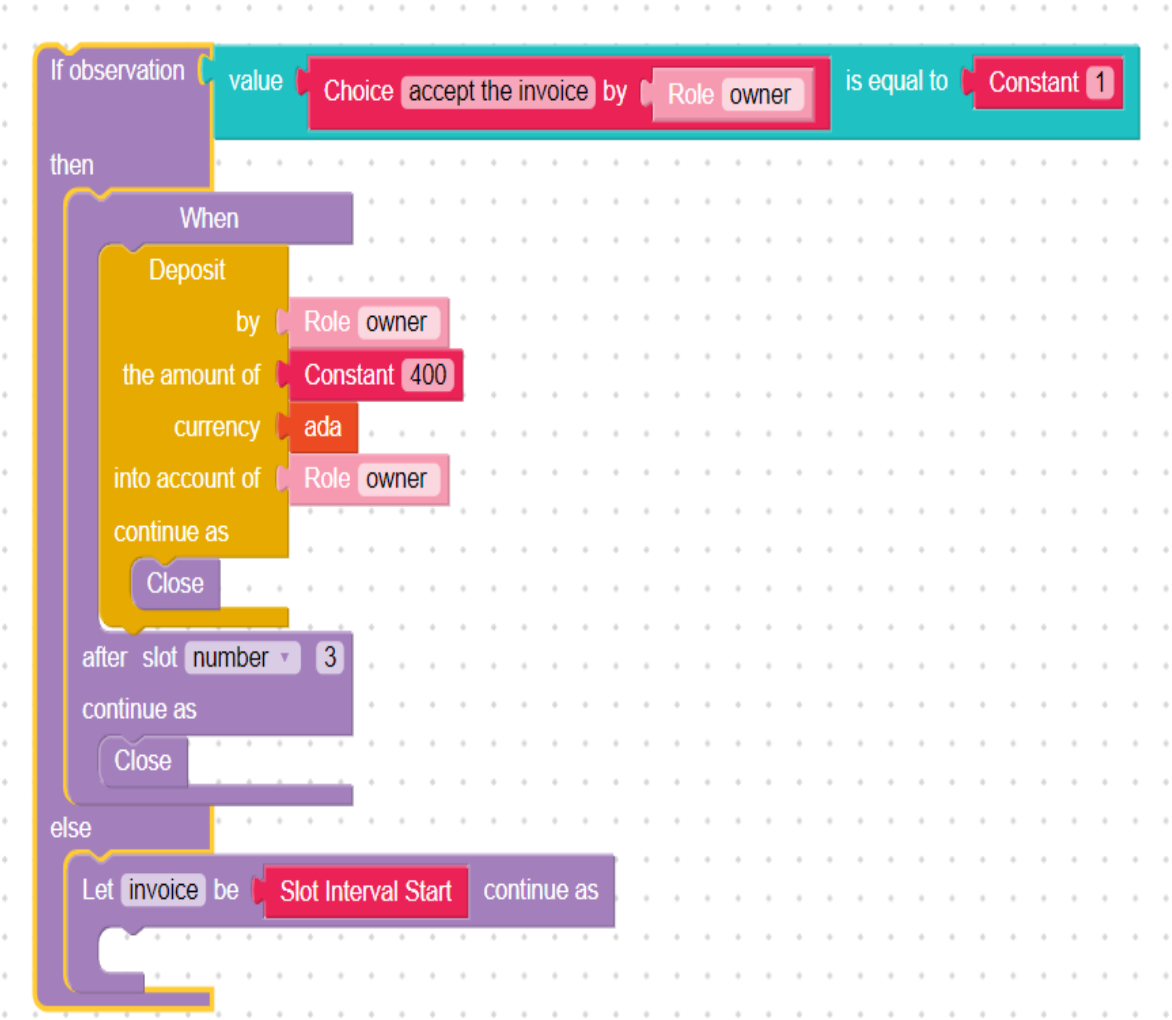


Figure (4-6) Smart Contract Condition

Figure (4-6) state the condition , in the condition its state if the owner check and the amount of work is that provided which is as build is equal to as-planned , and the as build information is been provided by using the camera and modeling the project using Recap software to sell the actual amount of the implemented project , then the invoice fee will transfer from owner account to the contractor account.

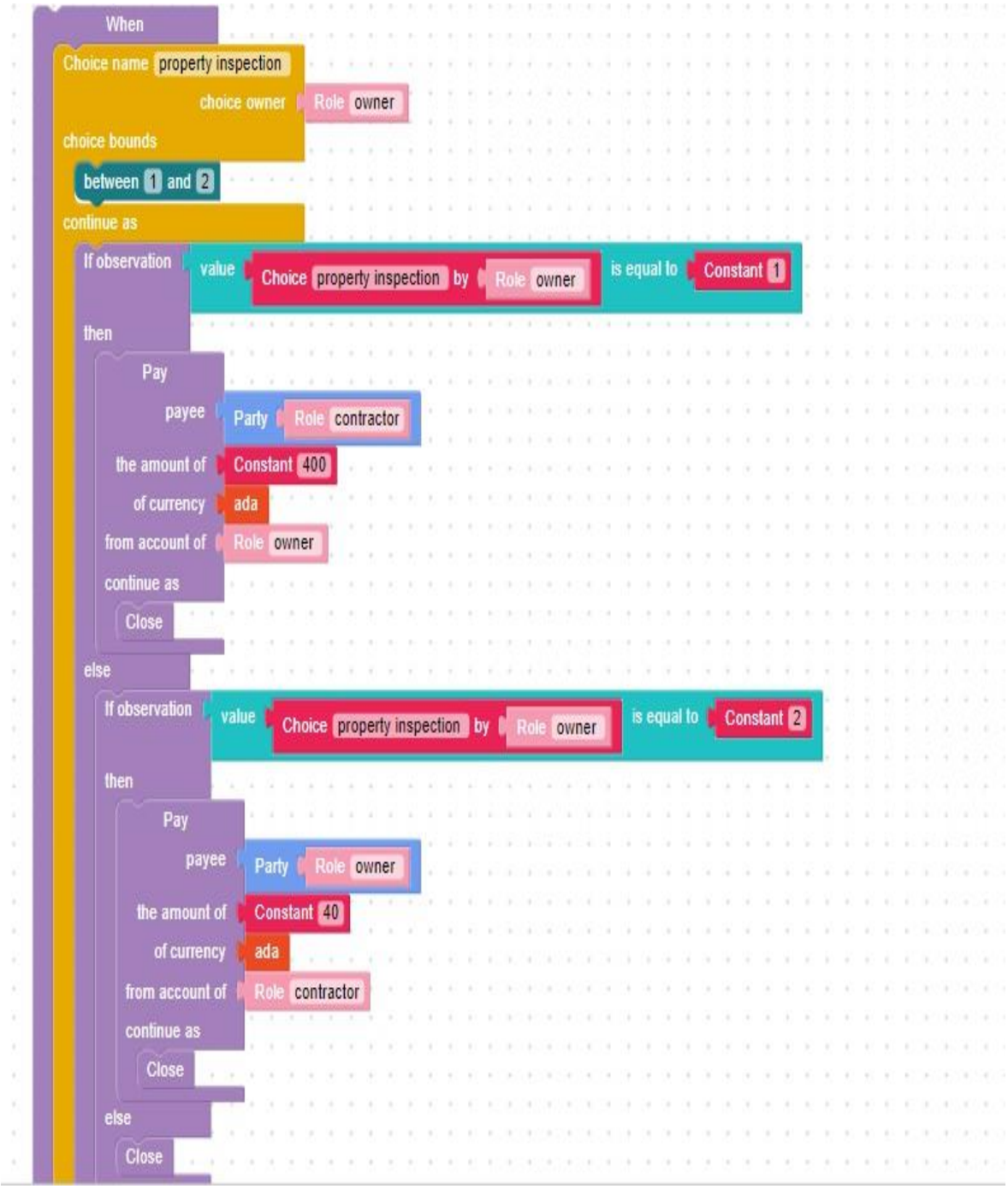


Figure (4-7) Smart Contract Sub Condition

Figure (4-7) indicate the sub condition for the first condition as state that if the quantity as build but before transfer it should check the property as it is not damage , then the payment will be made.

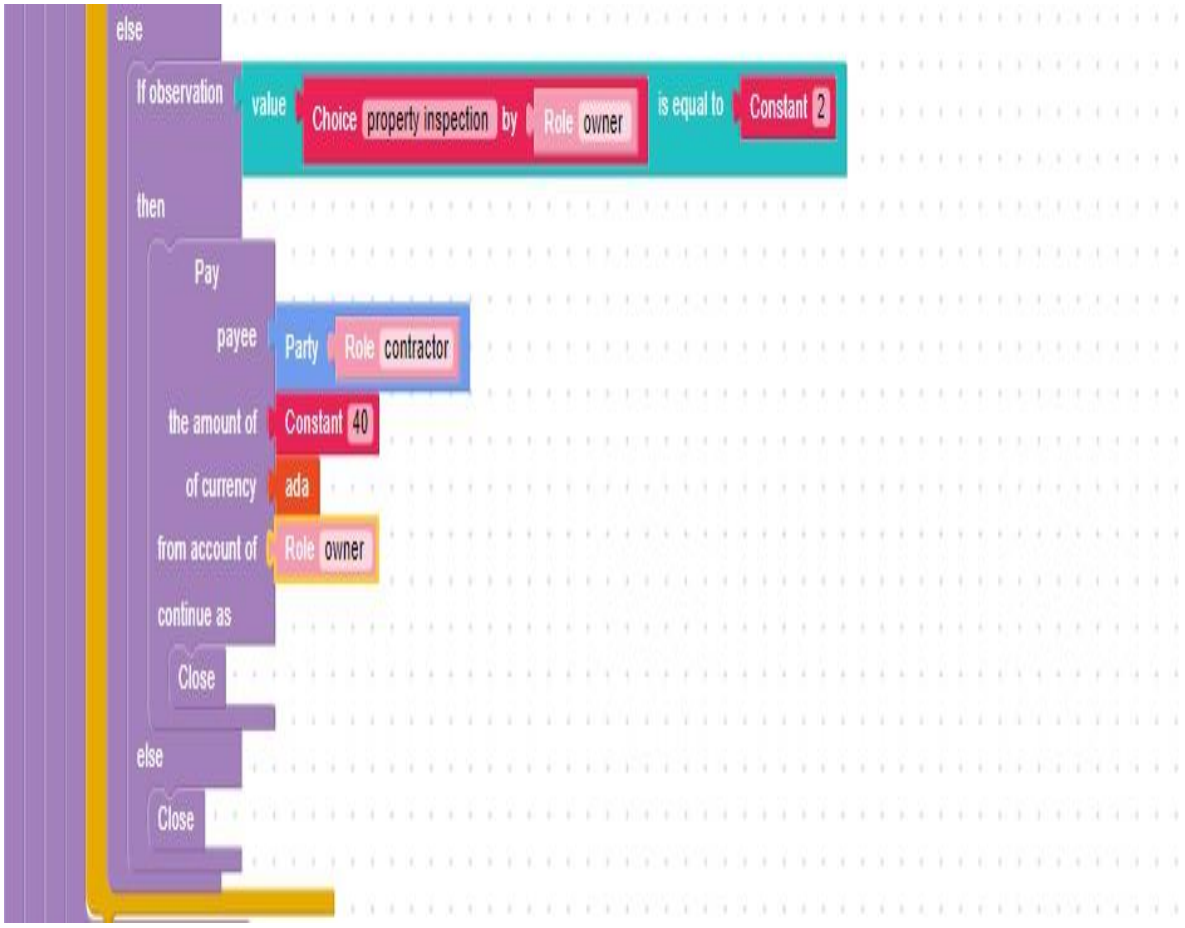


Figure (4-8) Smart Contract Sub Condition2

Figure (4-8) show the sub condition two if the owner didn't accept the inspection and the property was damaged , the owner has to pay for the defect of the work and correct it.

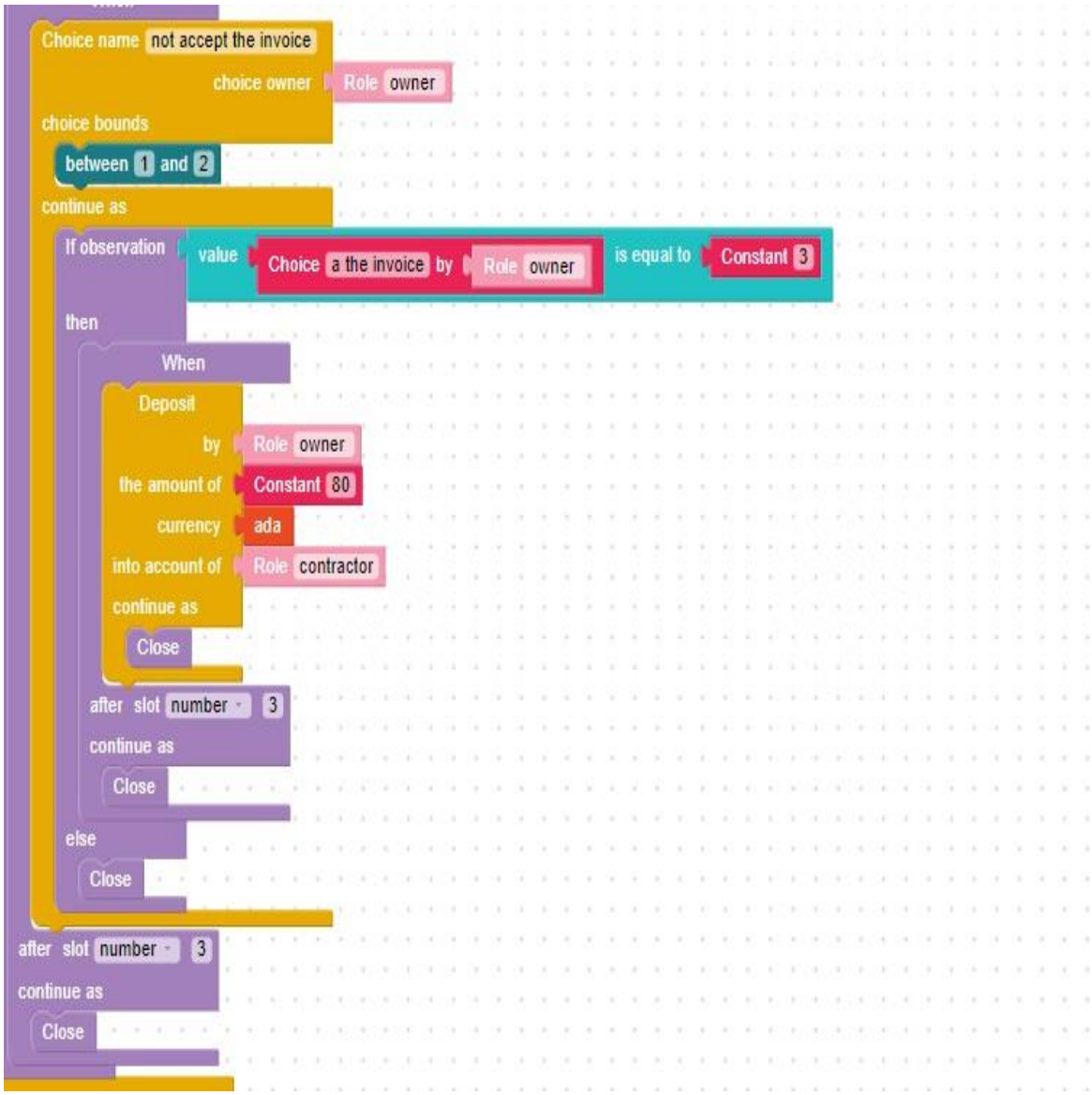


Figure (4-9) Smart Contract Sub Condition3

The figure (4-9)show the second condition of the contract and quantity was not as specified by the Recap , which mean not as-build , then the contractor has to pay or compensate for the different in quantity and pay the different in percentage decided by the both party in beginning of the work , furthermore the owner didn't accept the invoice as its more 20% of the changes or increasing the cost for un acceptable reasons .

Figure (4-10) show the first state of the contract and figure (6-10) show the progress of the contract with each step .

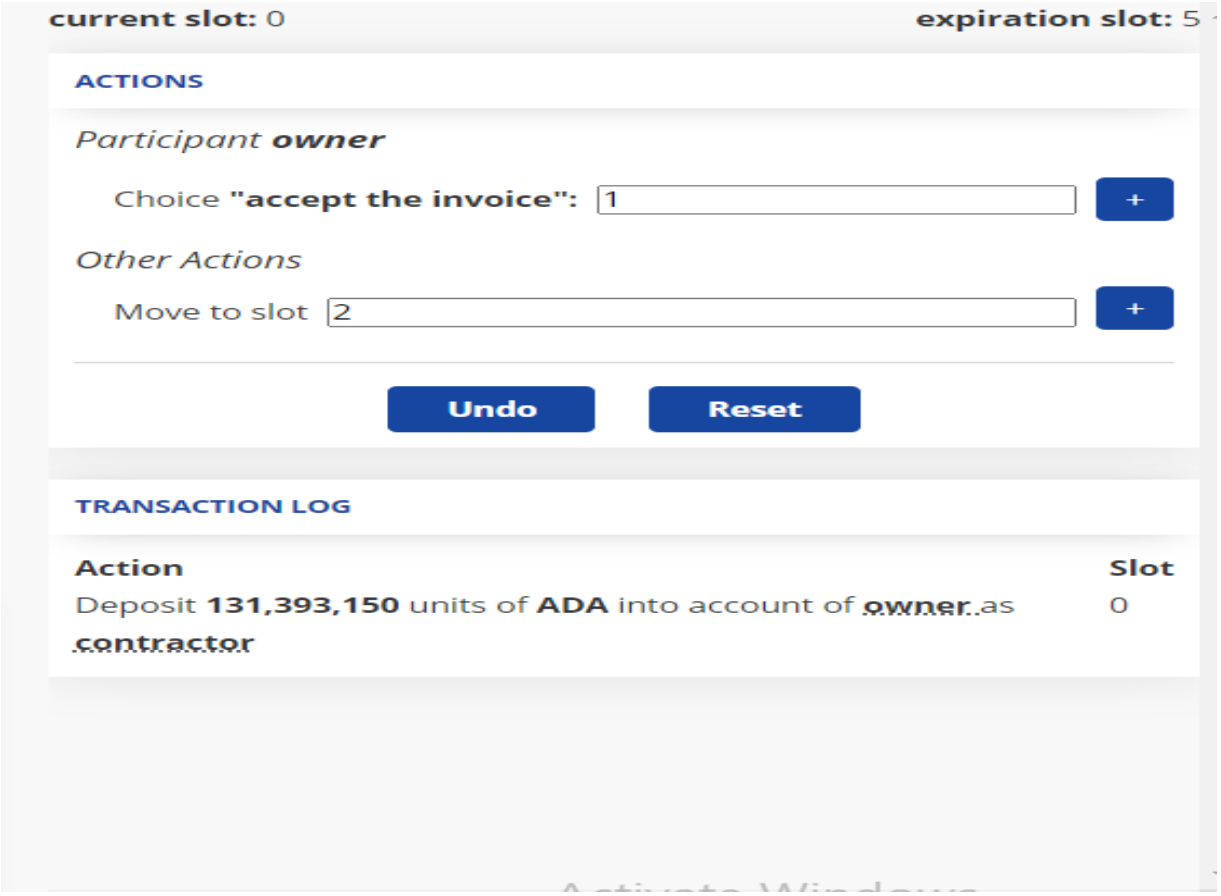


Figure (4-10) Show the First Transection

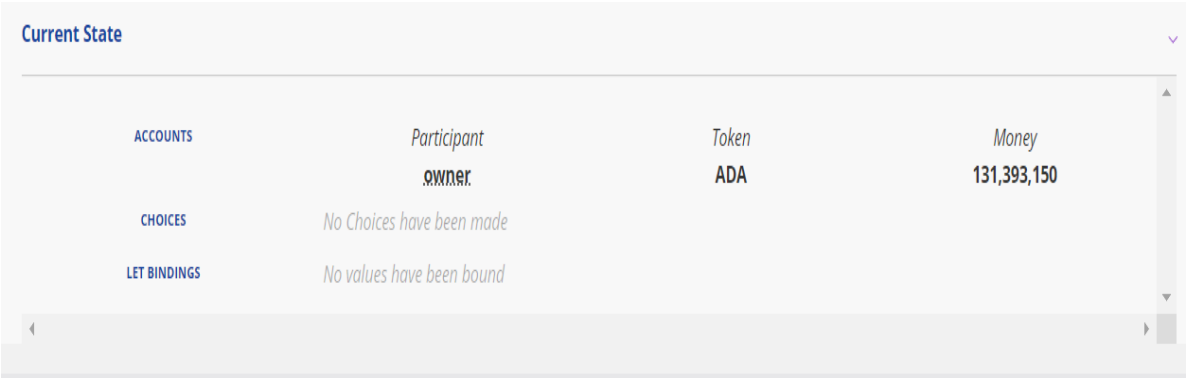


Figure (4-11) Show the First Transection

Figure(4-11) indicate that the legal insurance has been transfer from the contractor to the owner as the first step from starting the project.

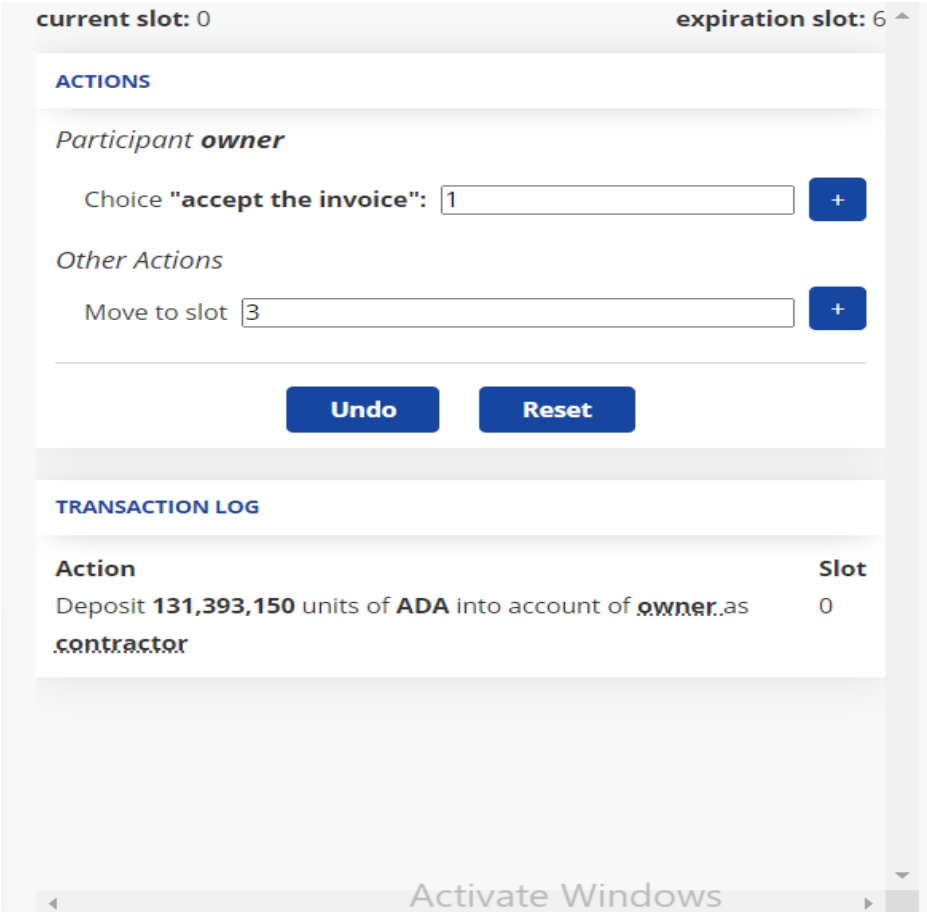


Figure (4-12) Show the Verification of the first condition

Figure (4-12) show if the owner accept the invoice it will lead to second condition which to make property inspection as shown in figure (4-13).

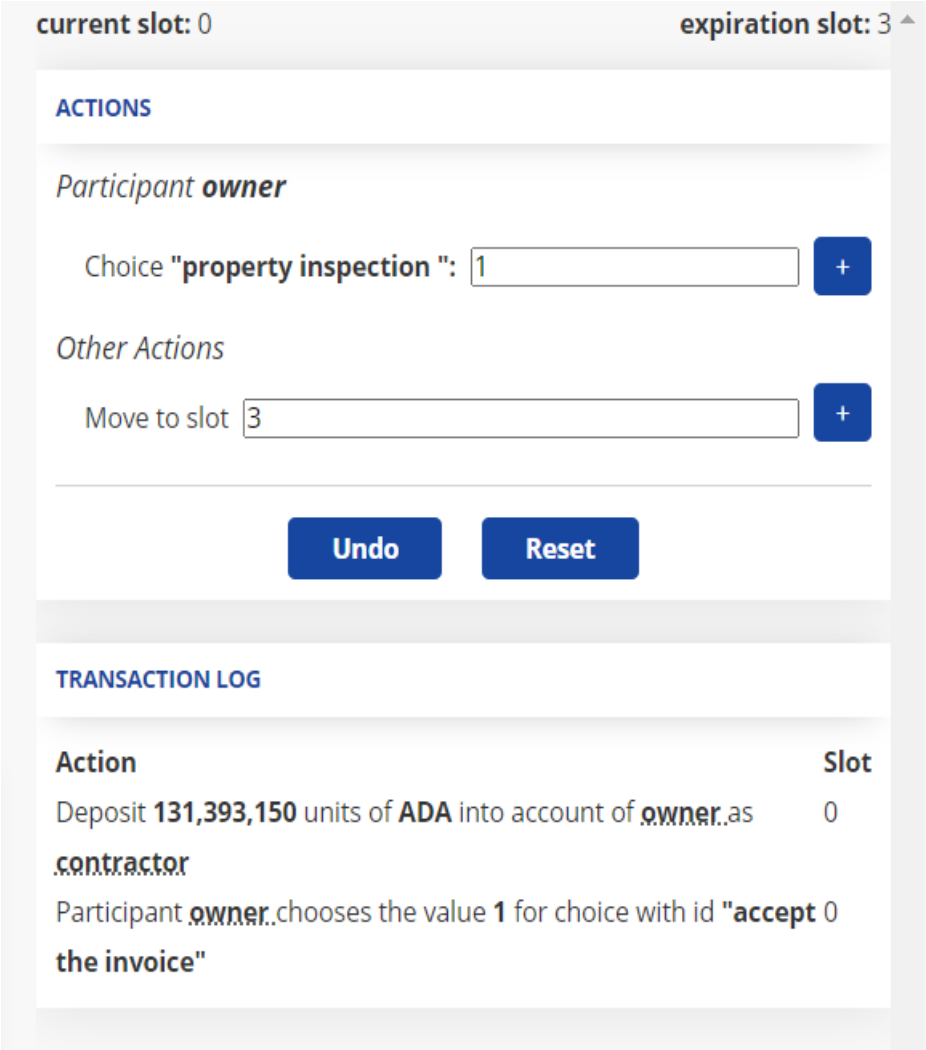
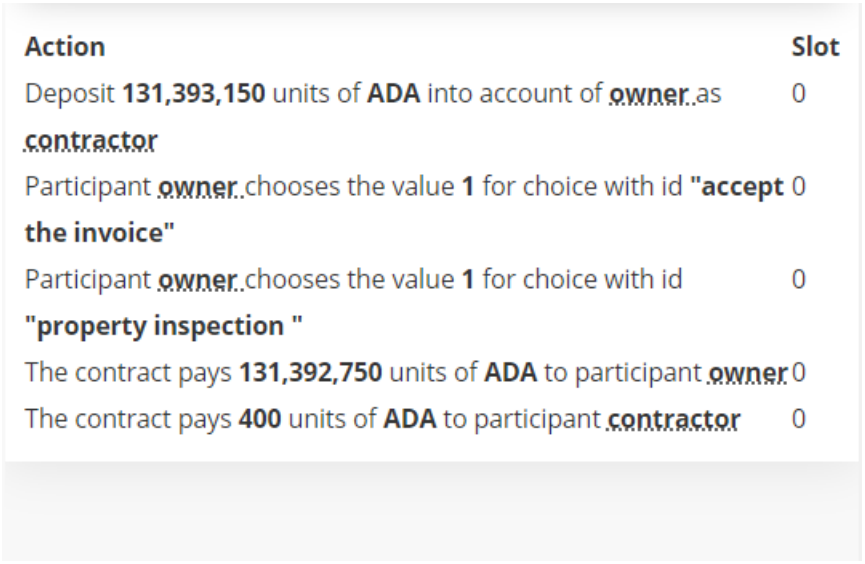


Figure (4-13) Show the Verification of the first sub condition

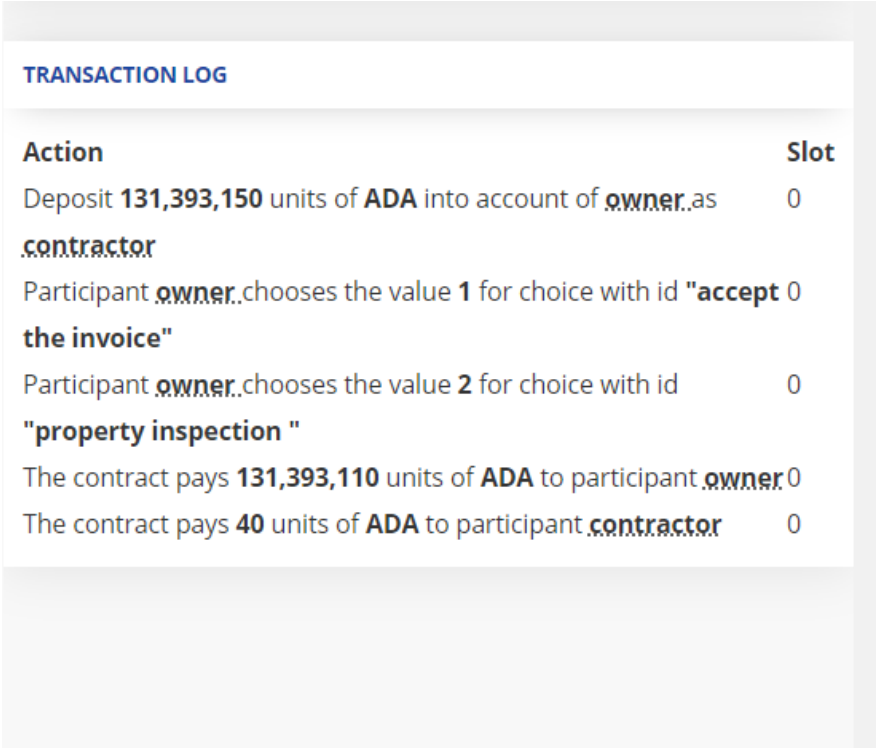
Figure (4-13) show the sub condition and asked which one of the condition verified , which mean dose the property compile with stated if yes chose one and if no chose 2 .

Figure (4-14) and (4-15) show the transection of the both condition if one of them is ensured.



Action	Slot
Deposit **131,393,150** units of **ADA** into account of **owner** as **contractor**	0
Participant **owner** chooses the value **1** for choice with id **"accept the invoice"**	0
Participant **owner** chooses the value **1** for choice with id **"property inspection "**	0
The contract pays **131,392,750** units of **ADA** to participant **owner**	0
The contract pays **400** units of **ADA** to participant **contractor**	0

Figure (4-14) Show the Verification of the first sub condition2A



TRANSACTION LOG

Action	Slot
Deposit **131,393,150** units of **ADA** into account of **owner** as **contractor**	0
Participant **owner** chooses the value **1** for choice with id **"accept the invoice"**	0
Participant **owner** chooses the value **2** for choice with id **"property inspection "**	0
The contract pays **131,393,110** units of **ADA** to participant **owner**	0
The contract pays **40** units of **ADA** to participant **contractor**	0

Figure (4-15) Show the Verification of the first sub condition2b

Figure (4-13) and (4-15) satisfy the sub conditions for the first one after checking the property if the property not damage then a money will transfer from the owner to the contractor with invoice fee else the contractor has to pay for the defect work to the owner.

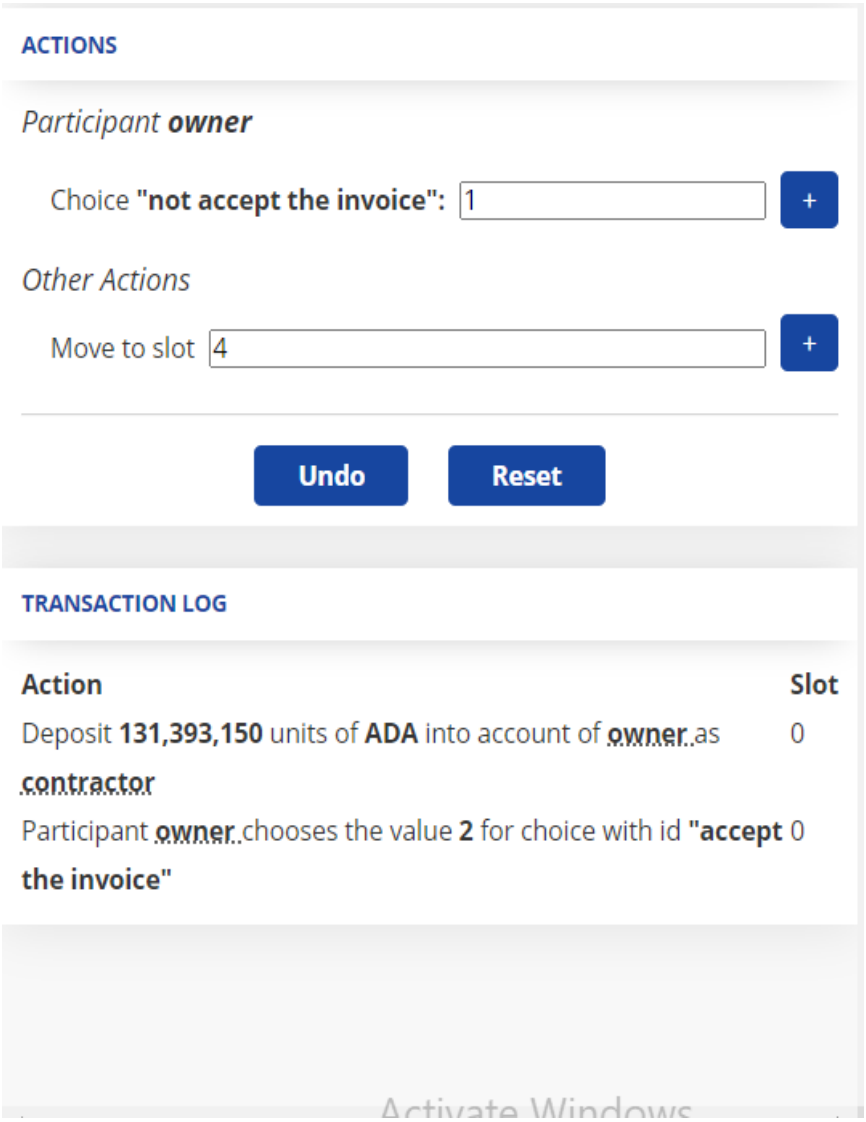
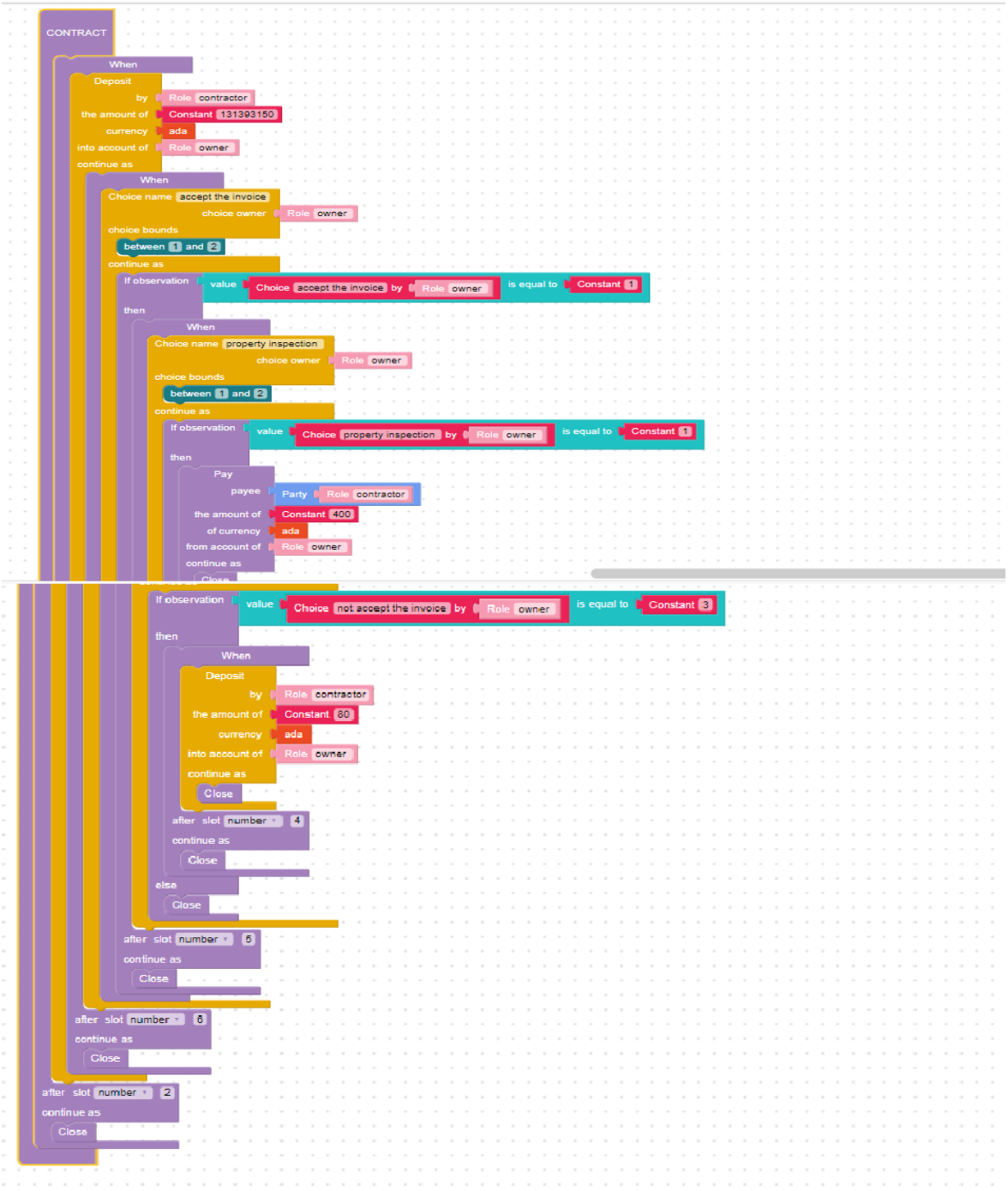


Figure (4-16) Show the Verification of the Second condition

Figure (4-16) show if the owner didn't accept the invoice as the quantity dose not compile with the Recap quantity the contractor has to pay for the different if is more than 20%. The final framework of the contract is shown in figure (4-17) .


CONTRACT
When
Deposit
by Role contractor
the amount of Constant 131393150
currency ada
into account of Role owner
continue as
When
Choice name accept the invoice
choice owner Role owner
choice bounds
between 1 and 2
continue as
If observation value Choice accept the invoice by Role owner is equal to Constant 1
then
When
Choice name property inspection
choice owner Role owner
choice bounds
between 1 and 2
continue as
If observation value Choice property inspection by Role owner is equal to Constant 1
then
Pay
payee Party Role contractor
the amount of Constant 400
of currency ada
from account of Role owner
continue as
Close
If observation value Choice not accept the invoice by Role owner is equal to Constant 3
then
When
Deposit
by Role contractor
the amount of Constant 80
currency ada
into account of Role owner
continue as
Close
after slot number 4
continue as
Close
else
Close
after slot number 5
continue as
Close
after slot number 6
continue as
Close
after slot number 2
continue as
Close

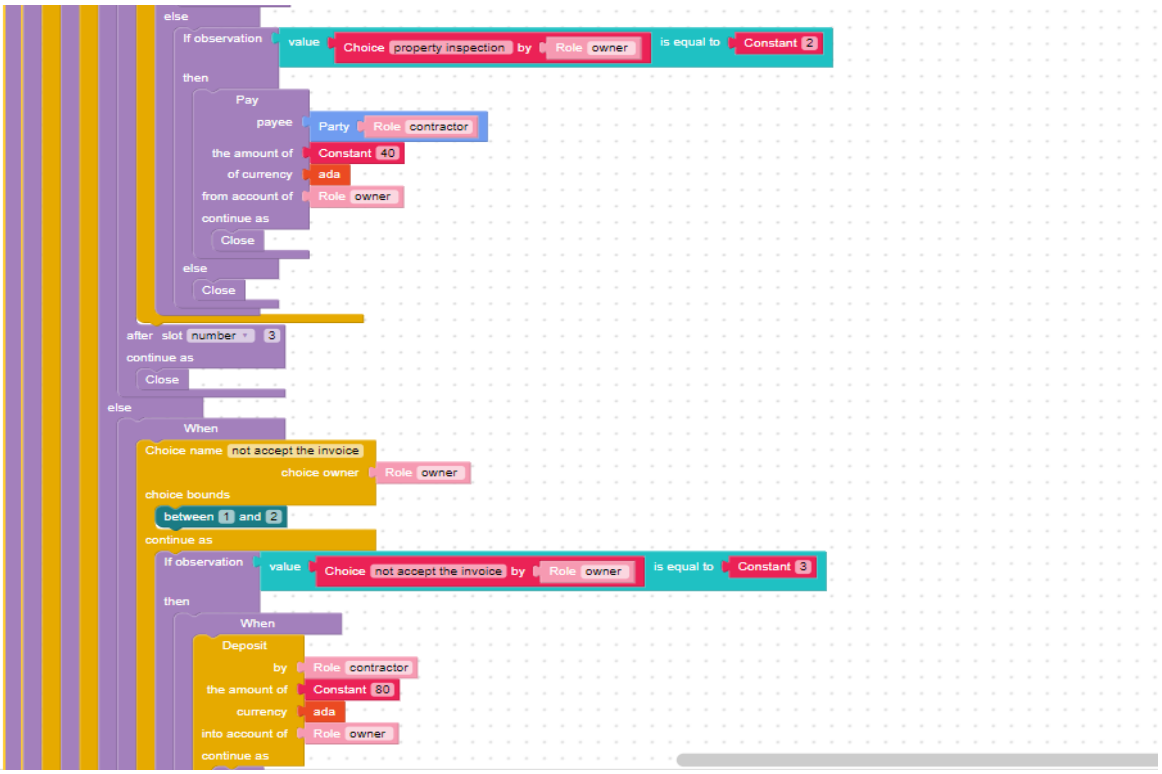


Figure (4-17) Show the Verification of the Second condition

Figure (4-17) show the whole contract format only for the first invoice and property inspection.

Summery

The summery of the chapter indicate that the contract cause the main problems in the projects and should be manage with right terms and conditions and design a smart contract that enforce its self through code and conditions that perceives both owner and contractor rights.

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