<Development of Green supply chain Evaluation System>

Environmental Defense Fund

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EDF Climate Corps embeds trained graduate students in organizations to help meet their energy goals by accelerating clean energy projects in their facilities.

The following report is the result of a <10> week Climate Corps fellowship at <Changhong>.

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OVERVIEW AND BACKGROUND

Established in 1958, Organization Changhong has been the best-selling of TV in Chinese market for recently 18 consecutive years. It has witnessed significant prosperity and is now one of the largest Chinese consumer electronics and home appliances providers headquartered in Mianyang, Sichuan.

Changhong is one of the earliest enterprises engaged in green supply chain management in China. At present, Changhong has formed a product life cycle industrial chain from R&D, design, procurement, manufacturing, sales to recycling. In 2017, Changhong is selected as the first green supply chain demonstration enterprise of the Ministry of Industry and Information Technology. My fellowship focused on the development of green supply chain evaluation system:

- Collect and analyze the index data of each link in the green supply chain
- Build the green supply chain database
- Develop the application interface of evaluation system

In order to create a green supply chain, Changhong began the transformation of intelligent manufacturing through the strategy of “IE +AT+IT” in 2015. Now, Changhong is promoting intelligent manufacturing in many factories and has achieved remarkable results. Among them, television products have achieved a site utilization rate increase of more than 30%, inventory turnover efficiency increase of more than 25%, unit cost reduction of 10%, per capita output value increase of more than 20%.

CTO Dan Yang, publicly announced that Changhong will build a "Intelligent System Management Platform" in the future where data from the front-end user needs to Changhong's intelligent transactions, intelligent research and development, intelligent manufacturing will be fully accessed, and the production equipment will no longer be a single, independent individual, and data will flow between different equipment. In the whole industry chain flow, Changhong will realize from the internal industry synergy to the external industry chain synergy, from a larger dimension to achieve integration synergy, to achieve lower cost, higher efficiency, and become a truly data-driven smart enterprise.

A team call “the circular economy research department” is making plans for this "Intelligent System Management Platform" to further promote the greening and efficiency of productive and manufacturing process. As a member of the team, I was asked to develop an evaluation platform for the green supply chain to reflect the operational quality and efficiency of the chain. In the last two weeks, I found that the information asymmetry and opacity still existed in every link of the supply chain. So I have tried to develop a decentralized application called “Supplychain Blockchain Demo” with the technology of blockchain. and I hope Changhong could apply this technology to the entire green supply chain process in the future.

RECOMMENDED SUSTANABILITY ENGAGEMENT PROJECTS

The following sustainability engagement projects are projects that I have divided this green evaluation system into several parts for further understanding the whole system software development process, development language and development framework. A summary table of these recommended parts is below, with detailed descriptions of each project in the following section.

Project	Part name	development language	development environment	development framework	Development purpose
Part 1	Establishment of Database	MySQL	Windows	N/A	Store collected supply chain index data
Part 2	Development of Main Page	HTML/CSS	Windows	ExtJS/SpringMVC /SpringBoot	The display of various supply chain subsystems
Part 3	Development of Evaluation Page	Java/JavaScript /JSP	Windows	ExtJS/SpringMVC /SpringBoot	Expert scoring of indicator data
Part 4	Development of Comprehensive Score Table	Java/JavaScript /JSP	Windows	ExtJS/SpringMVC /SpringBoot	Show and output the final score table
Part 5	Development of Data Input Interface	Java/JavaScript /JSP	Windows	ExtJS/SpringMVC /SpringBoot	Edit and modify the index data directly through the user interface
Part 6	Development of “Supplychain Blockchain Demo”	Solidity/JavaScript /HTML	Linux	Truffle	Apply the technology of blockchain to the supply chain

INDIVIDUAL PROJECT OVERVIEW

Part 1 (Establishment of Database)

Basic Project Information

In order to develop a complete WEB application, I need to establish a system database and evaluation index database on the server side. For the system database, I adopt the original database development framework of IT department of Changhong. For the evaluation index database, I develop it according to the specific function modules of the supply chain evaluation system.

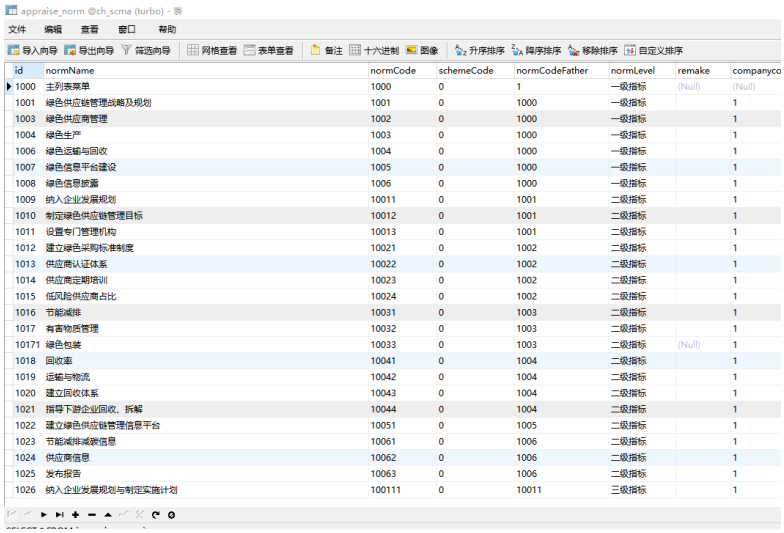
Project Details

The database is called" ch_scma", system data field and supply chain index data field was put in the MySQL database. As shown in the figure1, I use the SQL command to query the database.

```
mysql> show tables;
+--------------------------+
| Tables_in_ch_scma        |
+--------------------------+
| appraise_norm            |
| appraise_norm_data       |
| appraise_norm_file       |
| appraise_norm_score      |
| appraise_scheme          |
| appraisescoreprinciple   |
| list_analyze             |
| sys_employee             |
| sys_employeeorganization |
| sys_employeerole         |
| sys_model                |
| sys_organization         |
| sys_parameter            |
| sys_role                 |
| sys_rolemodel            |
+--------------------------+
```

Figure 1 "ch_scma" database

In order to observe the MySQL database more intuitively, I used the software called "Navigate for MySQL" to analyze and operate the data table. As shown in figure 2, the collected evaluation indicator data fields (Table name: "appraise_norm") are fully placed into the database.



id	normName	normCode	schemeCode	normCodeFather	normLevel	remake	companyco
1000	主列表菜单	1000	0	1	一级指标	(Null)	(Null)
1001	绿色供应链管理战略及规划	1001	0	1000	一级指标		1
1003	绿色供应商管理	1002	0	1000	一级指标		1
1004	绿色生产	1003	0	1000	一级指标		1
1006	绿色运输与回收	1004	0	1000	一级指标		1
1007	绿色信息平台建设	1005	0	1000	一级指标		1
1008	绿色信息披露	1006	0	1000	一级指标		1
1009	纳入企业发展规划	10011	0	1001	二级指标		1
1010	制定绿色供应链管理目标	10012	0	1001	二级指标		1
1011	设置专门管理机构	10013	0	1001	二级指标		1
1012	建立绿色采购标准制度	10021	0	1002	二级指标		1
1013	供应商认证体系	10022	0	1002	二级指标		1
1014	供应商定期培训	10023	0	1002	二级指标		1
1015	低风险供应商占比	10024	0	1002	二级指标		1
1016	节能减排	10031	0	1003	二级指标		1
1017	有害物质管理	10032	0	1003	二级指标		1
10171	绿色包装	10033	0	1003	二级指标	(Null)	1
1018	回收率	10041	0	1004	二级指标		1
1019	运输与物流	10042	0	1004	二级指标		1
1020	建立回收体系	10043	0	1004	二级指标		1
1021	指导下游企业回收、拆解	10044	0	1004	二级指标		1
1022	建立绿色供应链管理信息平台	10051	0	1005	二级指标		1
1023	节能减排减碳信息	10061	0	1006	二级指标		1
1024	供应商信息	10062	0	1006	二级指标		1
1025	发布报告	10063	0	1006	二级指标		1
1026	纳入企业发展规划与制定实施计划	100111	0	10011	三级指标		1

Figure 2 "appraise_norm" table

Part 2 (Development of Main Page)

Basic Project Information

The development of the main page is mainly used to display the system platforms of each link of the green supply chain of Changhong, which also indicates the informatization, automation, compositive change of the supply chain.

Project Details

I divided the supply chain into six parts based on the data collected from the supply chain indicators. They are classified as Green Manufacturing(MES), Green Purchasing(SRM), Green Transportation(LES), Green Information(CRM), Green Trading(USO) and Green Designing. Every icon represents a network link, so when you click an icon then you will have access to the corresponding supply chain system.

Figure 3 "Main Page"

For example, if you click the "SRM" icon, then you will enter in the information platform of Changhong Green Purchasing.

Figure 4 Green Purchasing(SRM)

Part 3 (Development of Evaluation Page)

Basic Project Information

This evaluation system is a subsystem of the “Green Supply Chain” national project that Changhong has applied, So when the experts check the national project in the future, the evaluation system should guarantee that the collected index data of the green supply chain can be evaluated on this page. In addition, the various data shown on this page are synchronized with the MySQL database in real time.

Project Details

The evaluation page is divided into four panels: Evaluation indicators of supply chain(Position: left panel), Expert scoring(Position: top panel), Data list(Position: center panel), File list(Position: bottom panel). And the data on the page almost comes from the database except the scoring text-field in the top panel where expert could enter the score of each index after looking at the specific data(in the Data list or File list) and evaluation criteria(in the Expert scoring) of each supply chain indicator.
As shown in the figure, when we click on the "energy conservation and environmental compliance" indicator, this is the corresponding evaluation page:

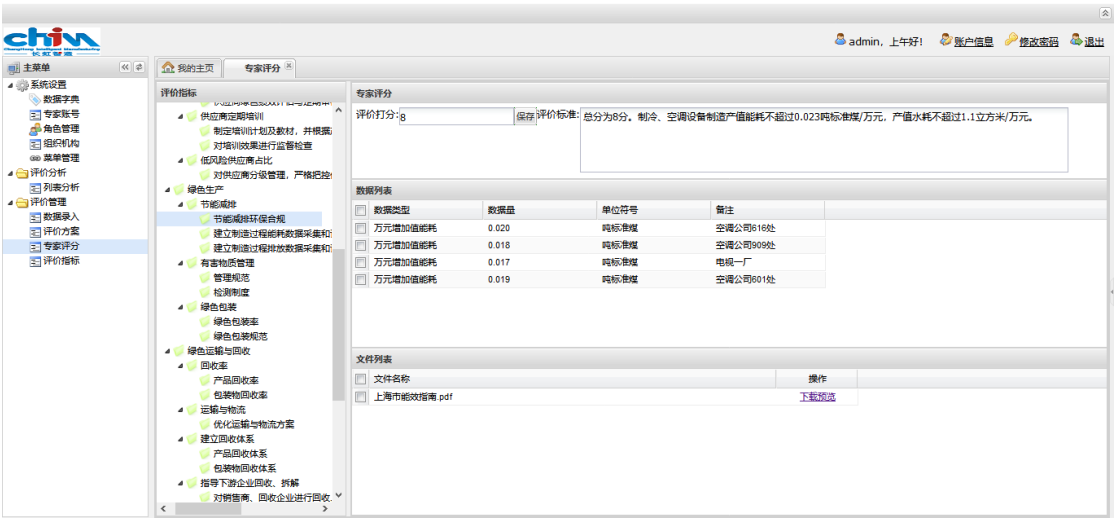


Figure 5 "energy conservation and environmental compliance" page

- Evaluation indicators of supply chain(Position: left panel): It is a tree panel where the indicator data is divided into three levels. For example, the second index “energy-saving and carbon emission” is the father node of the third index "energy conservation and environmental compliance", and the first index “Green manufacturing” is the father node of “energy-saving and carbon emission”. For each click on a third index, the entire page's dataset is refreshed.
- Expert scoring(Position: top panel): It shows the scoring criteria for each indicator data, and it's where experts can evaluate and score the data.
- Data list(Position: center panel): It shows the specific data of each subsidiary in the supply chain under the corresponding evaluation index.
- File list(Position: bottom panel): It shows the specific text files of the corresponding evaluation index and the expert can read or download them.

Part 4 (Development of Comprehensive Score Table)

Basic Project Information

After the experts have finished scoring all the supply chain indicators, the score data will be synchronized to the comprehensive score table interface. You can get different experts' ratings by dropping the combo-box, and you can edit and modify the score table by “creating”, “editing” and “deleting” three buttons. Finally, the synthesis score table is saved as a excel file into the system hard disk by the “export excel file” button.

Project Details

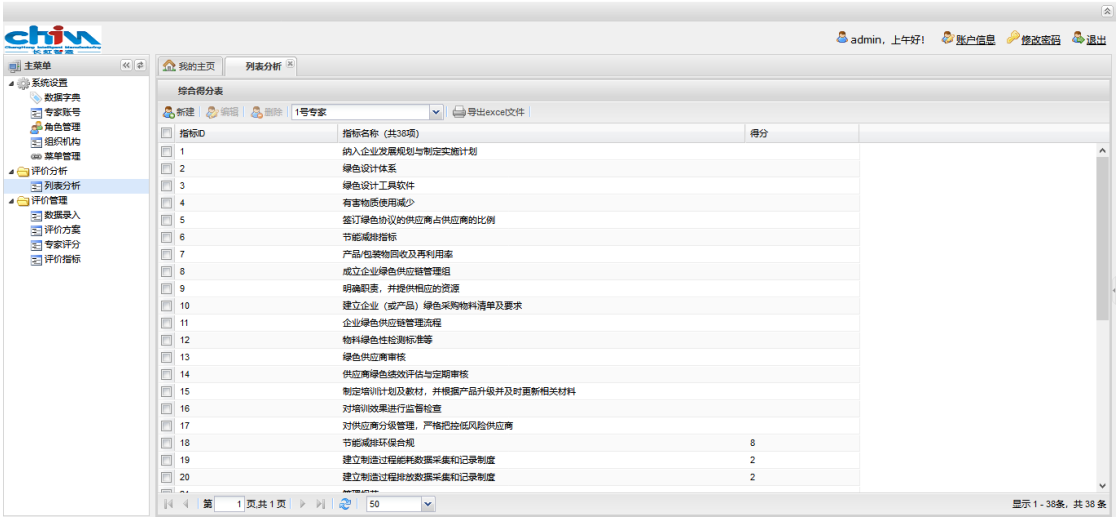


Figure 6 " Comprehensive Score Table " page

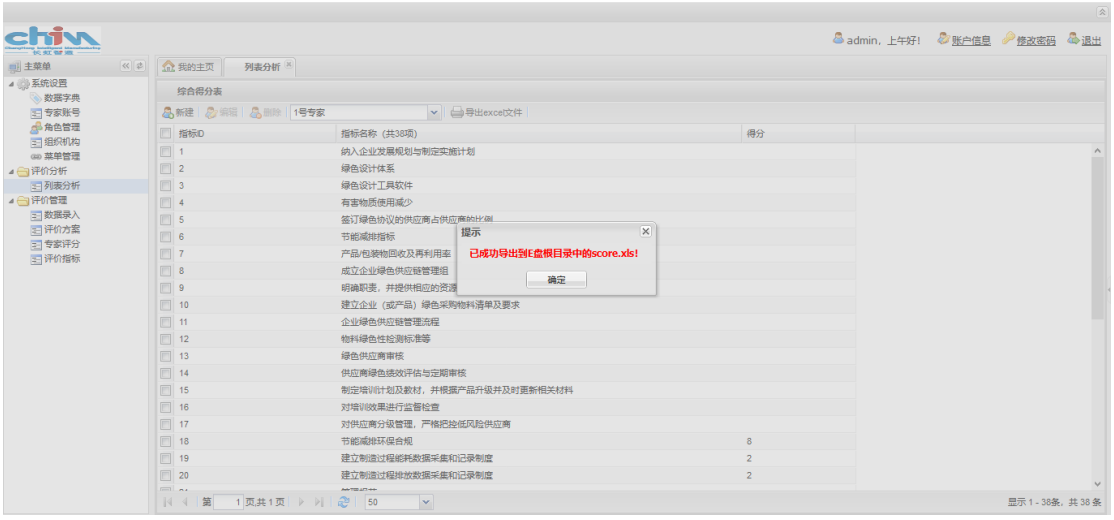


Figure 7 after clicking “export excel file” button page

- “Experts combo-box”: It shows different experts' evaluation and scoring of supply chain.
- “creating” button: Admin can add extra data bars for statistical analysis of score tables.
- “editing” button: Admin can edit the index data in the original index database.
- “deleting” button: Admin can delete extra data bars created by “creating” button.

- “export excel file” button: The comprehensive score table of different experts can be saved in the computer hard disk and provided to the company for later research and analysis.

Part 5 (Development of Data Input Interface)

Basic Project Information

Usually Data sources for "Data list" and "File list" in the expert evaluation page are entered into the database through SQL statements. I developed a separate input interface to make it easier for system managers to input data into the system database

Project Details

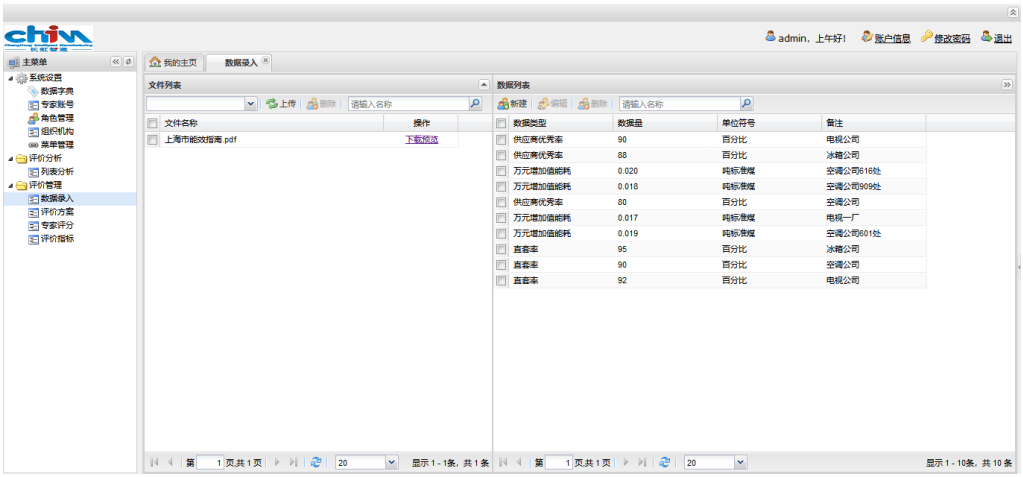


Figure 8 “Data Input Interface” page

- “File list”(left panel): Admin can input file texts for each supply chain index data.
- “Data list”(right panel): Admin can input quantitative data for each supply chain data.

“File list”:

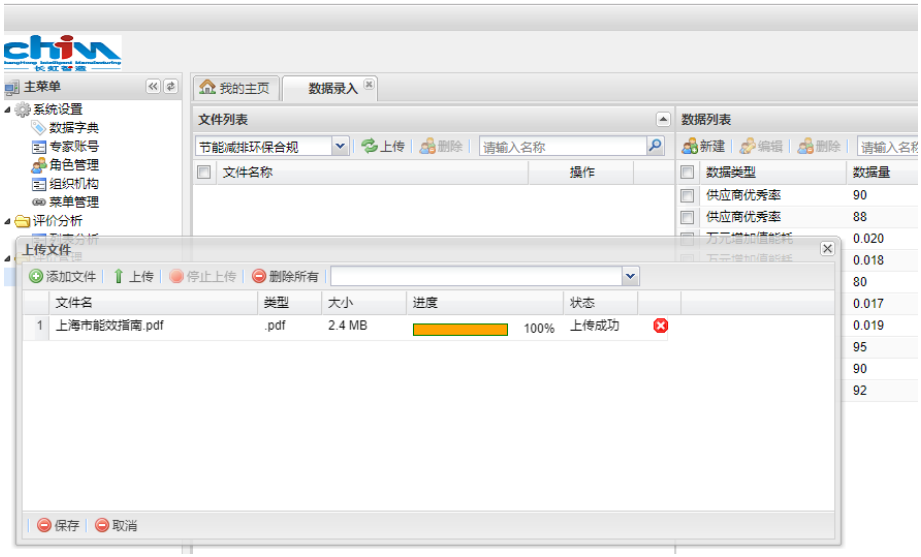


Figure 9 “File upload” button

- “Add file”: Admin can choose the corresponding index file from the computer hard disk.
- “Upload”: Admin can upload the selected index file from the computer hard disk.
- “Delete all ”: Admin can delete all file texts for each supply chain index data.
- “Save”: Admin can save file texts for each supply chain index data.

“Data list”:

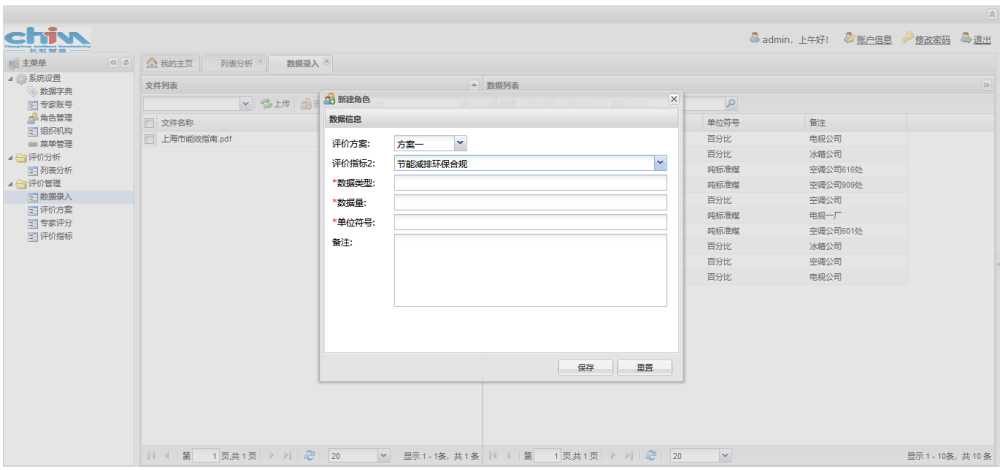


Figure 10 “Create newrole” button

- “Create newrole”: Admin enters data into the database according to a certain data format like “selected evaluation index”, “data type”, “data amount”, “unit” and “remark”.

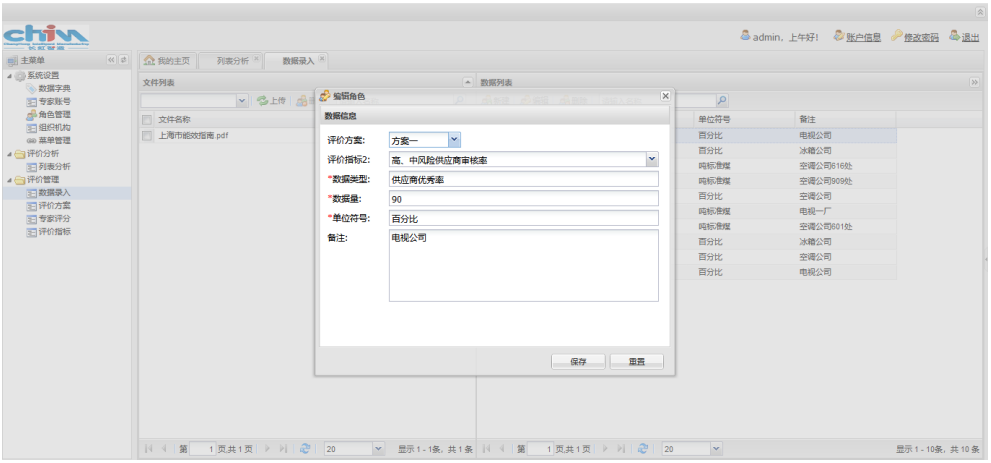


Figure 11 “Edit role” button

- “Edit role”: Admin can edit the selected data in the same data format created by the “Create newrole” button.

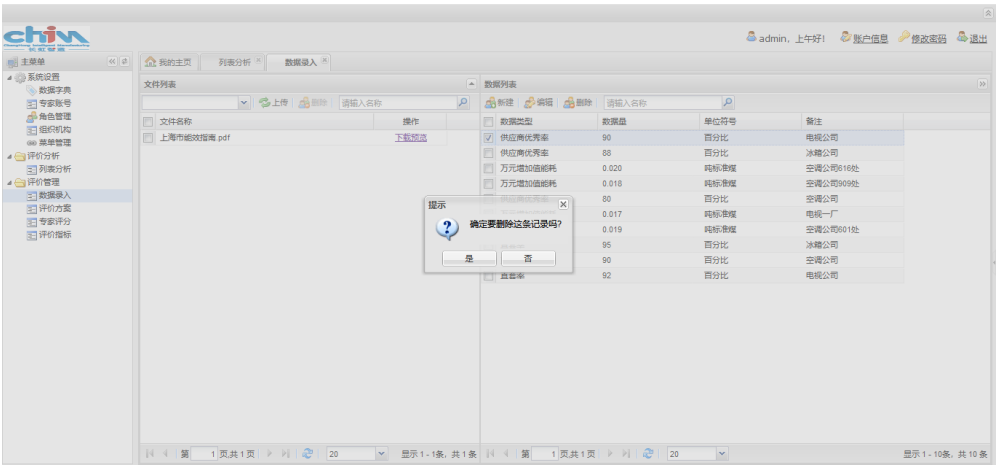


Figure 12 "Delete role" button

- "Delete role": Admin can delete the selected data that exists in the database.

Part 6 (Development of "Supplychain Blockchain Demo")

Basic Project Information

Every link of the supply chain still has the shortcomings of information asymmetry and opacity. So I tried to apply the technology of blockchain and develop a decentralized application called "Supplychain Blockchain Demo" to solve this problem. The dapp called "coffee-supplychain-etherum" gave me lots of inspirations and you can see its source code in the https://github.com/imperialsoftech/coffee-supplychain-ethereum. .

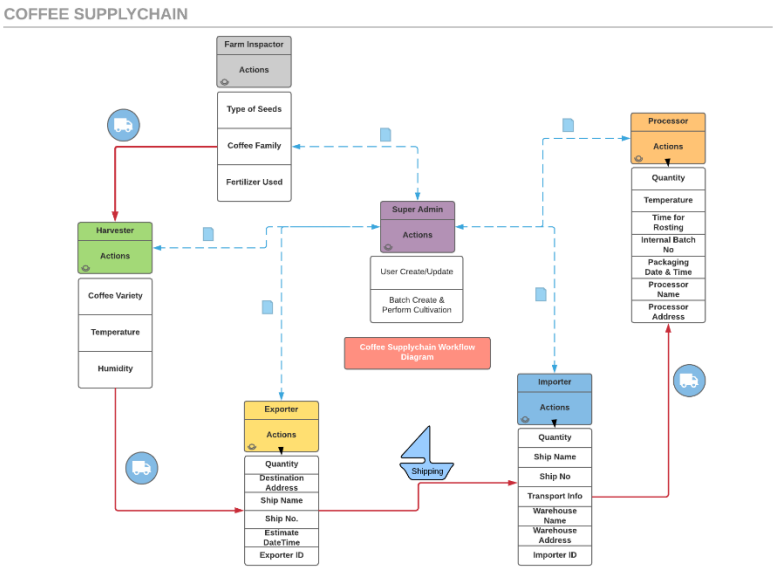


Figure 13 Coffee Supplychain

Project Details

My dapp is also developed in the etherum network, and this application is divided into four stages: Supplychain platform, Supplier, Manufacture and Distributor.

(1) writing the smart contracts and using Ganache to verify that smart contracts can be deployed on a block chain:

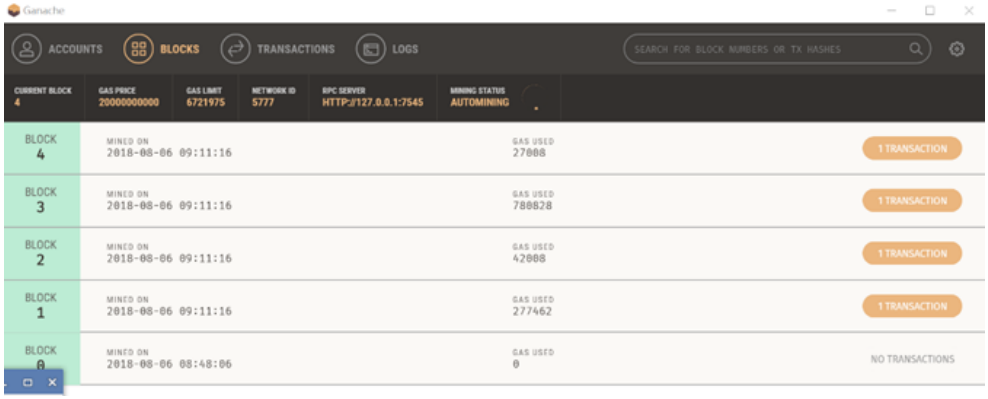


Figure 14 Verify "SupplychainRegister.sol"

(2) Debugging the front-end logical programs for the smart contracts:

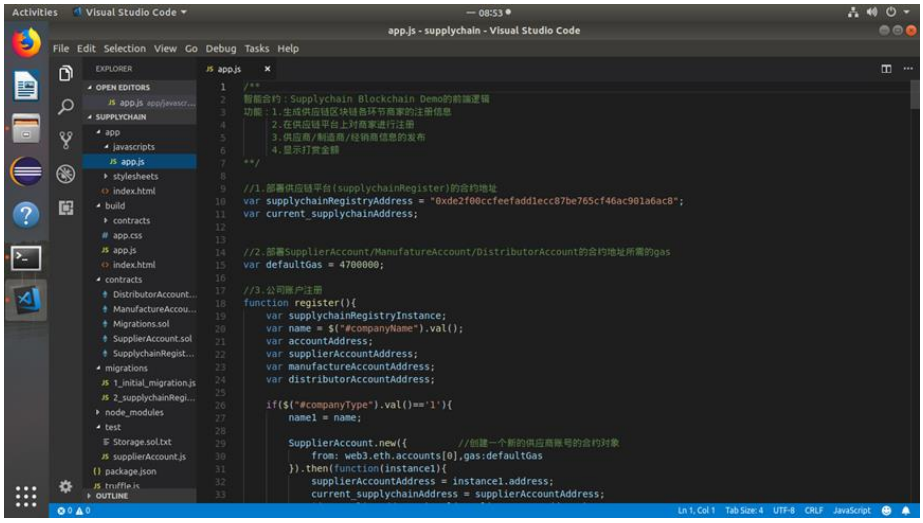
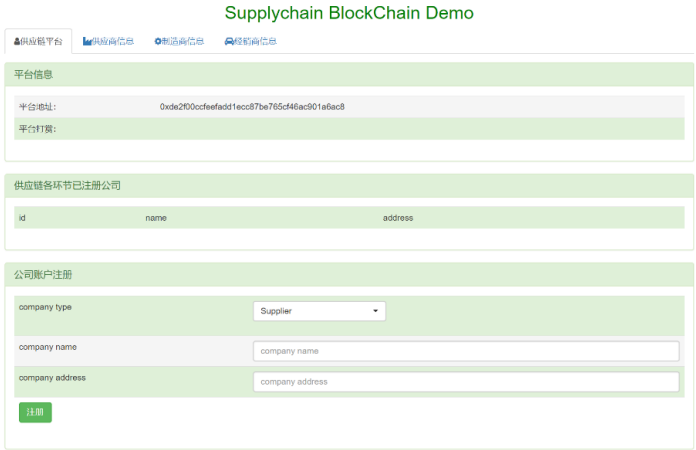


Figure 15 Debug "App.js"

(3) Develop Web interface to display the function of decentralized application:



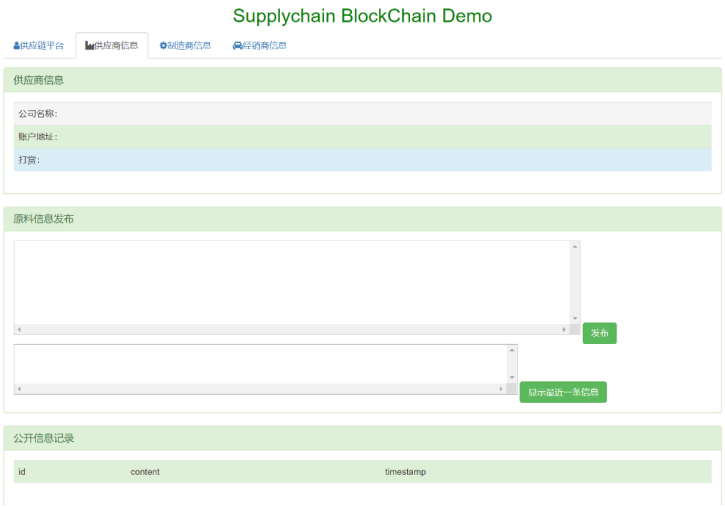


Figure 16 "Supplychain Blockchain Demo" page

- "Register" button: User can register all companies' information: company type, company name, company address.
- "Publish" button: Supplier/Manufacture/Distributor publishes their product information in real time.
- "Show last message" button: Display the last message published by Supplier/Manufacturer/Distributor.

Noted:

I set up the account address(0xde2f00ccfeefadd1ecc87be765cf46ac901a6ac8) of the supply chain platform randomly in the app.js file, so the platform account will not contain any tokens like ether. And the function of "Register" "Publish" and "Show last message" will consume gas when you enter information in the Ethernet network. Thus it is not yet possible to write actual data.

SUANTAINABILITY ENGAGEMENT PROJECTS SUMMARY

I have developed a green supply chain evaluation system and supplychain blockchain demo over the last 10 weeks though these two applications are not perfect. It's the first time that I applied Java and many corresponding coding languages and development frameworks to develop an evaluation software. It was hard for me to learn these at the beginning, but great honors came to me when I developed a web page and achieved the functional modules successfully. As a programming enthusiast, now I have a better understanding about the development process of Java Web and blockchains, and my programming ability has been significantly improved. Finally I have published my source code in my GitHub: https://github.com/turbohiro.