ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301

Beijing-Hebei Intelligent Agricultural Science and Technology Collaborative Innovation System

Hou Shaojie[1,a], Zhou Zenghui[1,b,*], Sun Xuehua[2,c]

[1]School of Information Technology, Hebei University of Economics and Business, Shijiazhuang, Hebei 050061, China
[2]Center for Evaluation and Faculty Development, Hebei University of Economics and Business, Shijiazhuang, Hebei, 050061, China
[a]shaojhou@163.com, [b]tejing4587@126.com, [c]sunxuehua795@126.com
**Corresponding author*

Abstract: *In view of various problems emerged from operation mechanism of the Beijing-Hebei intelligent agricultural science and technology collaborative innovation, combined with the characteristics of product-education-research work, UML modeling technology was adopted to study the corresponding software system for Beijing-Hebei intelligent agricultural science and technology collaborative innovation. First of all, through analyzing the main target function of the system, the role and users of every participant, including universities, scientific research institutions, enterprises, towns and villages, governments and system administrators, were designed by use case diagram. Then, the data flow and interaction between each other was deeply analyzed and described by E-R diagram, , including 8 aspects: "user- role- authority" mechanism model, "product-education-research" collaboration model, experimental field and data collection model, scientific achievements and research team model, teaching feedback model, "project-technology-product" model, policy interpretation model, management model. Finally, the architecture diagram of the system was constructed, which provides the design basis for the software platform development.*

Keywords: *Agricultural science and technology; Collaborative innovation; System design; Beijing-Hebei*

1. Introduction

At present, the most arduous and onerous task of building a modern socialist country in an all-round way is still in the countryside. Agricultural science and technology innovation is an important support for the development of modern agriculture and plays a prominent leading role in accelerating the construction of an agricultural power [1, 2]. The Beijing-Hebei region is one of China's important agricultural production areas. To develop it, we must give priority to agricultural and rural development, adhere to the integrated development of urban and rural areas, and earnestly promote all-round rural revitalization.

With the continuous progress of agricultural science and technology and the rapid development of emerging technologies such as big data, cloud computing and artificial intelligence, the various walks of life have stepped into the fast lane of industrial transformation and upgrading, and the specialized division of labor and the integration ability of agricultural industry chain have been continuously improved [3, 4]. How to give full play to the roles of universities, research institutions, enterprises, towns and villages, achieve industry-university-research cooperation and innovation and integration, and further promote the leading role of agricultural science and technology innovation has become an important subject for the development of the Beijing-Hebei region [5, 6].

2. Necessity of collaborative innovation system research on agricultural science and technology

Industry-university-research cooperative innovation is the common practice of the world's powerful countries in science and technology. It is the deep integration of multi-agents, multi-elements and multi-chains, which can continuously break through the original organizational boundaries, regional differences and information barriers and form a more effective innovation mode. At the same time, industry-university-research collaborative innovation is a highly penetrating of innovation chain,

ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301

industrial chain, capital chain and talent chain. It is characterized by intellectual intensity, resource concentration, technology integration and ecological complexity. Its organizational process needs to realize orderly and dynamic element flow among various subjects and various innovation elements, and it also needs to find problems and adjust them in real time. To coordinate and lead the optimal allocation of resource systems such as projects, bases (platforms, facilities, etc.), technologies, funds, and talents.

Hebei Province is one of the major agricultural production areas in China, with an area of arable land of about 6 million hm2, mainly planting wheat, corn, millet, beans, cotton and other crops. It is one of the three major wheat production areas in China. With the promotion of poverty alleviation, rural revitalization and agricultural modernization, grain output in Hebei has remained above 50 billion jin for 10 consecutive years, a large number of characteristic industrial clusters have made remarkable progress, and the integration of new technologies and agricultural industries has been greatly improved.

Science and technology to promote agriculture has become the main theme of agricultural development in Hebei Province in the new era. In order to give full play to the role of universities in Beijing and Hebei Province, scientific research institutions, enterprises, towns and villages, further promote resource sharing, deep cooperation, industrial integration and joint training of talents, etc., It is necessary to design and implement a set of collaborative innovation system for intelligent agricultural science and technology in Beijing and Hebei [7, 8].

3. Requirements analysis and the use case diagram design

The Beijing-Hebei intelligent agricultural science and technology collaborative innovation system adopts the mechanism of "user-role-authority". Users come from universities in Beijing and Hebei Province, scientific research institutions, enterprises, towns and villages, among which universities in Beijing and Hebei province can be merged into universities in terms of roles, and the other roles are towns and villages, governments and system administrators. A total of six roles are generated which are universities, scientific research institutions, enterprises, towns and villages, governments and system administrators. Users are the carriers of these roles. From the perspective of permissions, the analysis is as follows.

3.1. Universities

Collect and summarize the problems encountered by towns and villages in the process of scientific and technological development, and then find the scientific questions in them by the in-depth analysis and summary. At last, we can get a number of scientific research projects. At the same time, a docking scientific research team is set up to conduct field visits and data collection, and use relevant theoretical or experimental research methods to explore solutions and solutions, and obtain scientific research achievements. At the same time, in order to cultivate scientific and technological talents, the construction of scientific research team is also one of the important contents. We should build a talent echelon, implement the "old to new" step training mode, and form a good, sustainable and self-operating scientific research team. Finally, periodical scientific research achievements should be sorted out, condensed and published in time, and the relevant data or cases should be to construct teaching cases, constantly enrich the teaching resource base, and then integrated into the process of talent training.

3.2. Scientific research institutions

In terms of scientific research, it has similar functions to universities, but it is stronger and faster than universities to engage in research. Scientific research institutions undertake less education and teaching process, so they have more energy and more flexible mechanisms to connect with various parties. They can cooperate with universities to carry out theoretical or experimental research, and can also participate in technology development, product development or market activities with enterprises, which can accelerate the incubation and landing of scientific research achievements.

3.3. Enterprises

In the process of teaching reform and practice of "production, education and research", enterprises play a relatively key role. Continuous scientific and technological innovation is the key to long-term survival, continuous healthy operation and good social services for enterprises. China's Haier, Lenovo, Huawei, ZTE and foreign Microsoft, Google, Siemens and other enterprises are all excellent

ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301

representatives of integrating production, learning, research and development and constantly improving innovation ability. In the Beijing-Hebei intelligent agricultural science and technology collaborative innovation system, the main role of enterprises is to connect universities, scientific research institutions with towns and villages, and bring the achievements of universities and research institutions to the countryside through enterprise production activities and market behaviors.

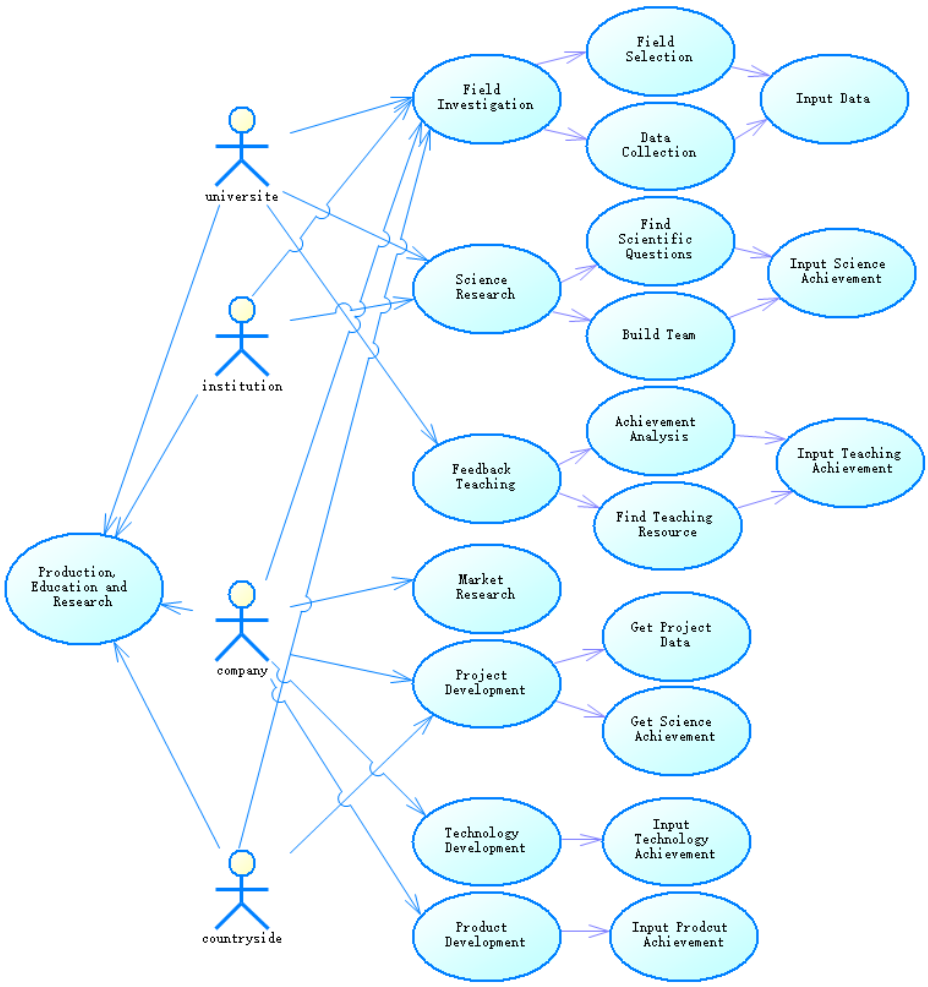
3.4. Towns and villages

Towns and villages are the end roles in the collaborative innovation system of intelligent agricultural science and technology in Beijing-Hebei, and also the main body to realize the value of scientific and technological innovation. The main work is to coordinate with universities and research institutions to cooperate with field investigation, data collection, etc. and coordinate with enterprises to survey markets, process experiments, develop products, and also try to find and feedback problems, etc.

3.5. Governments

As the administrative department of rural revitalization and agricultural development through science and technology, governments will guide and supervise the whole process of collaborative innovation of intelligent agricultural science and technology in the Beijing-Hebei region. In this system, their main functions are to interpret and train the policies, guide the reform and innovation direction of "production, education and research", continuously optimize investment for the scientific and technological innovation, and constantly improve management ability. They should try to solve the experiment field selection and other difficult problems. Their ultimate goal is to improve the cooperation efficiency of universities, scientific research institutions, enterprises and towns and villages.

3.6. System administrators



ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301

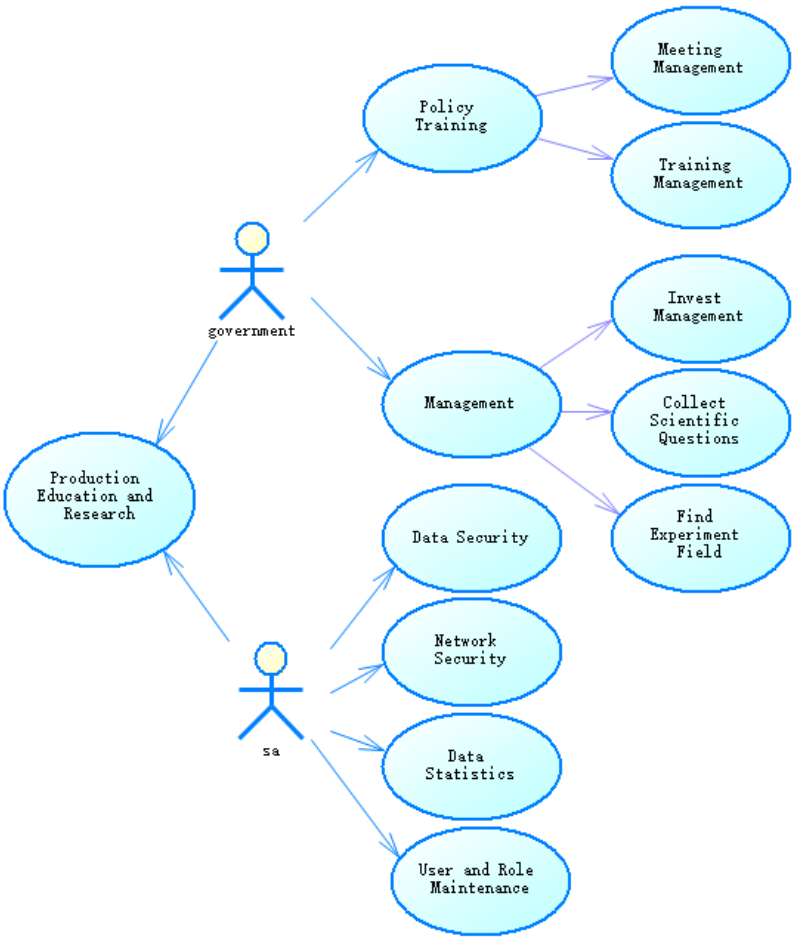


Figure 1: The use case diagram of Beijing-Hebei intelligent agricultural science and technology collaborative innovation system

They are mainly responsible for the data security, network reliability, data statistics and other aspects of the Beijing-Hebei intelligent agricultural science and technology collaborative innovation system, and solving various problems encountered during the system operation.

To sum up, the permissions of each role are extracted and the construction method is shown in Figure 1.

4. Database model design

The database model is the process of abstracting the real world from the information world. Generally, it starts from the use-case diagram obtained from the requirement analysis, analyzes the data involved in the each case. Especially the data structure should be focused, including entities, properties and relation between them, and then designs the E-R diagram model of the system.

4.1. Model design for the "user-role-authority" mechanism

According to a variety of roles and relationships, the entities named as "role" and "role_detail" were constructed to implement role and permission management. Then two entities, namely "user" and "depart", were introduced, in which "depart_id" is a foreign key to associate with each other.

4.2. Model design for the "production-education-research" collaboration

On the basis of the entity "user", the collaboration entities "link" and "link_detail" were established in which "user_id" is a foreign key.

ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301

The above description is shown in Figure 2.

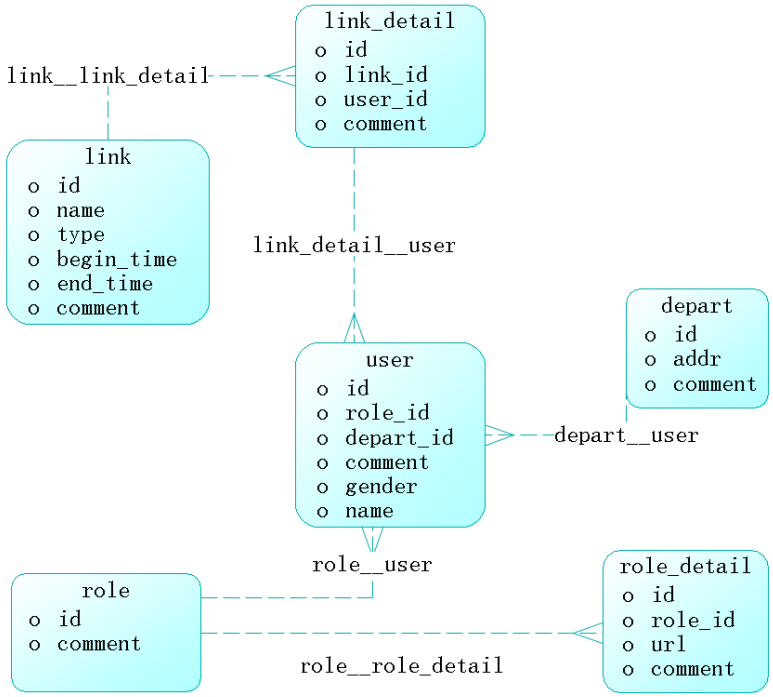


Figure 2: The E-R diagram for the user-role-authority part and product-education-research collaboration part in the Beijing-Hebei intelligent agricultural science and technology collaborative innovation system

4.3. Model design for the experimental field and data collection

Two entities, "field" and "dataset" were constructed to store the experimental base field information and the data collected in the relevant experiments.

4.4. Model design for the scientific achievements and the research team

The entity "science" was constructed to describe the information of scientific questions, and the entity "achievement" and "team" were also designed for the gained scientific achievements and the working team. Based on these, two relations, named as "dataset_science" and "science_achievement", and one foreign key "team_id" in "achievement", were constructed to reflect the relationship between them.

4.5. Model design for the teaching feedback

We constructed an entity named as "teaching" to restore the teaching resources, and then created a many-to-many relationship "achievement_teaching" to describe the relationship between "achievement" and "teaching".

4.6. Model design for the "project-technology-product"

To describe the projects and its detail information, two entities "project" and "project_detail" were constructed, and then the other two entities named as "technology" and "product" were also established to store related data. In them, the foreign key "project_id" was saved as the connection between each other.

The above description is shown in Figure 3.

ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301

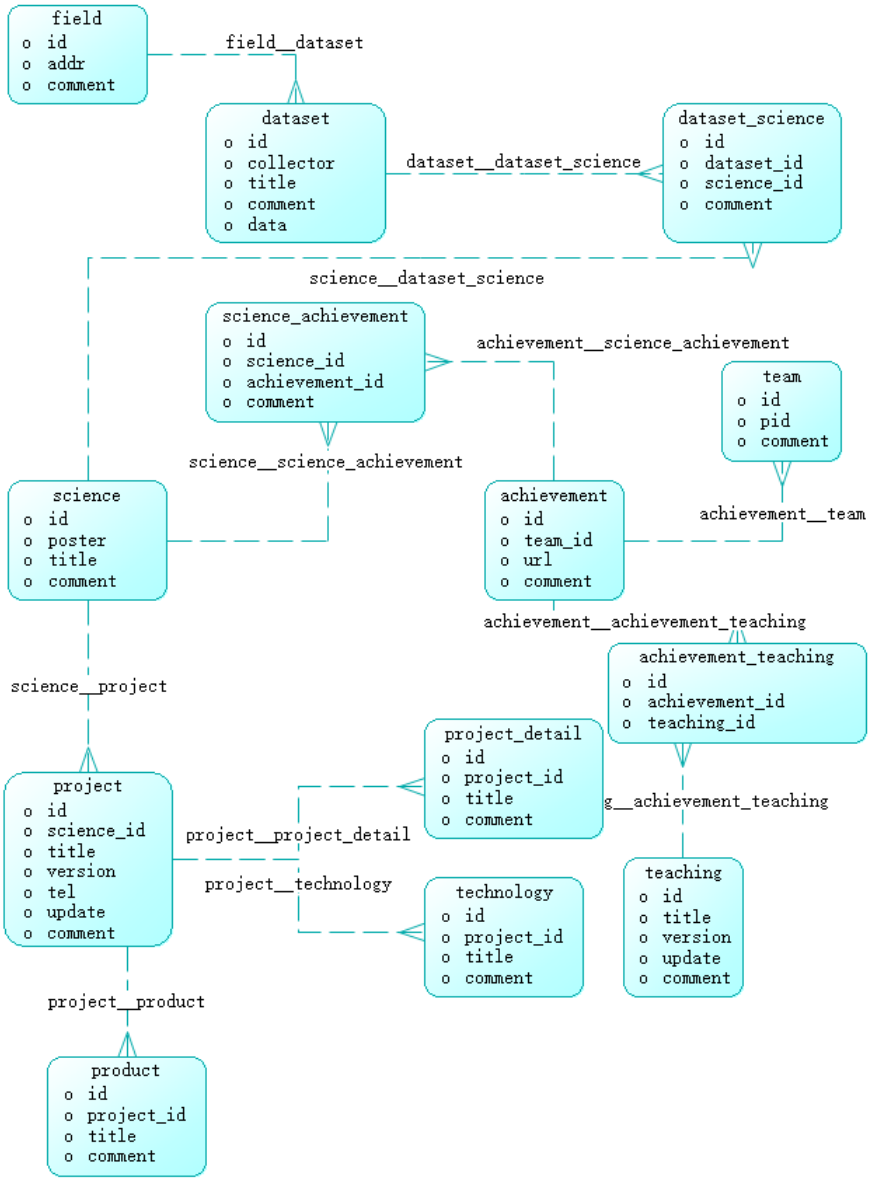


Figure 3: The E-R diagram for the experimental field and data collection part, scientific achievements and research team part, teaching feedback part and project-technology-product part in the Beijing-Hebei intelligent agricultural science and technology collaborative innovation system

4.7. Model design for the policy interpretation

The entity "policy" was conducted to describe the policies or store their related documents at various levels, and another entity "meeting" was designed for the data of conveying policy activities and organizing training activities, in which a property "type" is to distinguish activities' form, and a foreign key "policy_id" was used for their relationship.

4.8. Model design for management

The entity "collect" was constructed to store the research topics submitted from universities, scientific research institutions, enterprises, towns and villages or governments. The entity "invest" was designed to demonstrate the investment for innovation and technology by the governments. There are two foreign keys, "collect_id" and "project_id", was used to connect the entity "collect" and the entity "project".

The above description is shown in Figure 4.

ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301

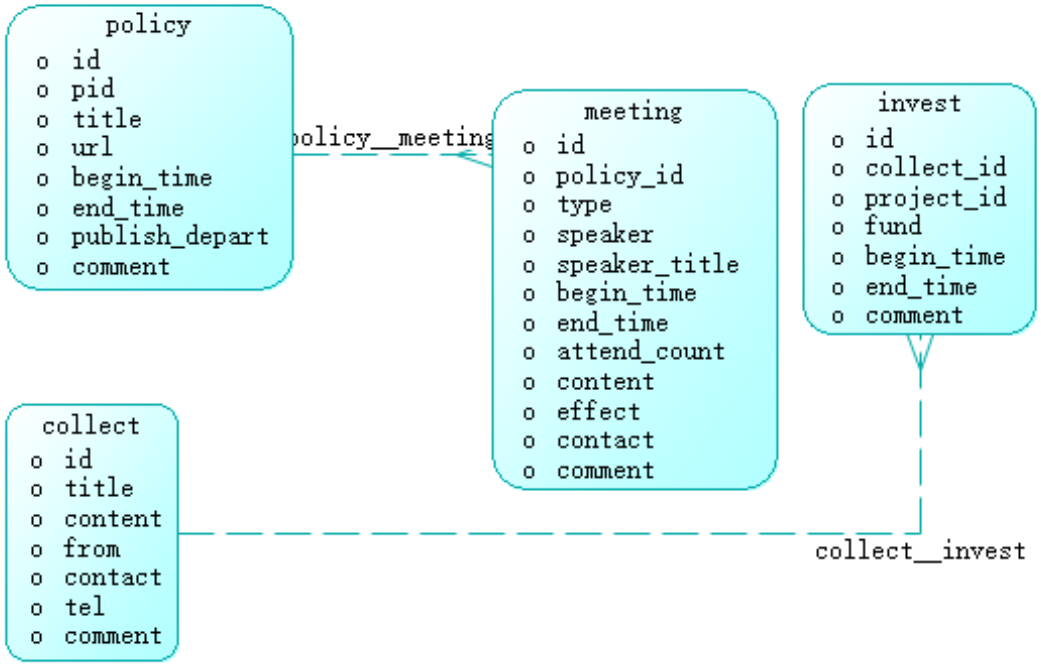


Figure 4: The E-R diagram for the policy interpretation part and management part in the Beijing-Hebei intelligent agricultural science and technology collaborative innovation system

5. Functional model design

According to the use case diagram design and database model design, each business and function was detailed and discussed layer by layer. Twelve modules can be formed as follows:

(1) User and Role

(2) Production, Education and Research

(3) Field Investigation

(4) Science Research

(5) Feedback Teaching

(6) Market Research

(7) Project Development

(8) Technology Development

(9) Product Development

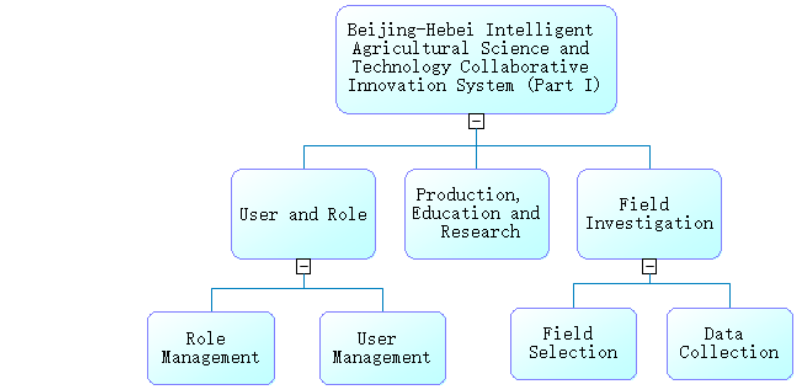
(10) Policy Training

(11) Management

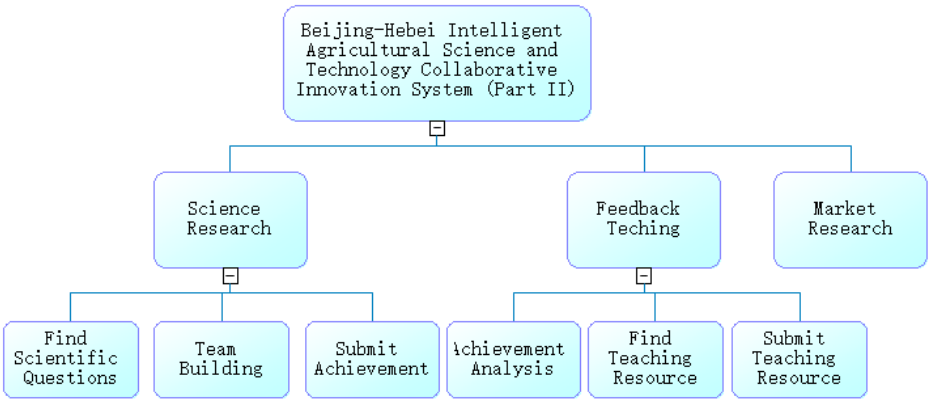
(12) System Maintenance

Base on these function modules, the further analysis and design was done to extend, and then the system architecture model was achieved as 4 parts, as shown in Figure 5.

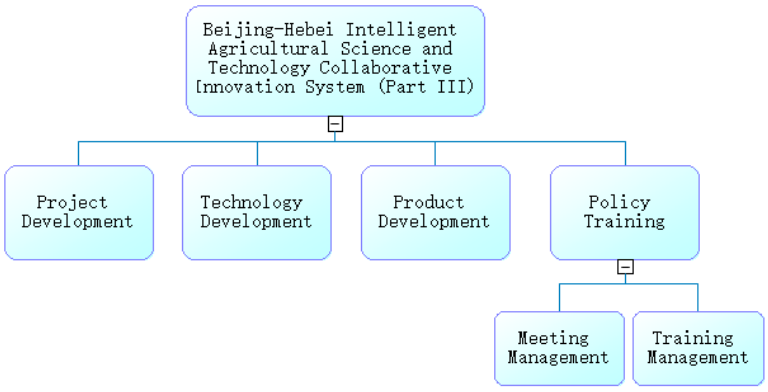
ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301



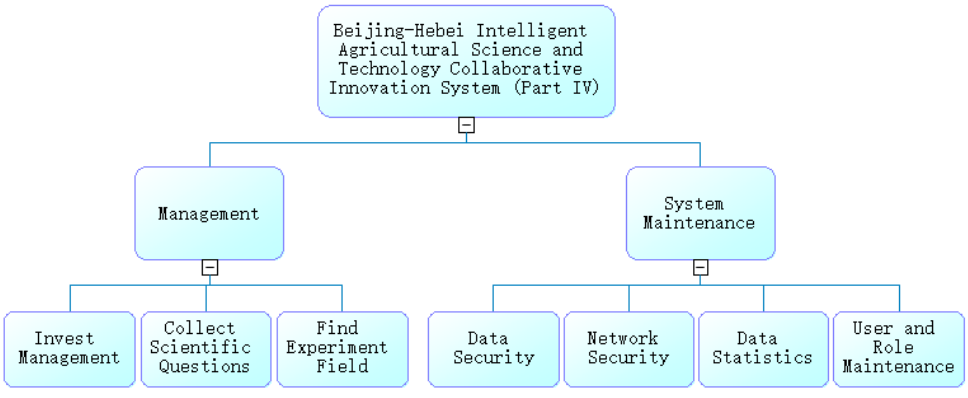
(a) Part I



(b) Part II



(c) Part III



(d) Part IV

Figure 5: The architecture diagram of Beijing-Hebei intelligent agricultural science and technology collaborative innovation system

ISSN 2522-3488 Vol. 7, Issue 3: 1-9, DOI: 10.25236/IJNDES.2023.070301

6. Conclusions

Based on the operation mechanism of the Beijing-Hebei intelligent agricultural science and technology Collaborative innovation, this paper uses Internet technology to study a corresponding software system for Beijing-Hebei intelligent agricultural science and technology collaborative innovation, to provide a useful solution for the complex coordination and management problems of all parties in the collaborative activities. The system takes the characteristics of production, education and research as the starting point, fully considers the functions and roles of participants in the collaborative process, and uses UML modeling technology to construct the target use case diagram. By analyzing the possible data flow and data interaction generated by the system, the E-R diagram is constructed, including 8 aspects: "user- role- authority" mechanism model, "product-education-research" collaboration model, experimental field and data collection model, scientific achievements and research team model, teaching feedback model, "project-technology-product" model, policy interpretation model, management model. Finally, the architecture of the system is constructed, including 12 parts, named as "user and role", "production, education and research", "field investigation", "science research", "feedback teaching", "market research", "project development", "technology development", "product development", "policy training", "management", "system maintenance", which provides the design basis for the development of the software platform.

Acknowledgements

This work was supported by Soft Science Research Project of Hebei Province Innovation Capability Improvement Plan (grant number 22557402D).

References

[1] Cui Ningbo. (2022) The Significance, Challenge and Realization of Rural Revitalization Enabled by Intelligent Agriculture [J]. People's Tribune, 5: 26-28.
[2] Li Denghua, Xu Shiwei. (2022) Current Situation and Prospect on the Construction of New Agricultural Infrastructure [J]. Forum on Science and Technology in China, 2: 170-177.
[3] Hong Shuai, Wang Tianzun, Fu Xiaoyi. (2023) Study on Evolution Context Combing and Frontier Trends of Intelligent Agriculture Research in China [J]. Jiangsu Agricultural Sciences, 4: 28-38.
[4] Cui Junhui, Song Shuen, Liu Shuling, Zhao Hongfang. (2019) Research on the Path and Strategy of the Strategic Emerging Agriculture Development in Hebei Province in the New Era [J]. Journal of the Hebei Academy of Sciences, 36(4): 72-76.
[5] Zhang Xuemin, Hou Fogang. (2018) From Adaptation to Leading: The Development Path of Application-oriented Talent Training in Colleges and Universities [J]. Jiangsu Higher Education, 8: 33.
[6] Zhang Yang. (2022) Research on Product-education-research Collaborative Innovation Mechanism in Higher Vocational Colleges from the Perspective of Artificial Intelligence [J]. Education and Vocation, 7(14): 58-63.
[7] Huang Xuetao, Wang Haixia. (2019) Discussion on Teaching Mode Reform of Production-Education -Research Collaborative Innovation [J]. Education Modernization, 6(1): 12-14.
[8] Li Xuebing. (2019) Practice on Practical Teaching Combined with Production Teaching and Research [J]. Journal of State Grid Technology College, 22(1):78-80.