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Research on Influencing Factors of Software Project Schedule Management of Bulk Commodity Electronic Trading Platform

Haiyang Zhou[1,*] and Panida Chamchang[2]

[1]College of Graduate Studies, Walailak University, Nakhon Si Thammarat 80160, Thailand
[2]School of Management, Walailak University, Nakhon Si Thammarat 80160, Thailand

([*]Corresponding author's e-mail: 447592697@qq.com)

Abstract

The lag of project schedule is the key and difficulty of software development projects. Effective schedule management of software projects can significantly avoid the problem of software development schedule lag, so it is necessary to deeply study the key factors affecting the schedule of software projects, to provide a strong basis for enterprise management decisions. Based on the analysis of the status quo of the implementation progress of the software project of the electronic trading platform for bulk commodities, this paper clarifies the relationship between the evaluation indicators and forms an indicator system. Among them, the first-level indicator is the influencing factor of the software project progress. Four secondary evaluation indexes are environmental factor, personnel factor, technical factor and management factor. The 12 3-level evaluation indicators are demand change frequency, customer capability, personnel capability, communication and collaboration, team stability, demand management, training management, communication management, development method selection, new technology application, and project reuse. The network analytic Hierarchy Process (ANP) is used to analyze various influencing factors, and the 6 key influencing factors are found: Demand management, communication management, demand change frequency, personnel ability, development method selection and project reusability. Finally, combining with the characteristics of a software development project and schedule control theory, get inspiration, in view of the commodity trading platform software projects, enterprises should improve demand management, improve the communication mechanism, clear communication channels, to build hierarchical professional talent team, carry out special training, improve the comprehensive quality of employees, make the schedule control changed from passive to active, Improve the effectiveness of software project schedule control, enhance the ability of fast delivery, create blockbuster products, enhance the core competitiveness of enterprises, and help enterprises develop high-quality.

Keywords: Electronic trading platform, Software development, Schedule management, Image factors, AHP

Introduction

Research background

The electronic trading of bulk commodities in China is in urgent need. The electronic trading market of bulk commodities in spot has been developing since 2008. After more than 10 years of development, according to statistics, there are 1,969 electronic trading venues for bulk commodities in China, and the annual physical transaction scale exceeds 30 trillion yuan, with the market scale increasing year by year. Although there are numerous trading centers for various commodities at present, there are many problems and risks due to rapid development and weak supervision. In addition, the development of China's futures market is backward, and the blind and repetitive construction of exchanges occur frequently. Therefore, the Chinese government issued relevant documents to emphasize the priority of developing the trading of bulk commodity spot market. Bulk commodity spot electronic trading system is under such a background, with the advantages of convenient system trading, convenient storage and distribution services, minimize regional differences, to provide information service support for China's bulk commodity spot trading. At present, the main trading methods supported by the bulk commodity spot trading system include: Spot

listing trading, spot bidding trading, spot mid - and long-term trading, bidding bidding trading, spot deferred trading, online mall trading, etc.

From the long-term development strategy of bulk commodity electronic trading platform, ensuring the delivery schedule of software development projects is the key to long-term development, and effective schedule control and management is the key to the success of software development projects. The delay of a software project will affect the market share of an enterprise. How to identify and analyze the key factors affecting the progress of software development projects, intervene against the key factors, provide a reliable basis for management decision-making, formulate a more reasonable enterprise development strategy, rationally use the limited resources of enterprises, improve the core competitiveness of enterprises and resource allocation efficiency, It is an urgent problem that the operating enterprises of bulk commodity electronic trading platform need to solve.

China-ASEAN Information Harbor co., LTD is a large-scale software development company, has a large number of software industry development experience, for Guangxi sugar trading market, Guangxi big data trading market, Guangxi Shipping Exchange Market, such as the shipping transaction platform to provide software development services, including the requirements of complete life cycle of software development, based on the development of requirements specifications, application software development, etc. In the context of increasingly fierce competition in China's commodity trading industry, the company has put forward stricter requirements on the cycle, on-time delivery rate and cost of its software development projects. Especially in the software project on time delivery rate, the enterprise has higher and higher requirements. Therefore, in order to adapt to the change of market demand, how to strengthen the project schedule management is an urgent problem that the enterprise needs to solve. In order to do a good job in software development project schedule management, we must first understand the factors that affect the enterprise's software development project schedule delivery in the bulk commodity electronic trading platform.

China-ASEAN Information Harbor co., LTD is a large-scale software development company, has a large number of software industry development experience, facing single cross, ability to disperse, customer focus, development technology and the pattern is not unified, human resources does not match with the business development and a series of problems, the main customers for the commodity trading platform, system correlation between strong, High complexity, rapid demand change, strong customer perception, high requirements for fast delivery, through the study of this paper, it is hoped to improve the enterprise's fast delivery ability, improve the core competitiveness and resource allocation efficiency, and help enterprises to high-quality development. At the same time, it can also provide reference for other peers to do similar research on schedule control. We should enhance the fast delivery capacity, create blockbuster products, enhance the core competitiveness of enterprises, and facilitate high-quality development of enterprises.

Objectives

To study the factors that affect the progress of software development projects and find out the key factors

To in the process of the implementation of the project for effective control of progress, the first thing to understand and analyze the factors that affect software development progress, take necessary measures in advance, and discover the actual progress and schedule, the deviation between the corrective measures immediately, narrowing the scope of the deviation, realize the development progress of active control.

The application of network analytic hierarchy Process (ANP) is a scientific decision-making method which can adapt to complex structure and is the development direction of studying and solving complex decision-making problems. ANP system is reflected in the form of network. There are not only hierarchical hierarchical structure, but also network hierarchical structure with internal dependence and feedback, so the analysis results are more reasonable and reliable.

Literature review

Research on schedule management of software projects in China

In 1991, China established the project management research committee and formulated the Chinese project management knowledge system and certification standards, which laid a foundation for the development of the basic theory and application practice of project management in China. After a long period of theoretical study and digestion, combined with the actual situation of Project management in China to carry out localized application and innovation, in recent years, China's project management research and application practice has also achieved quite excellent results. The Bayesian network model constructed by Li. using PERT diagram can identify the uncertain factors in project schedule management and balance the relationship among cost, schedule and quality well. Ma applied the idea of multi-objective optimization in the key chain and constructed a comprehensive optimization model based on multi-attribute utility function. The comprehensive optimization model was first used to optimize the multi-objective, and then the buffer zone of the key chain was set. The weight of cost, schedule and quality was adjusted reasonably to improve the comprehensive benefit of the project. For the study of multi-stage projects, Shao proposed a schedule risk warning model to realize the feedback of schedule warning information layer by layer and form linkage.

At present, the research on software development projects in China still adopts the traditional project management mode and method, and has not yet formed a management mode suitable for its own reality. The management level of software development projects is generally low, and the comprehensive competitiveness is weak. With the rapid development of computer technology and internet technology, information system has been widely used in various professional fields, human work and life rely more and more on the computer, the development and design of information system requirements are increasing, the implementation of information system development projects also face unprecedented problems. On the basis of traditional project management and combined with the characteristics of Chinese information system software development projects, how to introduce new theories and new ideas to plan and manage the whole life cycle of software development projects and promote the application process of China's information projects is a difficult problem that Chinese researchers need to solve.

Zhu used Gantt chart and Markov chain to predict the progress of software development projects with a simpler level. Wang discussed the progress planning, control and analysis application of P3 software project deeply. The scrum agile method introduced by Zhou into software development project management plays an important role in reducing the cost of software development projects, rationally distributing development tasks, improving customer satisfaction, increasing the participation of developers and improving the quality of developed products.

Research on foreign software project schedule management

As early as in the middle and late 20^{th} century, international research on project management has begun. Project management is generally considered to be a post-world war II product, a management method created for the construction of defense and military projects during the post-war reconstruction process. With the establishment of the British International Project Management Association (IPMA) and the American Project Management Association (PMI), the application of project management has been extended to the civil field, and has been widely promoted and applied in various fields of social production and life and all walks of life.

Project schedule management, as one of the iron triangle of project management, plays an important role in the success of the project. The progress management of international projects, whether on the theoretical basis or in the application of practice, is ahead of China's progress management research, and has made remarkable achievements. For example, Gantt chart technology invented by Grantt, critical path method proposed by DuPont, PERT plan review method proposed by The US Naval Special Projects Agency, Graph review technology (GERT) developed by Pritsker, etc.

With the rapid development of computer technology and Internet technology, software system has been widely used in various fields of economic and social life, and the functional requirements of software system have become more and more complex. Most software development projects cannot be delivered on

time, the development cost is seriously overspent, the quality of software development projects cannot meet the needs of customers and other problems, often not because of technical reasons, but because of poor management. Therefore, people pay more and more attention to the schedule management of software development projects. Today, with the rapid development of Internet technology, the progress management of software development projects is still difficult to predict. A large number of data show that only about 10 % of software development projects can be successfully delivered and used under the originally expected cost and time. Padberg was the first to use markov model in software development project schedule management. Firstly, the software development project was abstracted into discrete Markov decision process, then the software development progress was calculated by random optimization technology, and the optimal schedule decision was calculated by minimizing the cost function. In recent years, the research of software development project schedule management mainly focuses on how to solve the influence of various uncertain factors under the condition of limited resources.

Thus, for the study of IT software development projects, both abroad and in China, usually confined to the content of the software development project schedule management tools and platforms, less attention in the process of software development, project implementation schedule plan and schedule management of specific measures, for the study of the factors affecting software project delivery schedule, most is also the qualitative analysis, and lack of quantitative research.

Factors that affect the schedule of a software project

By reading the literature review, to better manage the process of software development projects, software development projects can be divided into 4 stages, the first stage of planning phase, corresponding to a software development project start-up phase of the process, the second phase of the requirements phase, corresponding to a software development project in the process of demand analysis, the third stage for the implementation phase, corresponding to the design, coding and testing stages of the software development project process, the fourth stage is the closing stage, corresponding to the acceptance stage of the software development project process. Each phase of a software development project has its own task, corresponding to different milestone events, and different process phase deliverables. In order to manage the software development project schedule in the whole life cycle, the factors affecting the development schedule in each stage of the software development project should be analyzed first.

Factors affecting delivery schedule in software development project planning stage

Start-up phase, the main task of the software development project is to develop products for integral definition, understand the characteristics of the software project of industry field and the background, from the aspects of economy, technology, and social factors such as the feasibility of a software development project, for the cost of the entire software development project, quality, progress, etc to make the forecast. The schedule management in the planning stage mainly starts from the following 3 aspects: Making the schedule of software development project, setting key milestone events and solidifying the software requirement change process.

Factors influencing the delivery schedule of software development project requirements phase

The main task of the requirement stage of software development project is to understand the customer's development demand as accurately and in detail as possible, analyze the customer's demand and express it in the form of requirement specification. In the demand stage of software development project, the main factors affecting the progress are: Technical factor, management factor and communication factor.

Factors influencing the delivery schedule of software development project implementation

Software development project implementation stage is the most workload in the whole development project, including design, coding and testing. Software design is to decompose software into data, program description or executable program units that can achieve a certain function. Coding translates software designs into programs that computers can read. Testing is about finding as many errors as possible at a fraction of the cost. In the implementation stage, the main factors affecting the progress of software

development are as follows: Personnel factors, technical factors, environmental factors, management factors.

Factors influencing the delivery schedule in the closing phase of software development projects

The end phase of a software development project is the end phase of the entire project. The workload and difficulty of this stage are not big, but it is the key stage for the smooth delivery of the whole project. If the work of this stage is not done well, the work of the previous several stages will be wasted. In the closing phase, as in the requirements phase, there is a lot of communication and communication with customers. Therefore, the most important factor affecting the closing phase is communication factor.

Table 1 The influencing factors.

The serial number	Affecting factors	Evaluation index
1	Environmental factors	Hardware facilities
2		Tool support
3		Organizational structure
4		Demand change frequency
5		Customer capabilities
6	Human factors	Member ability
7		Enthusiasm
8		Communication and cooperation
9		Team stability
10		Team size
11	Management factors	Demand management
12		Training management
13		Communication management

Methodology

Research methods

Literature research method

Through reading a large number of documents related to the influencing factors of software project schedule and schedule management, to find the theoretical basis for the evaluation of the influencing factors of software project delivery schedule; According to the results of literature analysis and quantitative analysis, this paper studies the status quo of software project delivery schedule of bulk commodity electronic trading platform, and analyzes the influencing factors of software development planning stage, demand stage, implementation stage and test and acceptance stage.

Questionnaire survey and internal expert interview

The commodity trading platform software project developers, testers, managers and commodity trading platform operating enterprises to carry out interviews and questionnaire survey, the progress of the 4 stages of software development projects, this paper analyzes the factors which influence and determine the commodity trading platform software development project schedule preliminary evaluation index influencing factors. Through interviewing experts of the technical Committee of the software project of the electronic trading platform for bulk commodities, the main causes of the problems in the software delivery schedule of the electronic trading platform for bulk commodities are analyzed, and the factors affecting the software delivery schedule of the electronic trading platform for bulk commodities are obtained.

Since there are many evaluation indexes for influencing factors of the delivery schedule of the software project of the electronic trading platform for bulk commodities, in order to ensure that the evaluation indexes are more targeted and highlight the importance of the indexes to the delivery schedule of the

software project of the electronic trading platform for bulk commodities, the preliminary evaluation indexes are screened in the first round. The specific process is as follows;

1) Design questionnaire: According to the preliminary evaluation indicators of the influencing factors of the delivery schedule of the software project of the electronic trading platform for bulk commodities, the influence degree is divided into 5 levels according to the importance, namely, very important, important, average, unimportant and uncertain. The content of the questionnaire is designed.

2) Determine the objects of the questionnaire: The objects of this survey are the developers, testers, managers and platform operators of the company.

3) Questionnaire survey: This questionnaire survey was carried out by issuing questionnaires to 145 respondents. After the survey was completed, a total of 145 survey results were recovered.

4) Sorting out the results: After sorting out and analyzing the results of the questionnaire, the index with approval rate lower than 50 % will not be taken as the evaluation index of the evaluation model for influencing factors of the delivery schedule of the software project of the electronic trading platform for bulk commodities.

Combined quantitative and qualitative analysis method

Evaluate the influencing factors of software project delivery schedule, establish and evaluate the model of influencing factors of software delivery schedule of bulk commodity electronic trading platform based on ANP, and obtain the key influencing factors.

ANP Network Analytic Hierarchy Process (AHP) was put forward by Professor Thomas L. Saaty, a famous American operational research scientist, in the 1970s. This decision making method is applied in an internally independent hierarchical structure. In 1996, Professor Thomas L. Saaty put forward an Analytic Network Process (ANP), another scientific decision-making method suitable for complex structure, for the interdependency Network structure. ANP introduces the concept of super matrix on the basis of AHP, ADAPTS to the wider situation of solving decision weight, and gradually develops into a new practical decision making method. Professor Saaty says: AHP is a special case of ANP, which can overcome the defects of 1-way and independence of elements or requirement criteria of AHP. However, ANP system is manifested in the form of network, which not only has hierarchical hierarchical structure, but also has network hierarchical structure with internal dependency and feedback. Therefore, ANP is the development direction of solving complex decision problems.

Step 1: Analyze the problem

Decision problem to system analysis, combination, form elements and element sets, this is a very important step, classified correctly, that is, “birds of a feather flock together”, mainly analyzes the internal independent judgment whether the element level, whether there is a dependent and feedback, expert analysis methods available for the meeting discussion, forms and methods, such as filling out a form.

Step 2: Construct ANP typical structure

The first is to construct the Control Hierarchy. The decision goal is defined, the decision criteria is defined, this is the basic problem, each criteria relative to the decision of the weight of AHP method.

Another is to construct the network hierarchy. To classify and determine each element set, analyze its network structure and mutual influence relationship, and analyze the relationship between elements can be carried out by a variety of methods. One is the internal independent hierarchical structure, that is, the hierarchy is relatively independent; One is internally independent, with a cyclic ANP network hierarchy between elements. The other is internal dependency, that is, there are cyclic ANP network hierarchy results within elements. These are special cases of ANP. In practical decision-making problems, there is basically no internal independence between element sets, and there are both internal dependency and cyclic ANP network hierarchy results. Benefit, cost, opportunity, risk and 4 control systems are usually established, and their criteria and system criteria are determined for each system.

Step 3: Construct the hypermatrix of ANP to calculate the weight

Let the criterion of control layer relative to target layer A be B, …, B_N. The network layer has sets of elementsC_1, C_2, …, C_N. C_i There are elementse_{i1}, …, e_{in},i = 1, …N.

Influence matrix of all elements at layer i on Layer j;

				C_1				C_2				…		C_N		
			e_{11}	e_{12}	…	e_{1n_1}	e_{21}	e_{22}	…	e_{2n_2}	…	e_{n1}	e_{n2}	…	e_{nn}
	C_1	e_{11}													
		e_{12}		W_{11}				W_{12}			…		W_{1N}		
		…													
		e_{1n_1}													
		e_{21}													
W =	C_2	e_{22}		W_{21}				W_{22}			…		W_{2N}		
		…													
		e_{2n_2}													
	…	…		…				…		…			…		
		e_{N1}													
	C_N	e_{N2}		W_{N1}				W_{N2}			…		W_{NN}		
		…													
		e_{NN}													

Influence matrix of all elements at layer i on Layer j;

$$W_{ij} = \begin{bmatrix} W_{i1}^{(j_1)} & \cdots & W_{i1}^{(j_{nj})} \\ \vdots & \ddots & \vdots \\ W_{in_i}^{(j_1)} & \cdots & W_{in_i}^{(j_{nj})} \end{bmatrix}$$

1) Each column of the hypermatrix is a sorting vector obtained by pair-wise comparison.

2) The super matrix W is derived by comparing elements in pairs, and each column of the matrix has a sorting weight based on a certain element.

3) The convenience of calculation, it is necessary to normalize each column of the hypermatrix and realize it with the weighted matrix ($W_{ij} = a_{ij}w_{ji}$) that is, the weighted matrix a_{ij} * the hypermatrix w_{ij}.

a) Internal independent layer, except the last layer element weight is no longer assigned: $W_{NN} = I$, all the others are: $W_{ii} = 0$.

Technical route of research

The research technical route of this paper is shown in the figure:

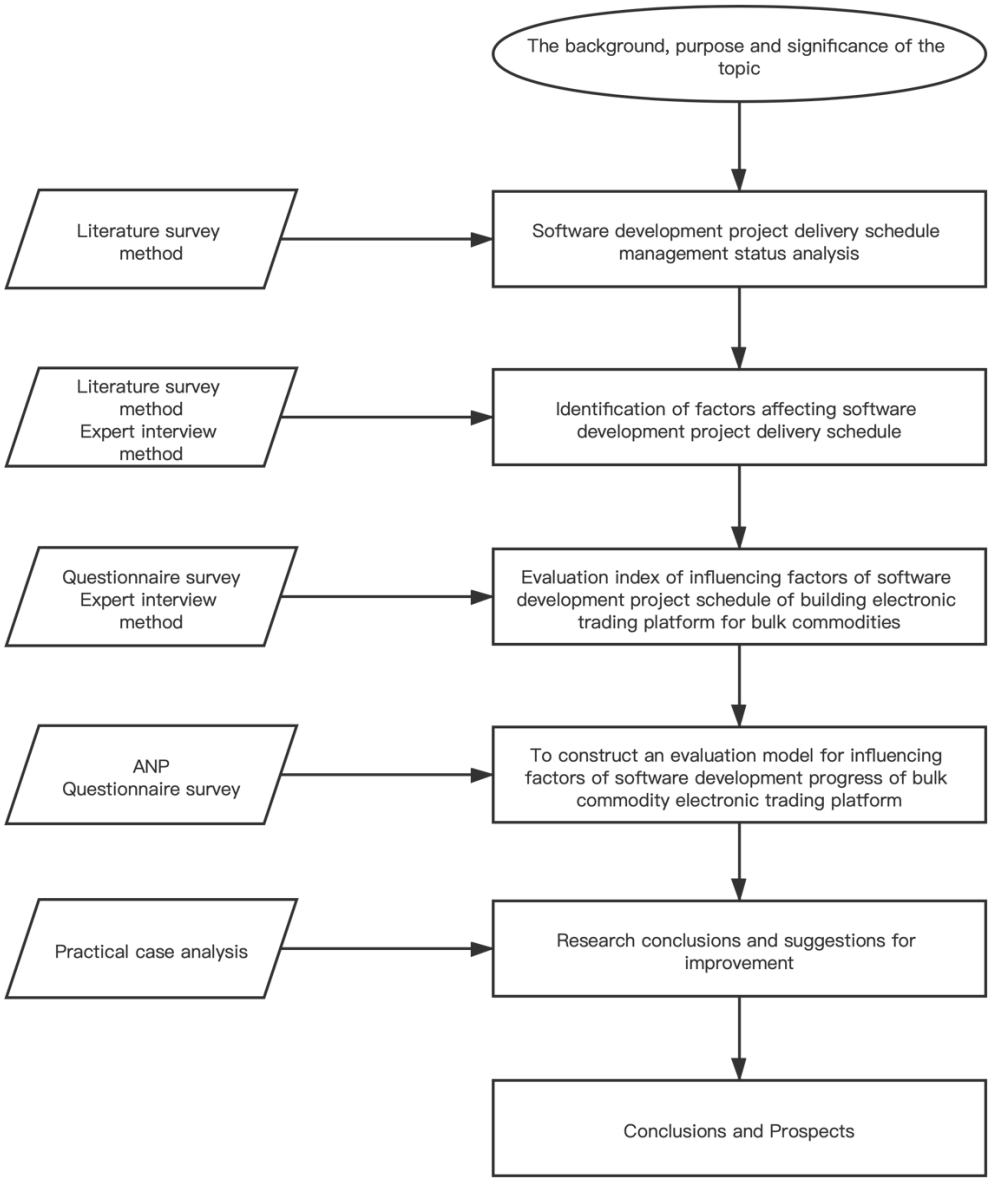

Figure 1 The research technical route of this paper

Results and discussion

ANP based model of influencing factors of software project delivery schedule of bulk commodity electronic trading platform

To construct the influencing factor model of the delivery schedule of the software development project of the electronic trading platform of bulk commodities, firstly, the problems to be solved should be analyzed, the relationship between the evaluation indexes should be clarified, and the index system should be formed. The index system of factors influencing the delivery schedule of the software project of the electronic trading platform of bulk commodities is a multi-level structure. The preliminary evaluation indicators are obtained from the hierarchical structure division of environmental factors, personnel factors, management factors and technical factors, as shown in the following table;

Table 2 The influencing factors.

Level 1 indicators	Level 2 indicators	Level 3 indicators
Factors influencing the delivery schedule of bulk commodity electronic trading platform software project	Environmental factors	Hardware facilities, tool support, organizational structure, demand change frequency, customer capabilities
	Human factors	Member ability, enthusiasm, communication and cooperation, team stability, team size
	Management factors	Demand management, training management, communication management, incentive management
	Technical factors	Development method selection, new technology use, project reuse

Table 3 The results of the questionnaire.

Affecting factors	Evaluation index	Very important	Important	Average	Unimportant	Uncertain
Environmental factors	Hardware facilities	0	5	68	72	0
	Tool support	0	20	87	38	0
	Organizational structure	0	3	35	97	10
	Demand change frequency	30	67	47	1	0
	Customer capabilities	13	62	29	35	6
Human factors	Member ability	42	73	23	7	0
	Enthusiasm	2	41	63	39	0
	Communication and cooperation	35	59	38	13	0
	Team stability	24	57	46	18	0
	Team size	0	12	28	99	6
Management factors	Demand management	64	49	29	3	0
	Training management	57	36	38	14	0
	Communication management	54	42	32	17	0
	Incentive management	6	64	35	40	0
Technical factors	Development method selection	12	65	41	27	0
	New technology use	5	76	25	39	0
	Project reuse	25	58	53	9	0

After deleting the indicators with approval ratings lower than 50 %, the evaluation indicators of the evaluation model for influencing factors of T company's software project delivery schedule can be obtained, as shown in the following table;

Table 3 The influencing factors.

Level 1 indicators	Level 2 indicators	Level 3 indicators
Factors influencing the delivery schedule of bulk commodity electronic trading platform software project	Environmental factors (E)	Demand change frequency E1
		Customer capabilities E2
	Human factors (P)	Member ability P1
		Communication and cooperation P2
		Team stability P3
	Management factors (M)	Demand management M1
		Training management M2
		Communication management M3
	Technical factors (T)	Development method selection T1
		New technology use T2
		project reuse T3

By analyzing the correlation between the indexes of the evaluation model for the influence factors of the software development progress of the electronic trading platform for bulk commodities, the index system of the evaluation model for the influence factors of the software development progress of the electronic trading platform for bulk commodities is constructed, the judgment matrix of the secondary and tertiary indexes is established, and the survey scale is designed. Establish ANP evaluation model of influencing factors of software development project progress, calculate the weight, unweighted super matrix, weighted super matrix and limit matrix of the judgment matrix of ANP evaluation model of influencing factors of software development project progress. Finally, the index priority ranking of ANP based software development project schedule influencing factor evaluation model is obtained.

The priority order of the evaluation model indicators of influencing factors of the delivery schedule of the software project of the electronic trading platform for bulk commodities is shown in the following table;

Table 4 The results of the ANP.

Number	Level 3 indicators	Priority
1	demand management (M1)	0.22237
2	communication management (M3)	0.19164
3	demand change frequency (E1)	0.11303
4	Member ability (P1)	0.10048
5	Development method selection (T1)	0.09173
6	project reuse (T3)	0.08650
7	communication and cooperation (P2)	0.08169
8	training management (M2)	0.06781
9	team stability (P3)	0.03057
10	customer capabilities (E2)	0.01087
11	new technology use (T2)	0.00331

Conclusions

As can be seen from the ranking, the most critical factor affecting the delivery schedule of software development projects of bulk commodity electronic trading platform is demand management, accounting for 22.237 %, followed by communication management, accounting for 19.164 %. Then, demand change frequency (11.303 %), personnel ability (10.048 %), development method selection (0.09173) and project reusability (0.08650) account for 80 % of the weight of the whole weight, which is the key factor affecting the delivery schedule of T company's software development project.

From environmental factor, personnel factor, management factor and technology factor dimensions, for commodities electronic trading platform software development, this paper analyzes the factors which affect to delivery schedule, for commodity trading platform, the factors that affect software development project delivery schedule management biggest, accounted for 48.182 %, the findings and the personnel factors accounted for 21.274 %, The second is technical factors, 18.154 %, and the last is environmental factors, accounting for 12.39 %. The priority order of secondary indicators in the evaluation model of influencing factors of software delivery schedule of bulk commodity electronic trading platform is shown in the table below;

Table 5 The results of the ANP.

Number	Level 2 indicators	Priority
1	Management factors（M）	0.48182
2	Human factors（P）	0.21274
3	Technical factors（T）	0.18154
4	Environmental factors（E）	0.1239

Two evaluation indicators directly related to demand, demand management (22.237 %) and demand change frequency (11.303 %), ranked first and third in terms of their impact on the delivery schedule of software development projects of bulk commodity electronic trading platform. The influence of these 2 factors on the delivery schedule of the software development project of the electronic trading platform for bulk commodities accounts for 33.54 %. The above data shows that for the electronic trading platform for bulk commodities, the impact of software demand on the delivery schedule of the software development project is obvious.

Acknowledgements

This paper makes a detailed analysis on the delay of software development schedule delivery of bulk commodity electronic trading platform, especially on the schedule control and management. This paper tries to use network analytic hierarchy process (ANP) to analyze the influencing factors of software development and delivery schedule of bulk commodity electronic trading platform and evaluate it quantitatively. Based on ANP commodity trading platform software development delivery schedule impact factor evaluation model, calculate weight evaluation model of the judgment matrix, not weighted matrix, to strengthen the super matrix and matrix, the limit in the end it is concluded that the evaluation index of prioritization, affecting commodity trading platform software delivery schedule of the key factors.

At the same time, it is also hoped that the research method of influencing factors of software delivery schedule of bulk commodity electronic trading platform can also provide reference and help for other software development enterprises to solve similar problems, so as to change the schedule control of software development project from passive to active and improve the effectiveness of software project schedule control.

The electronic trading platform of bulk commodities has a good beginning in the study of factors affecting the delivery schedule of software development projects. The ANP analysis method is adopted to analyze the factors affecting the schedule and evaluate them quantitatively. Next, the research of this topic should be extended to other types of software projects. However, since each software enterprise faces different customers and needs, and its own characteristics are also different, how to select the analysis method in line with its own characteristics for research is a very difficult task.

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