SIMULATION RESEARCH ON THE MOBILE E-COMMERCE PROCESS OF NON-GRID AND GRID BASED ON ARENA

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Abstract: The research on the process of Mobile E-commerce has become the focus. Both building new process and optimizing old process, determining the reasonability and reliability of the process by a scientific means is needed. This paper will finish the task below. Firstly, put in order the process of Mobile E-commerce and form the appraisal system. Secondly, simulate the model of Grid and Non-grid Mobile E-commerce process. Finally, appraise the out coming based on the appraisal system and point out the superiority of Grid Mobile E-commerce process. This paper is used to provide a new way of thinking in the research of Mobile E-commerce, for the purpose of integrating theory with practice and making for society.

1 INTRODUCTION

With the development of Mobile E-commerce industry and Grid Management Theory in recent years, Mobile E-commerce has developed to the specific facts and the application stage. Foundation Joint has got more and more attention. On the research of Mobile E-commerce, the process research is always the focus.

Both building new process and optimizing old process, determining the reasonability and reliability of the process by a scientific means is needed. However, the building of traditional process relies mainly on the experience and the appraisal focuses on qualitative aspects. For a complex process, the main points can not be seized. So a scientific means to reflect and evaluate the process is needed.

System simulation as a product of this demand came into being. With its unique approach to process design and optimization and reliable quantitative data, system simulation shortens the cycle and improves the scientific decision-making during the process optimization. As a simulation tool used in discrete systems, continuous systems and hybrid systems, Arena is widely used in different situations at all levels of the simulation. This paper takes it as a simulation tool to apply to the evaluation of Mobile E-commerce process.

Arena is one of the representative simulation software, developed by Rockwell Software. It can create many kinds of simulation models, such as production system model, service system model and so on. Arena can use parameters to simulate one dynamical system as true as possible, while it can keep itself easy to use and flexible depend on its hierarchical structure. Arena can even be integrated with some program language, just like Microsoft Visual Basic and C language, which makes itself more suitable for simulation optimization. Simulation process is divided into four steps. Firstly, create simulation model. Secondly, set the parameters of simulation model. Thirdly, run the simulation model. Lastly, verify the simulation model, analyze the result and choose the best solution. In addition, Arena uses event scheduling method, which uses events to analyze the system and determines logical relationship by delimit events and the change of system state.

Meanwhile, the formulation of mobile grid theory provides an integrated, open and dynamic

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environment for the building of Mobile E-commerce process. It integrates sellers' data to provide customers an access to resources with a unified interface. Customers and sellers communicate timely and smartly, greatly improving the sharing of information and resources.

Therefore, applying the mobile grid theory and simulation technology to building and optimizing Mobile E-commerce process and building the Mobile E-commerce process based on grid provide a new way of thinking in the research of Mobile E-commerce.

This paper builds the appraisal system of Mobile E-commerce process based on the research at home and abroad. Then put in order non-grid Mobile E-commerce process and simulate the model of process in Arena. Thirdly, build grid Mobile E-commerce process based on the application of mobile grid theory and simulate the model. Finally, appraise and compare the out comings based on the appraisal system and point out the superiority of the grid model.

2 LITERATURE REVIEW

At the first International Conference of Mobile Commerce Mylonopoulos proposed a broad definition of Mobile E-commerce: "Personal participants and business groups use wireless and mobile technology to create a new learning process of social interactive experience in specific historical and social environment." (N.A.Mylonopoulos, 2003) Therefore, Mobile E-commerce refers to the business activities through the combination of cell phones, PDA, notebook computers and other mobile communication terminals with the Internet.

In the late 1990s, since the advent of Mobile E-commerce application, scholars began to study the theory. But it is still in the early stage because the practice time is short.

The researches which have a certain influence are P-graph model (Heijden and Valiente, 2002) for Mobile E-commerce process by Heijden and Valiente and the Process Landscaping method (Volker Gruhn, 2003) by Gruhn.

In P-graph model there are actors, activities, locations and other model elements. The business activities form a structure of relations in space and time, including decision making, control and coordination. P-graph model is simple and intuitive by marking the place of actors and the mobile state of actors to identify the possible introduction of wireless information technology. It is easy to analyse and design business process.

Gruhn proposes a "mobile business process" concept and the Process Landscaping method. Operational implementation has a particular distributed architecture, while the executors have the mobility. He proposes that mobile business processes has three different characteristics with other business processes: the uncertainty of position and its determinants, the requirement of process implementation and coordination of external resources. Process Landscaping method is further than the P-graph model. It uses the procedure as the basic element of the process design and decomposes the business activities into perlsub. Ultimately determine the location of those actors and identify interactive information.

Domestic mobile business management scholars have gradually further study, such as "the analysis of Mobile E-commerce payment models and safety" by Deli Yang, "the empirical model and simulation of Internet content service pricing" by Zhongding Zhou, "Acceptable model of Mobile E-commerce and the key success factors in the enterprises implementation" by Haiqi Feng, "the Study of basic theory and technical methods in Mobile E-commerce" by HUST, "Comparative Study of Mobile E-commerce services between Korean and China: Government Policy and Corporate Strategy" by Tsinghua University and so on.

However, the domestic research of Mobile E-commerce mainly focuses on the basic theory, information security, industry level analysis, government policy formulation, technical application and diffusion. The researches of process are lacked. Only a few scholars simulate and analyze Mobile E-commerce process based on Petri or Flexism.

In summary, the research of Mobile E-commerce process is still scattered and in the state of qualitative description. Overall research and modeling method are needed. There are many kinds of modeling and simulation software, such as GPSS, SIMSCRIPT, SLAM, Flexism, and Arena. This paper uses Arena not only because of its visual interface, but also because of its unparalleled advantages for the process of simulation.

3 THE APPRAISAL SYSTEM OF MOBILE E-COMMERCE PROCESS

3.1 The Comprehensive Appraisal System of Mobile E-commerce Process

In the traditional process of E-commerce and Mobile E-commerce research, it did not have a set of appraisal system for Mobile E-commerce process. However, many researchers did some research on the website of Mobile E-commerce, customer satisfaction and sellers' credit. In addition, some scholars carried out analyse and research on the Mobile E-commerce process through the establishment of the process evaluation model and simulation methods.

- The Research of Foreign Scholars

LEE (LEE, 2001) believes that customer satisfaction decides repurchase rate of one online shop. And he brings forward customer satisfaction model in E-commerce. Yang and Jun (Yang Zhilin, Minjoon Jun, 2002) find that reliability is one of the most important indexes of service quality. Vijayasarathy and Jones (Vijayasarathy Leo R, 2000) believe the predilection and attitude of customers decide the satisfaction, concluding from their research on Internet customers. Szymanski and Hise (Szymanski D M, Hise R T, 2000) think that convenience, website design and safety could affect customer satisfaction.

- The Research of Domestic Scholars

Jinxiang Zha (Jinxiang Zha, 2006) studies from the perspective of the shopping websites and sets up a structure model among the service quality, customer expectation and customer satisfaction. The author divides the service quality into eight dimensions: web design features, network security, interactive of the network, product quality assurance, convenience of the website, price advantage, and operation difficulty of the website. The author also did an empirical research on the sample of college students who are one of the main participants in current shopping online. And the empirical research suggests that network security, price advantage and the product quality assurance are the main factors of improving customer satisfaction.

Ximei Dong (Ximei Dong, 2007) sets up a customer satisfaction index system based on the factors of customer satisfaction in the environment of E-commerce. The article points out five kinds of factors may have influence on customer satisfaction: transaction security, product information, the website design, service integrity and marketing planning.

Guo and Liang (Yan Guo, Laizhen Liang, Dazhi Huang, 2007) elaborate the importance of customer satisfaction in the network economy. They point out the main factors which affect customer satisfaction: product quality, safety, service quality and convenience. And this paper also puts forward some strategies to improve customer satisfaction.

Jianfeng Hong (Jianfeng Hong, 2007) analyzes the factors that affect customer satisfaction in the model of C2C E-commerce, based on the study of traditional customer satisfaction and the characteristics of C2C E-commerce. The factors are C2C web site, online shop, online shop type and individual customer's characteristics. On the level of C2C website, the web technologies and transaction security are important. On the level of online shop, the value of products, service and image value are the main factors. But the online shop type and individual customer's characteristics are different according to the product properties.

Establishing a scientific appraisal system of Mobile E-commerce should follow the scientific, comprehensive, feasible and comparable principle. The selection of indicators should cover all the requirements and characteristics of Mobile E-commerce process and avoid the association between indicators.

According to the research of domestic and foreign scholars above, build a more comprehensive and unified appraisal system of Mobile E-commerce process from the website of Mobile E-commerce and customer satisfaction as Table 1.

This paper builds a more comprehensive and unified appraisal system of Mobile E-commerce process from the website of Mobile E-commerce and customer satisfaction as Table 1. Most indicators are applied for qualitative analysis and comprehensive as far as possible. However, qualitative analysis is not enough systematic and convincing. The simulation model only evaluates several specific aspects. Therefore, this paper evaluates Mobile E-commerce process as the thread below: Firstly, establish the appraisal system as comprehensive as possible through qualitative analysis. Then convert the indicators that are not easy or inaccurate to evaluate through qualitative methods into indicators for quantitative analysis. Lastly, simulate the simulation model using Arena and analyse the results.

Table 1: The comprehensive appraisal indicators of Mobile E-commerce process.

appraisal indicators		
first-level indicators	second-level indicators	third-level indicators
website	service	T1 communication tools
		T2 individuation
		T3 BLOG, RSS
		T4 help online
	technology	T5 website access speed
		T6 searching function
		T7 design friendly
	content	T8 clear navigation
		T9 rich information
		T10 copywriter quality
		T11 update information in time
	process	T12 simple step
		T13 clear exit path
		T14 accurate statistics
customer satisfaction	online store condition	T15 types of goods, prices and other information
		T16 update goods in time
		T17 whether the goods correspond with the actual
	pre-sale and after-sale service	T18 response to questions
		T19 return goods
		T20 personalized service
	payment	T21 types of transaction
		T22 security of transaction
		T23 the protection of customer privacy
	logistics and distribution	T24 logistics and distribution methods
		T25 logistics and distribution time
		T26 package integrity

3.2 The Simulation Appraisal System of Mobile E-commerce Process

The quantitative evaluation of the indicators requires complex process, so the number of indicators can not be too much. Select quantifiable indicators from Table 1 and convert the many indicators into a few composite indicators using principal component analysis. Then establish the quantitative indicators table of Mobile E-commerce process. After classification of the intrinsic link between indicators, select the principal component indicators and establish the quantitative indicators table of Mobile E-commerce process as Table 2.

Table 2: The quantitative indicators of Mobile E-commerce process.

principal component indicators	comprehensive indicators	simulation indicators in Arena
service response capabilities	T1、T2、T6、T8、T14	Wait Time
system operating time	T12、T13、T19、T21、T25	Total Time
service congestion	T5、T11、T16、T18	WIP
service intensity	T3、T4、T7、T9、T10、T15、T20、T22、T23、T24、T26	Instantaneous Utilization

According to principal component analysis, find the internal relevance among a number of indicators and use four new indicators that have poor correlation to reflect most of the information among Table 1. Appraise Mobile E-commerce process through analysing the four new indicators that reflects in the Arena simulation system as Wait Time, Total Time, WIP and Instantaneous Utilization. In summary, by analyzing Wait Time, Total Time, WIP and Instantaneous Utilization the operational capabilities and actual results of Mobile E-commerce process can be reflected comprehensively and reasonably.

4 THE SIMULATION OF NON-GRID AND GRID MOBILE E-COMMERCE PROCESS

4.1 The Simulation of Non-grid Mobile E-commerce Process

4.1.1 The Process of Non-grid Mobile E-commerce

The main difference between Mobile E-commerce process and traditional E-commerce process is that they use different terminals. Traditional E-commerce mainly uses the Internet to communicate with customers. Position is fixed. While Mobile E-commerce combines Phone, PDA, notebook and other mobile terminals with the Internet to achieve mobile and individual service. Therefore, Mobile E-commerce process and traditional E-commerce process are similar. The difference lies in the customer's authentication and access points.

This paper studies the process and sums up the general non-grid Mobile E-commerce process as figure 1.

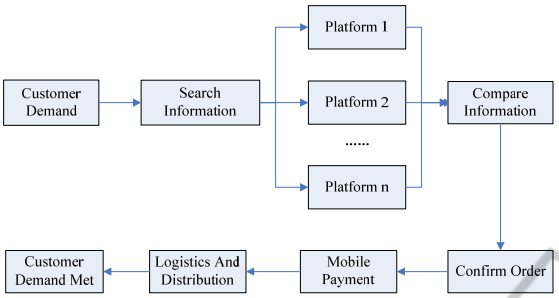

Figure 1: The Non-grid Mobile E-commerce process.

Firstly, the user enters the information platform through mobile equipment to search target product or service information. However, due to various platforms assigned to different users with different access rights and the lack of a unified interface between different platforms, the information can not be shared. If the user can not search satisfied information from the platform, he needs to enter other platforms to search information until he gets useful information.

Secondly, after receiving more than one seller's product information or service information, users need to compare them and determine which to buy. Then submit orders to the appropriate seller.

Thirdly, after confirming the order, users need to do mobile payment, while the seller organizes to finish the logistics and distribution.

Finally, the user receives the goods, which indicates that the transaction is successful.

4.1.2 The Simulation of Non-grid Mobile E-commerce Process

This paper simulates Mobile E-commerce process through Arena. The model's building and parameters' setting will be strictly in accordance with the rules for the implementation of Arena simulation, using the full hierarchical structure of the modeling method.

According to the method, convert the process model into logic model as figure 2. The logic model is divided into three parts: the incident arrive, the operation of the main process (MBP) and the incident left. The incident arrive module gets user demand and completes access point selection; MBP module completes the product selection, payment and distribution; the incident left module is responsible for follow-up treatment.

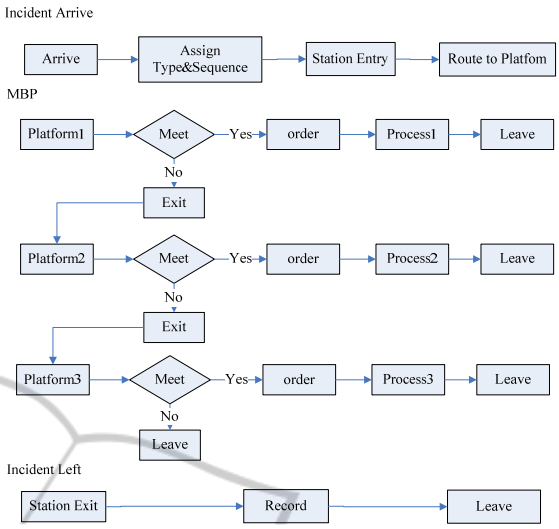

Figure 2: The logic model of Mobile E-commerce process on non-grid.

According to the rules for the implementation of Arena simulation, convert the logic model into simulation model as figure 3.

- The user enters the platform according to certain rules and user demand will be gotten by the system. Assuming the user's reach is relatively independent and data fluctuates strongly, set the parameters to consistent with the exponential distribution with mean 5 and 1 entity reaches during the average time.
- If the user's requirements are not met, then log out the current platform and continue to submit other platforms.
- If the user's requirements are met, then confirm the order and complete mobile payment. After the seller completes logistics and distribution, transaction is implemented. Transacting of each module reflects a certain probability distribution. There is a "most likely" time among the transacting time for each module, while other time fluctuates near the "most likely" time.

4.2 The Simulation of Grid Mobile E-commerce Process

By analyzing the process of non-grid Mobile E-commerce, this paper finds that the resources of Mobile E-commerce domain are not integrated efficiently.

The lack of resources hinders the development of Mobile E-commerce in some small enterprises, while other resources are vacant in large enterprises.

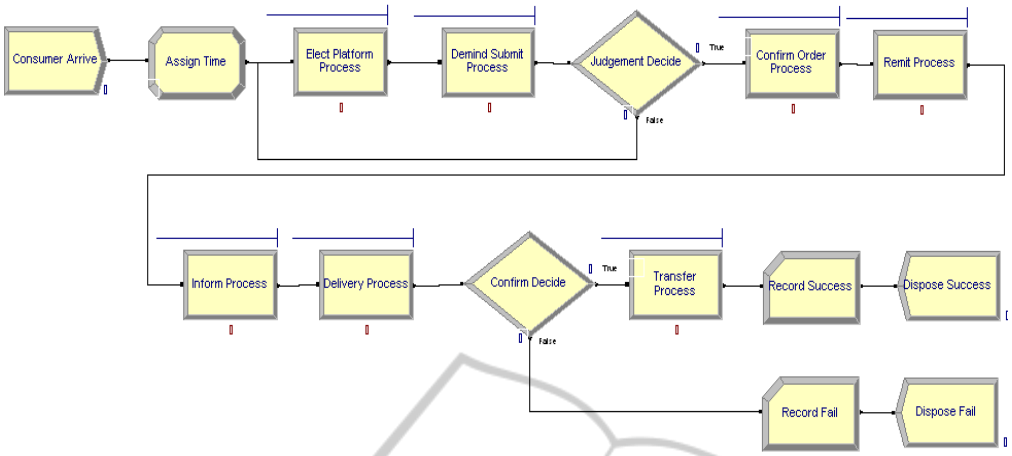

Figure 3: The simulate model of Mobile E-commerce process on non-grid.

The phenomenon not only results in great waste of resources, but also hinders the development of Mobile E-commerce. For the customers, there is not a unified and integrated platform. They need to visit different sites to browse and compare a lot of merchandises to meet their own needs.

At the same time, this paper finds that the user waiting time is the key factor which constraints the process through the Arena simulation, while nearly 90% of the time customers are waiting for service in the entire service process. A lot of time waiting in line reduces order processing speed and web site accessing speed greatly. Customer satisfaction is also reduced.

The emergence of grid management provides a theoretical and technical support and effective solutions to solve the above problem. The purpose of the grid is to integrate all physical and logical resources into a virtual super-computing environment, which breaks the previous restrictions on computing resources, such as geographic location, computing power, sharing and collaboration restrictions. So people can use computing resources freely and conveniently.

To solve these problems, based on grid management theory, this paper constructs grid Mobile E-commerce process and establishes a comprehensive resource platform. To provide customers an integrated, open and dynamic environment with a unified resource access interface, the platform integrates business resources to make communication better between users and sellers.

Therefore, Mobile E-commerce process is that applying mobile grid theory to traditional Mobile E-commerce process for resource integration and better communication.

4.2.1 The Process of Grid Mobile E-commerce

The idea of constructing Grid Mobile E-commerce process is to build a mobile business domain, which is made up of sellers, customers and the integrated resource platform. The seller has its own independent business system. The integrated resource platform is the bridge of communication between sellers and customers. It is responsible for information integrated into a unified platform and presented to the customers. The handling of business is finished in the integrated resource platform.

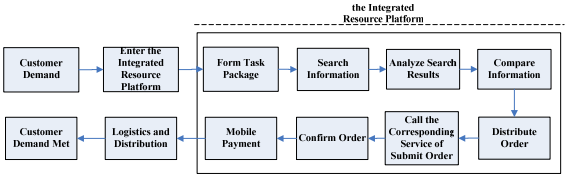

Figure 4: The Mobile E-commerce process on grid.

As shown in Figure 4, for the users, they enter the information platform through mobile equipment to search target product or service information. After receiving more than one seller's product information or service information, users need to compare them and determine which to buy. Then submit orders to the appropriate seller. Thirdly, after confirming the order, users need to do mobile payment, while the seller organizes to finish the logistics and distribution. Finally, the user receives the goods, which indicates that the transaction is successful.

In the user's entire operation, users only need to log an integrated resource platform to complete a series of operations without entering other platforms. These operations are done by the integrated resource

platform automatically. Many sellers' information is integrated in a unified platform, which allows users to complete mobile payment through task package judgment and order distribution.

4.2.2 The Simulation of Mobile E-commerce Process Based on Grid

According to the Arena simulation method, convert the process model into logic model as figure 5. The logic model is divided into three parts: the incident arrive, the operation of the main process (MBP) and the incident left. The incident arrive module gets user demand and completes access point selection; MBP module completes the product selection, payment and distribution; the incident left module is responsible for follow-up treatment.

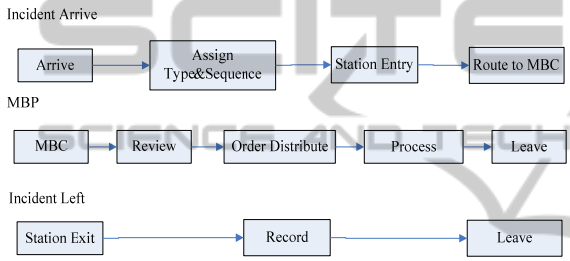

Figure 5: The logic model of Mobile E-commerce process on grid.

According to the rules for the implementation of Arena simulation, convert the logic model into simulation model as figure 6.

- The user enters the platform according to certain rules and user demand will be gotten by the system. Assuming the user's reach is relatively independent and data fluctuates strongly, set the parameters to consistent with the exponential distribution with mean 5 and 1 entity reaches during the average time. The rules are the same as those in non-grid mode.
- If the user's requirements are met, then confirm the order and complete mobile payment. After the seller completes logistics and distribution, transaction is implemented. Transacting of each module reflects a certain probability distribution. There is a "most likely" time among the transacting time for each module, while other time fluctuates near the "most likely" time.

5 THE COMPARISON OF SIMULATION RESULTS BETWEEN NON-GRID AND GRID

5.1 Setting a Simulation Example

This paper studies Mobile E-commerce process. Unlike the typical production business system, reliable data can not be obtained. So Arena refers it as "special data ". For this type of data, if it is relatively independent and fluctuates strongly, set the parameters to consistent with the exponential distribution. If time data represents activity and there is a "most likely" time among the transacting time for each module, while other time fluctuates near the "most likely" time, set the parameters to consistent with the triangular distribution. Thus, each module's parameter setting are used to reflect the probability distribution, monitoring and decision-making aspects are omitted, and assuming that system is in normal operation; system stakeholders are skilled in operation, and no conflict or acts are carried out; resource status is always good.

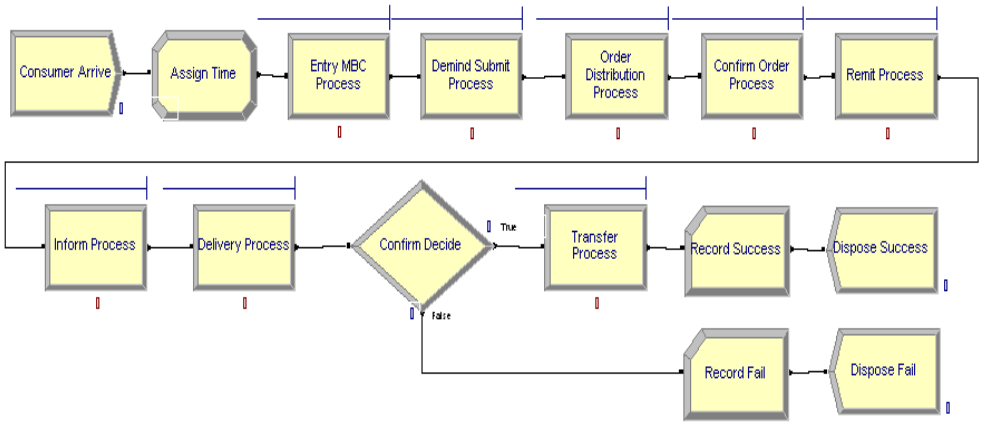

Figure 6: The simulate model of Mobile E-commerce process on grid.

The simulation parameter setting assigns the non-grid mode as the benchmark, which makes the non-grid mode is at a higher busy status and the resource allocation of each node process is also more balanced. In order to make the simulation also has certain practical reference value, the parameter setting of the grid mode references to the non-grid model and reality.

A simulation example sets a period of 8 hours; the user demand can be submitted at any time; the basic statistical unit is minute. Since the existence of random factors, any two simulation results are probably not the same. Therefore, this simulation adopts the results of statistical with 10 times.

5.2 The Analysis of the Simulation Results

As Table 2, the four principal component indicators: service response capabilities, system operating time, service congestion and service intensity, are corresponded to the four Arena simulation indicators: Wait Time, Total Time, WIP and Instantaneous Utilization. Therefore, this paper analyses the results from Wait Time, Total Time, WIP and Instantaneous Utilization as figure 7 to 10.

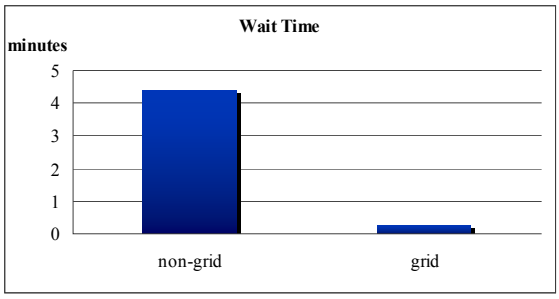

Figure 7: The comparison of Wait Time between non-grid and grid.

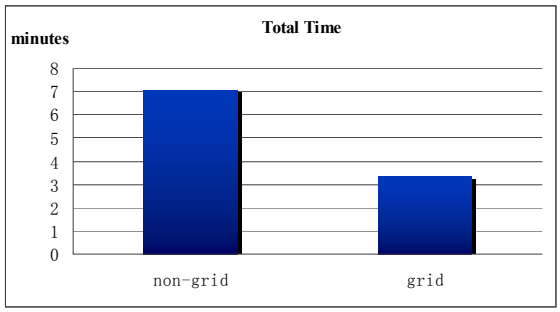

Figure 8: The comparison of Total Time between non-grid and grid.

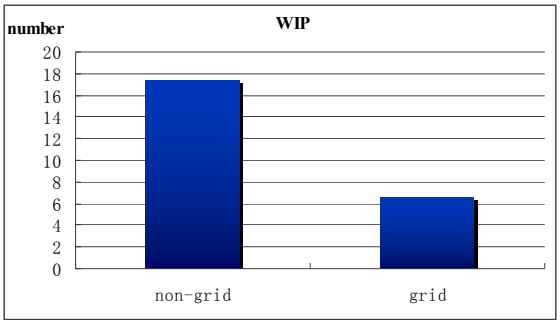

Figure 9: The comparison of WIP between non-grid and grid.

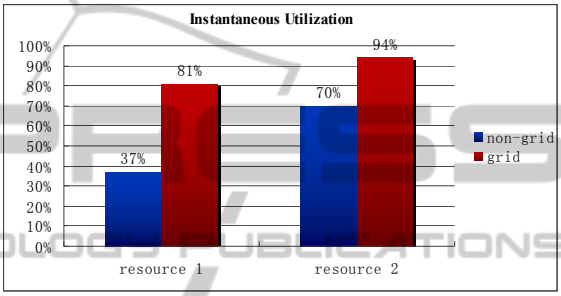

Figure 10: The comparison of Instantaneous Utilization between non-grid and grid.

- The Comparison of Wait Time;

Wait Time is the period from customer's arrival time to start time that he receives service. This indicator evaluates service response capabilities. Shown in Figure 7, by adding the grid management theory to Mobile E-commerce process, the user's average waiting time is reduced to 30% of the original and the system processing speed is greatly improved. Therefore, the grid mode has an advantage in service response capabilities than the non-grid mode.

- The Comparison of Total Time;

Total Time is the period from customer's arrival time to end time that he receives service. This indicator evaluates system operating time. Shown in Figure 8, by adding the grid management theory to Mobile E-commerce process, the system operating time is about 40% of the original and the time required is greatly improved. Therefore, the grid mode has an advantage in system operating time than the non-grid mode.

- The Comparison of WIP;

WIP is the number of customers in the system, the sum of the number of customers waiting in line and the number of customers in service. This indicator evaluates service congestion. Shown in Figure 9, by adding the grid management theory to

Mobile E-commerce process, the WIP is reduced to 61% of the original. Therefore, the grid mode has an advantage in service congestion than the non-grid mode.

- The Comparison of Instantaneous Utilization; Instantaneous Utilization is the utilization of resources during the entire service. This indicator evaluates service intensity. Shown in Figure 10, the resource utilization improves greatly on grid mode. Therefore, the grid mode has an advantage in service intensity than the non-grid mode.

From the above analysis, the Wait Time, Total Time and WIP on non-grid mode are longer compared with the grid model. Because on the non-grid mode, the business services are separately controlled by computer and the user needs to search for resources on different platforms. While on grid mode the user needs to submit only once demand, then he can get all of the corresponding information. This advantage on grid mode will reflect more obvious when the order involves a number of companies.

6 CONCLUSIONS

With the development of information technology, Mobile E-commerce has entered the stage of service as the theme and process optimization as the main line. The main difficulty is how to share information, collaborate and reengineer business process. This paper, combining qualitative analysis method with quantitative analysis method and using Arena, forms the appraisal system and simulates the model of Mobile E-commerce process based on Grid and Non-grid. Finally, point out the superiority of the model based on Grid and provide a new way of thinking in the research of Mobile E-commerce.

However, many aspects of this paper are needed to be strengthened, especially setting the parameters according to Arena simulation rules. This paper will further the research and collect more reliable data to evaluate the models more reasonably.

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