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A Study on Group Buying of O2O Mode using Generalized Stochastic Petri Nets

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Abstract

This paper proposes a Group Buying model (paid in advance) of online-to-offline mode using Generalized Stochastic Petri Nets. As the time cost of consumers is getting higher and higher, time efficiency is getting much more important in all aspects of life, especially in catering industry, and one way that can lead to direct communication between store owners and consumers is Group Buying of online-to-offline mode, the center of which is the brand building and service efficiency. Although researches based on both users' and sellers' perspective about online buying are very rich, these findings are not entirely applicable for this new e-commerce model, and most of current research on online-to-offline mode use qualitative methods. More importantly, few researchers have concerned about the efficiency of Group Buying process and come up with related solutions to improve it. By constructing a business model of GB and conducting time efficiency and performance analysis on it, we find that the key transitions of the system only take up less than half of the time before the whole process has been completed. And when we shorten the feedback process, the percentage of finishing consumption in physical store in the whole Group Buying model can be improved by 14.5%. Thus, we suggest that suppliers and sellers should be more focused and efficient in encouraging customers review timely as well as giving consumers feedback as soon as possible, since consumer comments are proved to be significantly important for the retailers. Besides, site operators and store sellers can also use other ways like WeChat and microblogging to promote their site linkages and gain more market share.

Keywords: *O2O mode, Group Buying, GSPN, Time efficiency, Consumer reviews*

1. Introduction

In recent years, the worldwide e-commerce industry has been through a rapid growth, consumption pattern of buy-online-consume-in-store is also in a meteoric rise. This pattern named as group buying (GB) is one kind of O2O modes. O2O refers to any kinds of activities that initiate online somehow finally results in a consumer going to a physical store. In this interconnected world, as the life of modern humans is fast paced and many jobs require extensive use of social media, consumers are increasingly trying to seek their own initiative chooses in service and brand. As a result, consumers' finding usable sources on websites are becoming increasingly hard or costly, and their expectations have never been higher. Compared to the traditional commercial activities, the Internet value chain has changed from manufacturers - distributors - stores - consumers to vendors - platform – consumers, which gets rid of the distributors – stores link, improving the whole system efficiency [1].

The online GB market is fragmented among hundreds of smaller players worldwide, which has little barriers to entry and has gained attention from shoppers and businesses alike globally [2]. The number of GB sites firstly soared up in Asia, especially in China, while

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recent developments have led to a wide increase of appearances of similar phenomena in Europe and North America, and on March 22, 2011, the popular New Zealand auction site Trade Me has launched a local GB site called Treat Me [3]. According to SmartMoney, by August 2010, there were more than 500 group-buying sites worldwide, including local sites that cater only to a single city in some instances [4]. What's more, based on the 2013 China electric dealer market report, online GB market in 2013 is only 0.6% of the online shopping market; potential growth is anticipated in the future. O2O platforms, like MeiTuan, Baidu Nuomi and Lashou, have been implanted into every corner of the electronic commerce field in China [5]. In Cosmetology GB market, Meituan takes up 53% of the whole market share, which is significantly ahead of other competitors, showing an obvious dominant trend, according to China life service O2O market research report 2014.

This study focus on GB (paid in advance) of the buy-online-consume-in-store pattern without concerning about logistics and other incidental services. By changing the physical stores into the display terminal of network mall, sellers have been able to do multi-brand whole series products business in their own stores. Generally, O2O platform is mainly related to Cosmetology, Food, Movies, etc., and has grasped more and more pro-consumers' gaze because of its unique consumer experience and the feature of being cheap and fine. Few researchers have concerned about the efficiency of GB process and come up with related solutions to improve it. Therefore, it is in urgent need of conducting a quantitative analysis on the GB model to enrich the related literature and provide site operators and retailers feasible suggestions.

1.1 Literature Review

Several earlier studies show that for those who are utilizing O2O e-commerce mode, more preferential promotions online than offline are effective ways to attract customers to pay online, which also saves a lot of expenditure for consumers. Chen et al. have discovered that online GB is more beneficial to customers than the traditional ways through study on the group-buying auction mechanism [6]. This is consistent with Lia, *et al.*, conclusion about the approach of improving buyers' overall surplus and allocating both buyers' and sellers' cost to the best [7]. Tom, *et al.*, have proposed a method and system that make buyers and sellers to communicate with each other more fluently and through which consumers can bargain the purchase terms of the featured products in a GB scenario [8]. As a result, an increasing number of stores are utilizing brick-and-mortar inventory data straightly acquired from vendors to turn online clients into offline purchasers [9]. These studies of marketing strategy in the group-buying transactions are helpful in providing information that will enable sellers to optimize their approach to pricing.

On one hand, some researchers focus on the factors influence consumers' intention of taking participation in GB, which vary from browsing time to pattern changes. Through multiple regression analyses on a total of 264 questionnaires, Tai, *et al.*, find that browsing time has a mediate effect on many other factors included in the paper [10], which means the sellers could do something more about web pages to enhance their customers' satisfaction. Using the same research method, Lu et al. point out that influence of perceived costs on the adoption of mobile shopping is very small, but the price cannot be ignored in the mobile phone GB [11]. By examining a model of duopoly firms selling to an exogenously formed buyer group consisting of members with heterogeneous preferences from seller's perspective, Chen and Li find out that the presence of buyer groups may increase symmetric firms' efforts in quality improvement, while may actually decrease firms' efforts in enhancing product quality in asymmetric ones, because a firm with disadvantage in quality may find it optimal to

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increase rather than to reduce its quality gap with the competitor in order to encourage buyers to purchase individually [12].According to Kauffman et al.'s research on GB auction, perceived price fairness has a significant impact on consumer's GB intention [13], which means the price is still a great factor for consumers buy online. Unlike buy-online-pickup-in-store pattern, this buy-online-consume-in-store project does not result in a reduction in online sales and an increase in store sales and traffic [14].

From our instinctive, it seems that customer satisfaction is the factor directly influence the formation of customer loyalty, but Lei et al.'s study show that at the present stage of China's online GB industry, there is no direct causal relationship between customer satisfaction and customer loyalty, but in the need of the brand trusting as mediation [15], which means promoting standardization of store image, advancing sales and after sales service and enhancing customers' satisfaction, are crucial to form long-term competitive advantage.

As for the current and future development of GB, Yu and Lu's study indicate that the GB market is still in Food, and Shopping is gradually being recognized, while Leisure GB concentration is declining [16]. Li has proposed a model which divides mobile shopping life cycle based on the pattern of O2O mode into six obvious time nodes [17], but it is merely based on theoretical experience without conducting depth analysis. Similarly, Xue, *et al.*, theoretical study on the future development of China's online shopping patterns shows that future mobile platform shopping, reverse GB, O2O pattern and preselling mode will be the four main directions of the development of online shopping in China [18]. According to Wang's study, although the e-commerce has experienced a rapid development in recent years, its transaction scale is less than one tenth of the traditional transaction scope. He believes that the main bottleneck is the lack of connection between online consuming and offline consuming, along with a series of problems with the progress of O2O method [19]. To solve these problems, there should be an improvement on O2O method according to the advantages and disadvantages of O2O method, so as to provide satisfactory service to consumers. However, these studies listed above merely base on theoretical experience. Lacking of empirical research, the conclusion and the forecast seems not so reliable.

In short, most of current researches on online-to-offline mode focus on influencing factors or the status quo of development using regression analysis on survey data or merely qualitative methods. Although researches based on users' perspective about online buying are very rich, these findings are not entirely applicable for this new e-commerce model. Most of all, few researchers have concerned about the efficiency of GB process and come up with related solutions to improve it. Therefore, it is in urgent need of conducting a quantitative analysis on the GB model to enrich the related literature and provide site operators and retailers feasible suggestions.

1.2 GSPN

Generalized Stochastic Petri Net (GSPN) is a popular modelling formalism for analyzing system performance and dependability. The concept of time was not introduced in the initial Petri net. In order to examine the dynamic system performance index of discrete event, people introduced time into Petri net in mainly two ways: 1. Between each change can be implemented linked with a fixed delay time, which is called timed Petri net; 2. Between each change can be implemented linked with a random delay time, which is called stochastic Petri net (SPN). Most of the stochastic Petri net performance analyses are based on the state space and the homogeneous markov chain. But the state space of stochastic Petri nets will exponentially increase with the development of the problems, which makes stochastic Petri net homogeneous markov chain difficult to solve. In order to address this problem, Marsan

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[20] leading colleagues in 1984 proposed the theory of generalized stochastic Petri nets. As time goes by, new research findings emerge in large numbers, adding additional elements to the definition and its application in the expanding fields of GSPN.

Ciardo, Muppala, and Trivedi [21] extend the basic GSPN model to the GSPN-reward models, which allow the succinct description of not only underlying stochastic process, but also the transitions of the stochastic process and the rewards attached to the states as well.

Due to ambiguities in the semantic interpretation of confused GSPNs, Christian, Holger, Joost and Lijun [22] have defined a simple semantics for every GSPN by using a non-deterministic variant of CTMCs, referred to as Markov automata. In their definition, no restrictions are imposed on the existence of misperceptions; cycles of instant transitions are admitted; instant transitions may be weighted but are not required to be as well.

Based on the conversion of a GCTBN model into a GSPN, Daniele and Luigi [23] present a software tool for analyzing Generalized Continuous Time Bayesian Networks (GCTBN) which extends CTBN introducing along with continuous time delayed variables, non-delayed or immediate variables whose evolution is tentatively and instantaneously determined by the values of other variables in the model.

As a profound analyzing tool, GSPN has been used in many fields, especially in supply chain [24], traffic congestion [25], P2P network [26], wireless control system [27], etc., GSPN describes a system graphically, which gives viewers visual impression. More importantly, it can better describe the dynamic characteristics of the system. Also, performance analysis of systems through GSPN models or similar formalisms has developed considerably since their introduction, particularly in a remarkable research direction concerning how to define and calculate pertinent performance measures [28].

1.3 Using GSPN in GB Model

However, few researchers have noticed the efficiency of O2O mode. In the existing GB pattern, price seems not to be the only reason for consumers' choice of buying online. Researchers are more concerned about what other factors that influence consumers' decisions, how the site operator and the store sellers improve the effectiveness of this O2O mode, and what needs to be improved in the whole GB process. Knowing about the detailed reasons for consumers' decision making can help operators to provide better services, so as to attract more new users.

There are a lot of evidence shows that one of the most noticeable features in GB is efficiency first [29-30]. In the field of electronic commerce there is even such a saying goes around: "Either fast or die". Thus, finding an effective tool to analyze the efficiency of GB is rather important. By translating the GB process into a dedicated petri nets, GSPN can dynamically display the entire transaction process, and estimate all aspects of the efficiency of the existing GB pattern, thus providing a good reference for the platform operators.

Instead of discussing O2O mode on theoretical studies, this paper proposes a GB consumption model from a different angle, using a powerful analysis tool – GSPN to analyze the estimated efficiency of GB pattern, which can be beneficial to both researchers and GB suppliers. Time efficiency and performance analysis of the proposed model. By speeding up the feedback process, the percent of consumption stage in the entire GB model can be improved by more than 10%. According to these findings, some novel conclusions have been reached, and feasible suggestions have also been proposed for site operators and store sellers.

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2. Modeling and Calculation

2.1 Constructing the Business Model

Li believes that in the new era of mobile shopping based on O2O mode, the traditional funnel model is fading away. Instead, the new life cycle of mobile shopping springs up, which is constituted by six repeating phases: demand confirmation, mobile search, mobile payment, purchase decision, consume in a store, and customer service feedback [17]. Du and Tang divide the operation flow of O2O e-commerce mode into four steps involving three characters. They are: 1. Consumers search service online and place the order on the O2O platform; 2. Order processing from online platform to offline entity; 3. Offline consumption; 4. Online feedback [5].

In this paper, we use GSPN modeling tool to analyze the flow of a business occurred both in a GB website and in the actual consumption process. Based on the theories above, the main GB process is divided into four steps: Seller's Management, Consumer's ordering, Consume in the Store and Feedback after Consumption. The business process model is presented in Figure 1. For the business process model of GB in Figure 1, we establish the corresponding workflow model based on GSPN (Figure 2). First, the seller releases GB news on the O2O platform, providing information and advice services for customers. Second, the transition t5 is triggered, and transaction information has been collected after the consumer finish the online payment, which triggers t6, generating the order validation for both sellers and consumers. Then, confirmation of transaction information eventually triggers t11 and t12, with consumers completing the consumption in physical store, returning back to the O2O platform to review the related orders. At last, the seller views the remarks of consumers and gives them feedback. Also, the performance index of performance, operational efficiency and other information about the system, providing some feasible recommendations for both sellers and platform administrator. That makes 19 Places and 15 Transitions in total. The meaning of each Place and Transition is shown in Table 1 and Table 2.

According to the order and review records on several GB platforms and our usual consuming experience, it won't take long for sellers to upload the GB news and site to audit this news. However, consumers will spend a relatively longer period of time to make a decision because they usually have to communicate with their friends [16]. If the choice is made near the physical store, it will not take very long at all time. But if it is far from being the basis, it takes longer. We suppose that the average time spent is half an hour. The time consumers spend at the physical shop will generally take some time. GB in Food is about 1 hour, health, beauty and home essentials could take more than 2 hours.

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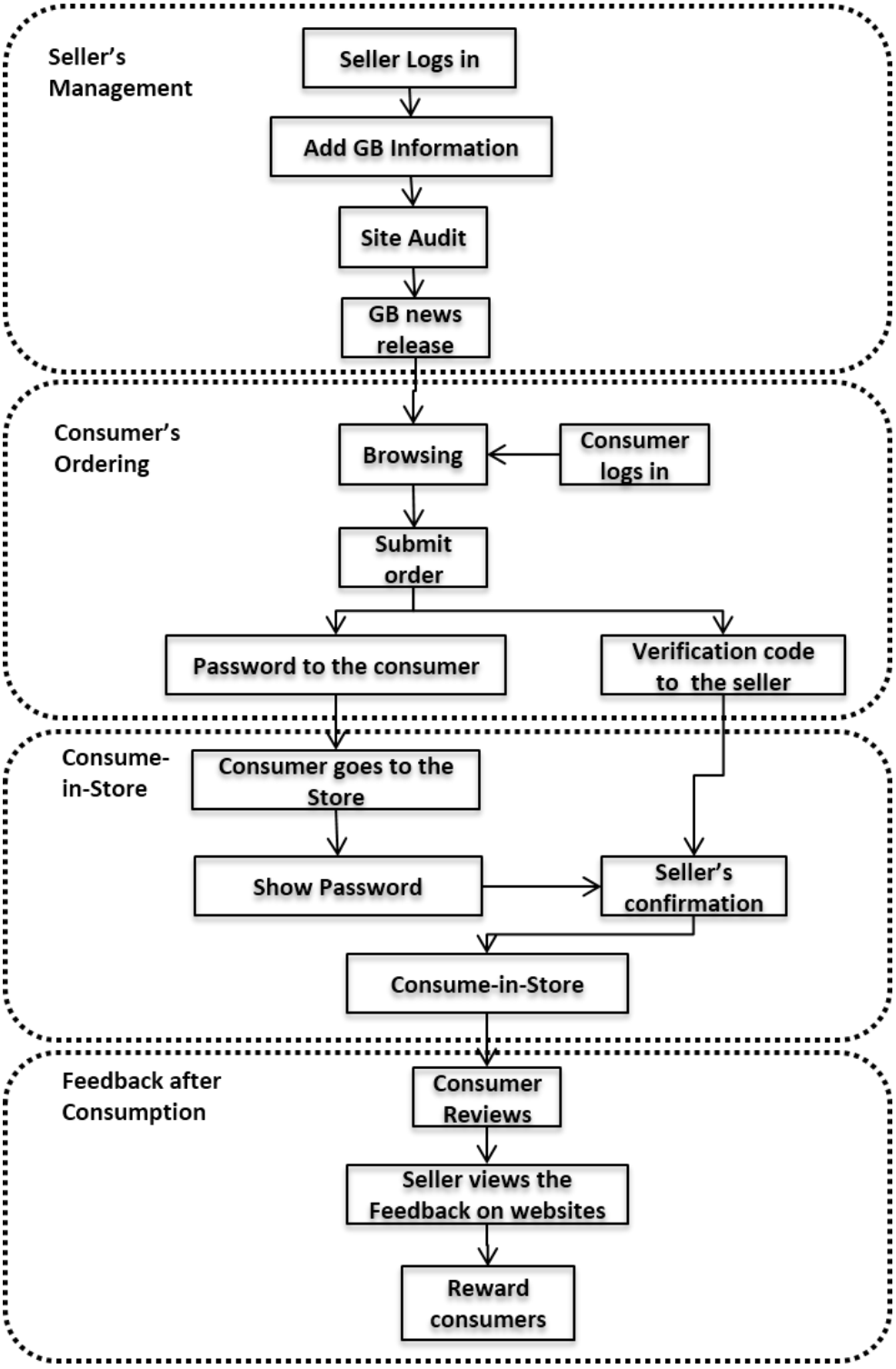

Figure 1. The Business Process Model of Group Buying

Feedback after consumption is a complicated process for most consumers. They are reluctant to make reviews until several days later, and that sort of evaluation doesn't tell you a

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whole lot about this consumption experience, unless it is really a wonderful one and consumers are willing to share it with their friends within a short period of time. Meanwhile, sellers give clients feedback even slower, generally two days after the consumer evaluation has been made.

Therefore, we assume that:

$$\lambda = \{4,3,4,5,2,2,4,4,2,4,2,1,2,2,1\} \quad (1)$$

As the random parameter of Transition t0~t15 following the exponential distribution.

2.2 Simplification and Calculation

As there are so many Transitions in the system, we simplify the GSPN model according to the Long and Luo's performance equivalent simplification methods [30].

Table 1. The Meaning of Places

Symbol	Place
P1	Seller has logged in
P2	Seller has GB news to release
P3	GB news have been added
P4	GB news released
P5	Consumer has logged in
P6	Consumer has needs for GB
P7	GB news available
P8	Consumer being logged in
P9	Consumer is satisfied with one GB
P10	Password to consumer being generated
P11	Order No. has been generated
P12	Consumer gets the password
P13	Seller gets the order details
P14	Waiting to consume
P15	Order No. and password has been distributed
P16	Agreed confirmation of the deal
P17	End trading in the real store
P18	Consumer's feedback is ready
P19	Seller has viewed the feedback

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Table 2. The Meaning of Transitions

Symbol	Transition
t1	Add GB news
t2	Site audit
t3	Release the GB news
t4	Consumer log in
t5	Consumer browse the GB news
t6	Consumer place an order
t7	Send password to consumer
t8	Send order details to seller
t9	Go to the real store
t10	Show order password
t11	Seller confirm the password
t12	Consume in the store
t13	Consumer add reviews about the GB
t14	Seller view the feedbacks
t15	Seller reward the consumers

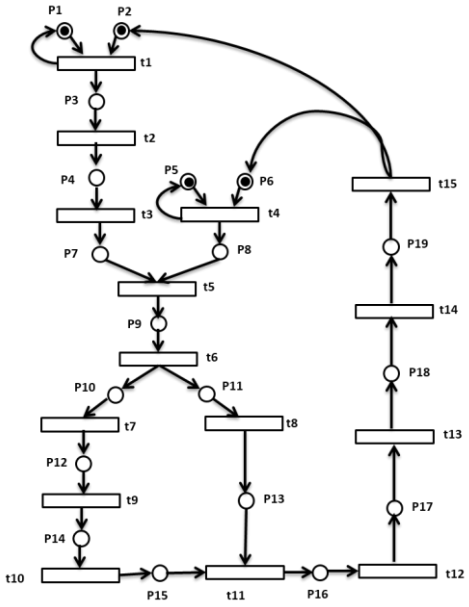

Figure 2. The Corresponding Workflow Model based on GSPN

Therefore, we could conduct a brief calculation of the series system's expected delay *i.e.*,

$$T' = E(Y) = 1/\lambda_1 + 1/\lambda_2 + 1/\lambda_3 = 0.83(\eta) \qquad (2)$$

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Simplified GSPN and reachable state graph are shown in Figure 3. The calculation process of λ changes before and after the simplification are illustrated in Table 3.

According to the definition of Petri Nets, we can get the transition probability matrix Q. Assuming X= $(\chi_1, \chi_2, \chi_3, \chi_4, \chi_5, \chi_6, \chi_7, \chi_8)$ is the steady-state probability for each identifier in the GSPN. Based on the Markov process, we have the following linear equations:

$$XQ = 0 \quad (3)$$

$$\Sigma\chi_i=1, \quad 1\leqslant i\leqslant n \quad (4)$$

The solution of this linear system of equations is the steady-state probability for each identifier P (Mi) = χ_i, ($1\leq i\leq n$). Reachable identifier table is given in Table 4. Transition probability matrix Q is presented in Figure 4.

Table 3. λ Changes Before and After the Simplification

Original parameter	Original value	Simplified λ'	Simplified value
λ1	4	λ1	1.2
λ2	3		
λ3	4		
λ4	5	λ2	5
λ5	2	λ3	2
λ6	2	λ4	2
λ7	4	λ5	1
λ9	2		
λ10	4		
λ8	4	λ6	4
λ11	2	λ7	2
λ12	1	λ8	0.33
λ13	2		
λ14	2		
λ15	1		

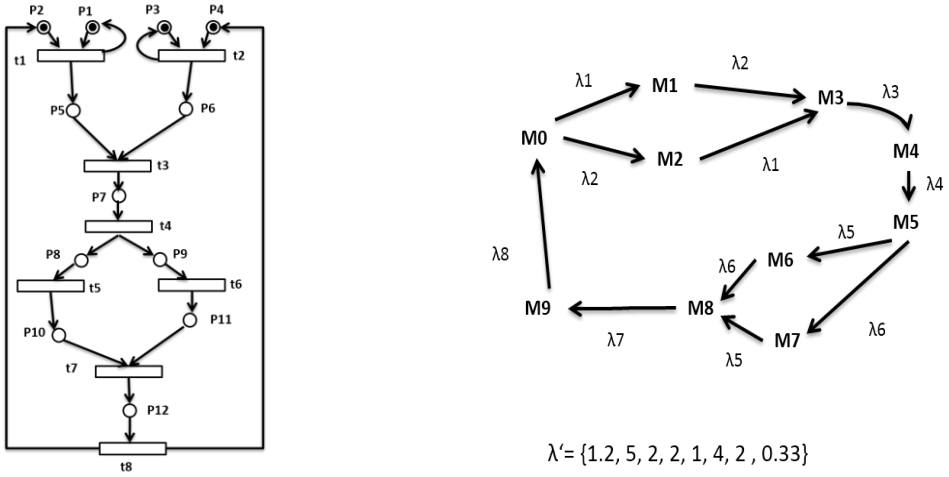

Figure 3. Simplified GSPN and Reachable State Graph

2.3 The Steady-state Probability

According to XQ=0, ∑xi=1, we use programming solver in Excel, and the result is：P(M0)=0.025，P(M1)=0.006，P(M2)=0.104, P(M3)=0.077，P(M4)=0.077，P(M5)=0.031，P(M6)=0.008，P(M7)=0.124，P(M8)=0.077，P(M9)=0.470.

Table 4. Reachable Identifier Table After Simplification

	P1	*P2*	*P3*	*P4*	*P5*	*P6*	*P7*	*P8*	*P9*	*P10*	*P11*	*P12*
M0	1	1	1	1	0	0	0	0	0	0	0	0
M1	0	0	0	0	1	0	0	0	0	0	0	0
M2	0	0	0	0	0	1	0	0	0	0	0	0
M3	0	0	0	0	1	1	0	0	0	0	0	0
M4	0	0	0	0	0	0	1	0	0	0	0	0
M5	0	0	0	0	0	0	0	1	1	0	0	0
M6	0	0	0	0	0	0	0	0	0	1	0	0
M7	0	0	0	0	0	0	0	0	0	0	1	0
M8	0	0	0	0	0	0	0	0	0	1	1	0
M9	0	0	0	0	0	0	0	0	0	0	0	1

$$Q=\begin{bmatrix} -6.2 & 1.2 & 5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -5 & 0 & 5 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1.2 & 1.2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -2 & 2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -2 & 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -5 & 1 & 4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -4 & 0 & 4 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -2 & 2 \\ 0.33 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -0.33 \end{bmatrix}$$

Figure 4. The Transition Probability Matrix

3. Time Efficiency Analysis

Based on Little's law and the equilibrium theory, Inflow and outflow rates of the subsystem should balance equal, and we can calculate the Markov chain with non-null recurrent. Little's formula is: $N = \lambda T$, where N is the average number of the identifiers in a subsystem of a Petri net at a steady state, and λ is the number of identifiers entered in the subsystem per unit time, T is average execution time of this subsystem. This formula can help to calculate the average executing time of the GB model.

Define a subsystem of GSPN: PN'= (P', T', F', M0, λ'), with P'= P - {P1, P2, P3, P4}, F' is a set of F with removal of directed arcs connected to places {P1, P2, P3, P4} is connected to the back-arc has been directed arc set, T' and λ' are the same as in the original net. As we can see, the token number of the subsystem entered per Unit time equals to that leaves places {P1, P2, P3, P4} within the same time period. Meanwhile, the subsystem contains all the

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transitions. Therefore, the average execution time of this subsystem is that of the whole system. As for the system shown in Figure 3,

3.1 Subsystem

For subsystem：P5, P6, P7, P8, P9, P10, P11, P12:
P (M (P5 = 1)) = P (M1) + P (M3) = 0.006+0.077=0.083
P (M (P6= 1)) = P (M2) + P (M3) = 0.104+0.077=0.181
P (M (P7 = 1)) = P (M4) = 0.077
P (M (P8 = 1)) = P (M5) = 0.031
P (M (P9 = 1)) = P (M5) = 0.031
P (M (P10 = 1)) = P (M6) + P (M8) = 0.008+0.077=0.085
P (M (P11 = 1)) = P (M7) + P (M8) = 0.124+0.077=0.202
P (M (P12 = 1)) = P (M9) = 0.470

3.2 Tokens in PN'

The number of tokens entered in subsystem PN' is:
N = P (M (P5 = 1)) + P (M (P6 = 1)) + P (M (P7 = 1)) + P (M (P8 = 1))+ P (M (P9 = 1))+ P (M (P10 = 1)) + P (M (P11 = 1)) +P (M (P12 = 1)) = 1.161.

3.3 Tokens in PN

In the subsystem PN', the number of tokens entered per unit time equals the number of those that got out through transition t1 and t2. And the transmission speed of t1 and t2, respectively, is (λ1, λ2) = (1.2, 5), so the number of tokens entered the system per unit time is:
λ= 1.2×P (M (P1 = 1)) + 5 ×P (M (P3 = 1)) = 0.155.

3.4 Average Execution Time

The average execution time of the GB model is: T = N/λ= 1.161/0.155= 7.49 (h).

4. Operational Performance Analysis

We assume A1 as the efficiency of the seller releasing the GB news, A2 as the efficiency of consumers' online payment process, A3 as the efficiency of finishing consumption at a physical store, and A4 as the efficiency of getting feedback after consumption. Then we have:
A1= {M1, M3} = P (M1) + P (M3) = 0.006+0.077=0.083
A2= {M2, M3} = P (M2) + P (M3) = 0.104+0.077=0.181
A3= {M7, M8} = P (M7) + P (M8) = 0.124+0.077=0.202
A4= {M9} = P (M9) = 0.470.
Then we have the consumption efficiency:

$$P_A = (\sum^{3}_{i=1} P_i) / (\sum^{4}_{j=1} P_j) = 0.498 \quad (5)$$

Which means that during the whole online and offline GB process, the efficiency of consumer's consumption process is 49.8%.

Meanwhile, we can have the efficiency of the order process regardless of the feedback part:

$$P_A = (\sum^{2}_{i=1} P_i) / (\sum^{3}_{j=1} P_j) = 0.567 \quad (6)$$

These results indicate that consumer's ordering is relatively fast compared to other processes.

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In order to figure out how much time will be saved if the feedback part of the GB model has been accelerated, we assume that the random parameter λ12 - λ15 of transitions t12 - t15, each of them plus 1, then the simplified parameterλ'8 is 0.6, which is almost twice the original value (as shown in Table 5).

Similarly, we have:

P (M0) = 0.032, P (M1) = 0.008, P (M2) = 0.132, P (M3) = 0.098, P (M4) = 0.098;

Table 5. λ Changes After Shortening the Feedback Process

Original parameter	Original value	Simplified λ'	Simplified value
λ1	4	λ1	1.2
λ2	3		
λ3	4		
λ4	5	λ2	5
λ5	2	λ3	2
λ6	2	λ4	2
λ7	4	λ5	1
λ9	2		
λ10	4		
λ8	4	λ6	4
λ11	2	λ7	2
λ12	1+1	λ8	0.6
λ13	2+1		
λ14	2+1		
λ15	1+1		

P (M5)= 0.039, P (M6) = 0.010, P (M7) = 0.157, P (M8) = 0.098, P (M9) = 0.328.

Then as above in this part, we have:

A1= {M1, M3} = P (M1) + P (M3) = 0.008+0.098=0.106

A2= {M2, M3} = P (M2) + P (M3) = 0.132+0.098=0.23

A3= {M7, M8} = P (M7) + P (M8) = 0.157+0.098=0.255

A4= {M9} = P (M9) = 0.328.

Then we have the consumption efficiency:

$$P_A = (\sum^{3}_{i=1} P_i) / (\sum^{4}_{j=1} P_j) = 0.643 \quad (7)$$

This result shows that during the whole online and offline GB process, the efficiency of consumer's completing consumption takes up 64.3% of the whole process, which means when we shorten the feedback process, the percent of finishing consumption in physical store in the whole GB model can be improved by 14.5%. Thus, we suggest that suppliers and sellers should be more efficient and concerned in giving the consumers feedback and finish the deal as fast as possible.

5. Discussion

Our result shows that the order process is of high speed and efficiency in the whole GB model. One reason is perhaps because of the 3G mobile interconnection bringing more

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convenience to online experience; another reason may also contribute to this efficiency is the general acceptance of online credit payment which brings new market opportunity to O2O e-commerce mode [31].

Meanwhile, the consumption process, which constitutes the main part of the whole GB process, is unlikely to hold the biggest probability of where the transition takes place, considering the relative low efficiency result calculated by the estimated data.

Compared to the order process, however, the feedback process takes too much time, which takes up over fifty percent of the whole firing time. When fire speed of each transition in the feedback stage adds 1, there will be a 14.5% advance in completing a single consumption process. This suggests that retailers should take measures to stimulate consumers' willingness to review online timely.

Evidence shows that comments and word of mouth are significantly important in e-commerce industry. Ennew, *et al.*, suggest that actively considering the integration of word of mouth into marketing strategy would be beneficial and efficient for the development of a customer focused market, according to their empirical analysis on small sample size from financial services sector in India from an organizational perspective [32]. Though this study does not involve the online transactions, it indeed sets the base for future studies. Later, Patrali finds that customer is more likely to seek negative WOM information when choosing unfamiliar retailers than those they are familiar with, especially for pure-Internet retailers [33]. Based on that, Michelle and Benda have conducted three studies to investigate the consumer demand for online food retailing, conclude with the recommendation for researchers to shift their attention toward addressing some of the more troublesome supply side issues such as timeliness, politeness and social skills, *etc.*, [34]. Even though this research is conducted when the e-commerce in its infancy and many areas still remain unknown to researchers, it enlightens Hennig, *et al.*, investigation on consumer's motives to review online, and come with the suggestion that firms should develop different strategies for encouraging e-WOM behavior among their users, which will help the firms gain new potential customers and enhance existing consumers' loyalty and stickiness [35]. Chiang's study on meal coupon GB also shows that WOM has significant impact on customers' stickiness to the GB websites [36].

Slowness of the online ordering system might not be completely under the control of the retailers due to the user's system and many other problems, but problems with communication skills and feedback process are almost all completely within the realm of retailers' control. Compared to traditional economy, consumers' power in the Internet economy is becoming so strong and susceptible to other people's shopping experiences online [37], that retailers online should never neglect this great business opportunities to attract potential customers, otherwise it will be difficult for them to survive in such an increasingly competitive environment.

Apart from concentration on the feedback stage, retailers can also enlarge their WOM by means of using WeChat, Weibo, *etc.*, since microblogging is now a powerful online tool for customer WOM communications and discuss the implications for sellers using microblogging as part of their overall marketing strategies [38].

6. Conclusion and Future Direction

Based on the analysis above, our findings suggest that the GSPN model for GB of O2O mode which is proposed in this paper takes a lot of time on the feedback process online after consumption, while evidence show that consumer review is so important in today's e-commerce industry. But when the fire speed of each transition in the feedback stage adds 1, there will be a 14.5% advance in processing the regular GB, which will hence improve the

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whole GB efficiency and give consumers more affinity and willingness to review online timely, which may draw more potential customers for the sellers as in return.

Therefore we recommend that sellers should take some measures in encouraging consumers to review timely, and give consumers some feedback incentives to enhance the WOM effect based on consumer reviews, which would also help sellers attract more potential customers. Accordingly, sellers can get more for their own earnings, and it also serves to improve the efficiency of buy-online-consume-in-store pattern. Besides, using microblogging tool, such as WeiChat and Weibo, can be another good way for retailers to promote their own market. Also, pricing mechanism can be involved in attracting more customers to buy online [39]. In the meanwhile, the GB pattern this paper concerns has two characteristics: low price and paid in advance. Because of these two characteristics, circumstances of use overdue and demand uncertainty within the validity date can happen [40], which requires the establishment of industry standards and the permission of humanized service in GB, to protect the interests of both consumers and sellers.

As we mentioned above, there is plenty of evidence show that efficiency is crucial for the future GB. Thus, finding an effective tool to analyze the efficiency of GB is rather important. Compared to other analyzing tools, Petri net uses a graphical representation of a system, which can better describe the dynamic characteristics of the system. Therefore, as a powerful tool for researching the efficiency of GB, Petri nets will be needed to be used more in the Internet financial sector. In this paper, we use Petri nets as a tool and a method to study the efficiency of GB of O2O mode. Through the establishment of GB Petri net models, the mathematical programming, and the analysis of time performance as well as operational efficiency of the entire process, we found that the online evaluation and feedback of this O2O mode after consumption can be done better and faster so as to enhance customer satisfaction, hence improving the efficiency of the whole buy-online-consume-in-store process.

Due to time limitation, the data this paper quotes merely come from the theoretical experience instead of statistical results. It would be more helpful and practical if the average time consumers spent in each session of the GB model proposed in this paper can be retrieved from the statistical results. Besides, to stimulate consumers' willingness to participate in GB, further study on factors affecting consumer's online purchase intention using quantitative method should be done before we can draw any additional conclusions.

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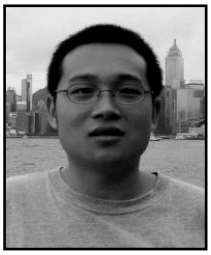

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