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Economic and Social Impact of Tourism on a Small Town: Peterborough New Hampshire

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ABSTRACT

This study examined the perceived impacts of tourism on the lives of people from a small New England town. Twenty seven in-depth unstructured interviews were conducted. The study found that most people perceive both positive and negative impacts of tourism and do not want to change their town for increased tourism development even if it results in increased revenue. People recognized tourism's benefit to the town's economy but less so to their economic situation. Working locals expressed worry regarding the town's gradually polarized economy and divided social classes and regard tourism as one of the causes. Wealthier members generally view tourism at its present level as beneficial. For further tourism development Peterborough' population will need to solve this dilemma.

Keywords: *polarization, tourism development and consequence*

1. Introduction

Studies on the impacts of tourism have shown that a destination's population recognizes economic and social benefits and costs of tourism on their community and lives [1,2,3,4,5,6,7,8,9,10]. Economic benefits are usually regarded as the most important benefits of tourism and include increased employment opportunities, income generation, tax revenue and improved standard of living [5,11,12,13,14,15,16]. Social benefits include the maintenance of traditional cultures, increased intercultural communication and understanding, improved social welfare, quality of life, improved shopping and increased recreational opportunity [7,15,17,18,19,20,21].

Economic costs of tourism include increased tax burdens by developing infrastructure used primarily by tourists, inflation, increased cost of land and housing, over commitment of resources and development budgets to tourism, immigration of labor and increased local government debt [5,18,19,22,23]. Social costs include increased crime rates, prostitution, friction between tourists and residents and changes in traditional cultures and host's way of life [5,6,7,14,19,24,25].

Studies have shown that different groups within a community may have different perceptions of the impacts of tourism on their community and lives. Haralambopolous and Pizam [14] examined a tourism destination on the Greek island of Samos and found that local residents who were economically dependent on tourism had a more positive attitude towards the tourism industry than those who were not. Besculides *et al*. [26] studied how differently the Hispanic and non- Hispanic populations living along the Los Caminos Antiguos Scenic and Historic byway in southwestern Colorado perceived cultural benefits derived from tourism. While both groups recognized the value of tourism, Hispanic more than non-Hispanic residents felt that, while tourism can provide important cultural benefits to residents, care should be taken to preserve the distinct cultural atmosphere of the place. Dyer *et al*. [10] developed a structural model to describe tourism impact perceptions of residents in the Sunshine Coast, Queensland, and found that the perceived positive economic impact factor has the largest influence on residents' support for further tourism development. Additional factors affecting different groups' perceptions of tourism's benefits or costs include length of residency, extent of tourism development, residents' proximity to the tourism sites, the degree of dependency on tourism, the degree of community cohesiveness and/or local patriotism, age, gender, reasons for moving to the community, income, employment status, education, contact with tourists knowledge about the tourism industry type and the type of tourism at a the destination [16,27,28,29].

Today many communities are either establishing or expanding their tourism industry as a means of low environmental impact wealth and job creation. As such we need to better understand the attitudes and believes of the local population on the benefits and costs of tourism on their lives and community. In this paper we present the attitudes and opinions of Peterborough, New Hampshire's residents on the economic and social impacts of tourism on their lives and the town.

2. Impact of Tourism

2.1 Peterborough New Hampshire

Peterborough's tourism industry is based on nature and cultural tourism assets. Peterborough, population 6,100 [30], is located in the Monadnock region and is a one and half hour drive from Boston, Massachusetts. Peterborough's major industries are education, health, and social industry (696 employees), retail trade (including tourism related retail trade, 436), manufacturing (428) professional and management (311) and tourism attractions and products (124) (US Census, 2000). Peterborough's per capita income is $26,154, above the region's average ($22,269), and its unemployment rate was 2.5%, lower than the region's 3.2% [30]. The major tourism attractions in Peterborough include MacDowell Colony, Mt. Monadnock and its local cultural assets and town atmosphere. Over 500,000 tourists visit annually.

Peterborough is in the process of deciding how and to what extent to expand its tourist industry. Its tourism infrastructure is limited, e.g. there are only two Bed & Breakfasts in town and no public transportation from other towns and cities to Peterborough. Downtown Peterborough has been preserved with care and has the feel of a classical "New England" town. The majority of the downtown stores and restaurants are medium to high-end in terms of price and product selections. Tourism in Peterborough is mostly day tourism. Peterborough was selected as one of "the coolest town in the U. S." [31].

2.2 Research Design

In-depth unstructured interviews were used to identify factors which affect residences' opinions and perceptions on the existing tourism industry as well as their expectations and anxieties of increasing tourism development [32,33,34].

Table 1. Questions asked in interviews

Questions to all interviewees	**Specific questions for local residents living less than 5 years**
1. How do you feel about tourism in Peterborough? 2. Why do you think tourists come to Peterborough? 4. How do you think tourism affects Peterborough economically and socially? 5. How do you think tourists affect Peterborough? 6. Do tourists increase activities for local people? 7. Do you have favorable or unfavorable opinion about tourism? 8. How do you see the potential of tourism in Peterborough? 9. How does tourism affect local people's lives economically and socially? 10. Do you see a change in tourists and tourism over last few years?	1. What about Peterborough attracted you to come to Peterborough? 2. Do you want to see tourism expanded in the future? How?
	Specific questions for local residents living more than 20 years
	1. How have you seen Peterborough change due to tourism? 2. Are you satisfied with tourism in Peterborough? 3. Do you want to see tourism expanded in the future? How?
Specific questions for industry interviewees	**Specific questions for local teenagers**
1. How does tourism and tourists affect your business? 2. How do you see your business 5 years from now in respect to tourism? 3. How is your business going lately in comparison to 5 years ago? 4. When is the busiest season? 5. How have you tried to develop tourism in Peterborough? 6. What percentage of your customers is tourists/local? 7. Is housing market influenced by tourists in Peterborough How? (only for real estate)	1. Would you like to live in Peterborough after you graduate from high school? 2. Will you come back to Peterborough after you graduate from college?

Table 2. The perceived and anticipated impacts of tourism and tourists

		Economic	Social/Cultural
Perceived impacts	Perceived positive (benefits)	* The town's economy in general * Increased options in restaurants and shops	* Social interactions * More diverse tastes in town
	Perceived negative (costs)	* Increased prices in restaurants and rent * Unsustainable employment	* Conflicts between tourists and locals
Anticipated impacts	Expectation (positive)	* Further tourism development may generate more options to shop and eat	* Tourism may increase social interactions.
	Anxiety (negative)	* Big box corporations may invade local small business opportunity. * Tourism may accelerate polarized economy.	* Tourism may accelerate polarized social classes.

Lepp (2007) pointed out that this method allows for the injection of new and often unexpected ideas. Hernandez *et al*. [32] said that the main advantage of in-depth unstructured interviews is that a better understanding of respondents' thinking and attitudes on key issues could be obtained than with structured interviews. Ten open ended questions were asked to all interviewees while additional questions were asked specifically to people in one or more categories (Table 1). Interviewees were informed that the information collected will be used only for this research and each person signed a confidentiality agreement. All interviews were recorded and transcribed verbatim. Answers related to economic and social/cultural perceptions were sorted as either: 1) perceived impacts which are what interviewees have already experienced and felt about tourism; or 2) anticipated impacts which are what interviewees assume will happen in the future (Table 2). The perceived and anticipated impacts can have both positive and negative responses. Each section contains four elements: perceived benefits, perceived costs, expectation, and anxiety. Thematic analysis was used for establishing and analyzing themes. The interviews were conducted in Peterborough during the summer 2007.

Purposive sampling technique was used for selecting interviewees. Peterborough's Chamber of Commerce helped to initially contact potential interviewees and later we contacted people via e-mail or direct contact. The interviewees were selected to represent seven residential categories (Table 3). To make interviewees as comfortable as possible all interviews were held either in the interviewees' work place or home. Twenty seven interviews were conducted with the time of interview varying from 24 minutes to one hour and 20 minutes with an average time of 40 minutes.

2.3 Themes from the Interviews

Peterborough's population has a very strong self and town identity. Most said that a main priority was maintaining a town for the comfort of the local population and not for tourists. "I don't think we are going to lose the character of the town. I don't think we are going to sell out because people care about the town" (Living more than 20 years, #2). Peterborough's quaint and cute "New England" atmosphere is a major draw for tourists. "I think Peterborough is attractive to tourists. We have old buildings, we have history… it's a beautiful town. It's got its own character… I think that's the big thing and we preserved New England flavor without selling out to big corporations" (Living more than 20 years, #4). "Peterborough is very cutie town for New England… tourists are looking for that cute New England town" (Recreation, #18). Most interviewees were aware of the importance of town planning and care how the town develops. "There is a real effort not to have big box stores and franchises…fast food places" (Real Estate, #13). Therefore large chain and box stores are not found downtown.

Table 3. The code number, gender and category of the 27 interviewees

Code Number	Gender	Category
1	Female	Live 20 years or more
2	Female	Live 20 years or more
3	Male	Live 20 years or more
4	Male	Live 20 years or more
5	Female	Live 5 years or less
6	Male	Live 5 years or less
7	Female	Live 5 years or less
8	Female	Teenager
9	Male	Teenager
10	Male	Teenager
11	Female	Real Estate
12	Female	Real Estate
13	Male	Real Estate
14	Male	Recreation
15	Male	Recreation
16	Female	Recreation
17	Female	Recreation
18	Female	Recreation
19	Male	Retail
20	Female	Retail
21	Male	Retail
22	Female	Retail
23	Male	Hospitality
24	Male	Hospitality
25	Female	Hospitality
26	Male	Hospitality
27	Female	Hospitality

While several interviewees mentioned that the potential for tourism growth is limited "I think it's going to grow a little bit but I don't think it's going to grow a lot" (Hospitality, #25), others said that tourism can be expanded but how it is to be done is the key issue. "If it grows as a sustainable level with the town, go for it. If it stops being sustainable, if we have to change our character, then no. I think that is a concern for some people" (Living more than 20 years, #4). Several interviewees mentioned that the few overnight accommodations available for tourists in Peterborough are a problem for tourism's future development. "The thing is we have very few places for people to stay overnight. We need to have a place for people to stay overnight." (Real estate, #11). "I don't think tourism will increase greatly because again no place to stay" (Recreation, #17).

Twenty one out of 27 interviewees had an overall favorable opinion about tourism and tourists. "Favorable, I do. Though some of them are rude, generally, it's a good positive because it increases my sales" (Retail, #25). "They are interesting people" (Hospitality, #26). "For the most part, it's [having tourists] great" (Retail, #19). "I

think we get to like them because we don't attract obnoxious tourists… thoughtful people who are happy to be here" (Recreation, #17). "We love to see tourists. They bring a lot of money" (Real estate, #13). However some interviewees' did have negative attitudes towards tourism and tourists or could have if more tourists came. "Tourists are rude…they are usually inconsiderately rude" (Living less than five years, #6). "A lot of them are very nice but tourists from the larger cities can be very rude." (Retail, #25). "They were all dressed up and caked with makeup and they just sat here and pretty much downed the entire town of Peterborough… it was very unpleasant" (Retail, #25). "We don't have that many tourists and I guess that's why I've got a positive feeling about tourists. If this was a tourist destination that people were swarming in, I might not like it as much" (Retail, #20). Many local people have a stereotype of Peterborough's tourists as old, affluent and snobby who are from big cities. "They are mostly old people" (Real estate, #11). "We have this arrogance [of tourists] …like New Yorkers working in finance and trying to get out of cities" (Hospitality, #24).

Many interviewees mentioned that the current balance between tourism and local peoples' lives is fine and believed that the point that local's feel that they are sacrificing their way of life for tourism has not yet been reached. "I don't think it hit that point [tourism intrudes on local people's lives] yet. I think we have a long way to go before we have to worry about that…as long as we can maintain the character of the town" (Living more than 20 years, #4). "Tourism doesn't go overboard like in some towns where tourists are there all summer and double or triple the population of the town" (Hospitality, #26). Several interviewees expressed a degree of indifference about tourism or its impact on either them or Peterborough. "[Tourist] doesn't bother me" (Teenager, #9). "I haven't thought about it much" (Living more than 20 years, #2). "It just seems not to have big impact…I am certainly not aware of tourism per se" (Living less than five years, #5).

2.4 Perceived Economic Benefits

Regardless of category, most interviewees perceived positive economic benefits of tourism. "Definitely helps" (Teenager #8). "Economically it affects local people wonderfully" (Retail #19). "Definitely tourism is a big factor in the economics of the town and is important" (Hospitality #26). "I think it's very important for the health of the community. Most of the businesses in town rely on it. They would not survive without tourists" (Recreation, #17).

Only a few interviewees mentioned that tourism created jobs in town. The reason may be that there are no mega tourism products in Peterborough which employ a large number of people in a single business. Rather, most tourism businesses are small and employ few people and thus tourism may not be perceived by many locals as being an important job creator. One exception was "I think so [tourism increases jobs] because I think tourism develops the community. When I come back I may be able to get a job around here" (Teenager, #8).

Several interviewees mentioned new business opportunities generated by tourism with several interviewees in retail saying that they stock or develop specific products for tourists. "I think retail has to be part of that [opportunities generated by tourism] because shopping in the U.S. is a past time rather than a necessity. I think Peterborough has great opportunity for businesses" (Retail, #21). Interviewees also mentioned that a positive affect of tourists is increased options for locals for shopping, entertainment and restaurants. Their perception is that tourists contribute to sustaining local businesses which are also used by local people. "If there are no tourists, we would not have wonderful restaurants. I am not sure whether we would have seven plays [in a local theater] in a season if we could not depend on tourists. Businesses dependent on tourists such as restaurants and shops would not survive without tourists. It impacts the rest of us by having those things here in town and we don't have to go someplace else" (Recreation, #17).

Real estate agencies perceive a positive economic impact of tourists on their business. The more tourists who visit, "fall in love with" and decide to live in Peterborough, the more people are likely to purchase houses using these agencies. Interviewees from real estate agencies mentioned that people from outside tend to buy more expensive houses than locals. "Tourists are coming and bringing out of state money. Often make money in Boston or New York. These people are going to buy million dollar houses. That kind of money is nice to have come in" (Real Estate, #13). "They often come back again and again. Pretty soon they buy a second home and become a member of the community" (Real Estate, #11). "People buy second homes for summer or for skiing and love it so much and became primary residence. It happens a lot because this is fantastic place to live" (Real Estate, #13).

2.5 Perceived Economic Costs

Although interviewees spoke about the economic benefits of tourism and said that the negative impacts of tourism were still tolerable, several had a negative attitude towards tourism due to the economic costs of tourism to residents. One cost that many, especially younger, interviewees saw was price increases. "Tourism drives up prices" (Living less than five years, #5). Elderly interviewees or those with high paying jobs were less aware

of increasing prices. The high price of restaurants was often mentioned by interviewees as a consequence of tourism. "Some residents do suffer because restaurants are over priced. They can't go to restaurants. They can't go to a play. Very expensive. That's something people come from outside to go to. Local people can not go to these restaurants. Even though tourism is positive for the economy, it's bad" (Recreation, #18). On the other hand, some interviewees mentioned that the increased option of different restaurants is good for residents and the complaint that the prices of the restaurants are too high is not entirely valid. "I think that people who can not afford what we have here now could not afford what was here 10 years ago and I don't think restaurants are expensive… It's a complaint that I am not sure is valid" (Recreation, #17). "I think it's very balanced. I think there is a perception because of a few shops some people can't afford to go to and this is horrible…but that's life …I mean I can go to a supermarket and buy beer in five different prices…it depends on where economically you are" (Living more than 20 years, #4).

Several comments regarding increasing housing costs and rents due to "outsiders" buying property were made by interviewees. "Housing cost is increasing dramatically" (Recreation, #17). "I was in an apartment up here before I got a house. That one went up from when I first move in and moved out…one hundred fifty dollars as soon as I moved out…another one hundred fifty a few months later. Three hundred increase in a year" (Retail, #19). "Honestly a lot of people can not even afford the rent any more around here. It is a stigma…you do not want to be known as not well off …but there are people who are definitely not making a lot of money and live here. It's hard for people who work here to live here" (Living more than 20 years, #3).

Some interviewees emphasized that tourism creates jobs which are not sustainable, do not require professional skills and do not provide a sufficiently high salary to afford having a family. "I think that economically obviously…it's a double edge sword…everybody benefits to some extent…because it brings more lower level jobs here…people who take care of housing and landscaping" (Living less than five years, #5). "It creates unsustainable jobs…jobs that you can not really live on….live but you can not have a kid" (Hospitality, #24).

Interviewees mentioned that the closing of stores who catered to the needs of the local population only to reopen as businesses catering to tourists caused significant inconvenience when people need basic products. "There is a sacrifice which is some stores and some restaurants are changing towards serving tourists more than locals" (Living more than 20 years, #2). An interviewee in Peterborough for more than 20 years experienced his family business, a consignment shop which had second hand furniture, having to close. "We had nice things and some antiques. We also had furniture and house wares and stuff. It worked really well for both tourists who are very interested in collectibles and people in low income range who just need new furniture. We shut down and moved around numerous times and the reason given by the landlords were 'this is not the attractive kind of business you want in this primary rental space because tourists come in here we do not want them to see this trash'. We have actually experienced having a business closed because it is not attractive enough to tourists even though we are serving needs [for locals]" (Living more than 20 years, #4).

While some interviewees mentioned that tourism was not an essential industry for the town's economy, others pointed out that Peterborough has been transformed into a town which can not be economically sustained without tourists; i.e. it has become tourist dependent. "If you go to Peterborough you can tell…there are fancy restaurants, which is very unusual for any other these [surrounding] small towns. Peterborough could not survive without that kind of influx" (Recreation, #18). "Economically, I think tourism is necessary. It's a small town…we need that influx of people" (Retail, #22).

2.6 Economic Expectations

The potential of tourism was frequently stated by the interviewees. Several interviewees mentioned that Peterborough is a unique and quaint New England town which satisfies tourists' expectations and preserving the town's traditions and cultures was recognized as important. "There is a lot of potential here" (Living less than five years, #5). "We want to preserve things we love. They need funding to keep going and tourism is the best option. Tourists just come and go and there is money left behind… in that sense it's really positive. …as long as you know we don't try to become Disneyland" (Living more than 20 years, #4). "I think it will grow more because the town is so charming. And I think there are probably tons of little projects that I am not even aware of… I think the tourism industry becomes more and more. Definitely improve" (Recreation, #18).

2.7 Economic Anxiety

Several interviewees mentioned that they try to buy local in order to support local businesses and mega stores may reduce the town's individuality and uniqueness. They were worried that a heavy influx of tourists might change the local population's effort to buy local, and tourists and new residents would buy from cheaper "big box" stores. "Every town is losing its individuality. You could be in Nashua, New Hampshire or you could be in Phoenix, Arizona, and you're going to come out of an Applebee's, a Wal-Mart, a whatever. Some people love to travel and

say oh isn't this great I can go to Applebee's and I know what, what I'm going to eat" (Retail, #20).

2.8 Perceived Social Benefits

Interviewees mentioned that the social impacts of tourism were less important in comparison to economic impacts. "Socially I don't think it affects much. It's not a place people come for a week. They are either here for a day so we don't have much interaction or they are here for the whole summer and go within the community. There are very few bus tours" (Recreation, #17). "I don't know socially" (Teenager, #8). Most interviewees said that they believe interactions with tourists either do not happen or are limited to activities such as giving directions. "The only interaction I have seen is direction giving" (Recreation, #18). "I don't see that many people mingling. I mean there are conversations that go on in the store, directions given. It's a friendly town so everyone's willing to help anyone find anything or they want to know where to eat… I don't think that there is any large interaction between the people that live here all the time and tourists" (Retail, #20). However several interviewees stated that interactions with tourists can benefit local population. "I would mostly say social interactions… exposure to different ideas can help us" (Retail, #19).

Interviewees regard different tastes and diverse cultures that tourists bring as benefiting Peterborough. "Socially as well, because what we find is the more different kinds of people that come…the more we want to provide to their tastes,… like I find the people in Peterborough like a certain kind of cheese and then the tourists will want something different, so we learn from each other, we learn what they like" (Retail, #21). Real estate interviewees mentioned that tourists who purchase houses in Peterborough often reinforce what exists today. "I think that [people] often came as tourists [and] now become at least part-time residents. Part-time residents are just as involved as full-time residents. They tend to support what's already here" (Real estate, #11).

2.9 Perceived Social Costs

Although several interviewees mentioned that the belief that Peterborough is being overtaken by tourism is not yet pervasive among locals, negative feelings towards tourism and tourists were found. "Socially like I said it's only cost right now" (Living more than 20 years, #3). "Socially I think we all tend to feel a little intruded on sometimes" (Retail, #19). "People that I know here are generally annoyed by tourists. If not, a little bit hostile sometimes" (Recreation, #17).

Several interviewees, especially the younger generation, mentioned that due to tourism polarization was occurring between affluent people who earned money outside Peterborough and settled in Peterborough and working class residents whose families have been in Peterborough for generations. Although tourism may not be the only reason for polarization in Peterborough, disparities in wealth among locals is real and interviewees emphasized tourism as one of the major reasons for economic and social polarization between the affluent and the working residents. An interviewee who works in a downtown restaurant said "Tourism caters to a high-brow affluent market. It is very expensive. I can not afford to eat there. As far as local people, always the same coming in, people who are white, relatively affluent. For those people identifying themselves as working class, it is really difficult. I think it (tourism) kind of polarized Peterborough economically because a lot of people who moved in are more affluent… They have already made money outside" (Hospitality, #24). "This town is kind of a unique mix…liberal affluent and working class in New Hampshire. But it is really like no middle class around here. And tourism kind of like …tourism helps perpetuate this low wage class" (Hospitality, #24). Several interviewees equated tourists with affluent local people as they interchanged words such as "affluent people" and "wealthy locals" with "tourists". "There is a huge gap between the poor and the wealthier people. I think tourists in Peterborough really demonstrate this…They are richer people" (Recreation, #18). "People want to keep the town pretty…so that people driving along the highway see this nice little town and stop to spend money. So we are doing for tourism. But those places {fast food chains} are affordable, really affordable. A lot of people stretch their budgets" (Living more than 20 years, #three) Interviewees mentioned that tourists who first vacation and then purchase homes and become residents accelerate polarization. "I think more people, people who had come and decided to stay, make it worse" (Recreation, #17). "I think that most of the negativity existing in this town is the fact that there are a lot of people living from a lot of different social classes in this town. They don't really acknowledge the other people" (Recreation, #18).

No interviewee said that the crime rate was increasing due to tourism and views the type of tourist who comes to Peterborough as not likely to harm the town's security. "I don't know any security issues that have been raised" (Recreation, #18). "I don't believe there is increase crime rate in this town by tourism" (Hospitality, #25). "No. No. No. I don't think we draw such kind of crowd which increase crime rate to a quaint little village. I think a lot of activities you can do here appeal to an older sophisticated audience" (Living less than five years, #5).

2.10 Social Expectation

Some interviewees said that tourists who become new community members bring new ideas for the town's

management. "I think the town benefits from an influx of younger people" (Living less than five years, #5).

2.11 Social Anxiety

Several interviewees mentioned a degree of concern brought about by tourist/local population contact and that further tourism development may cause future friction between affluent locals/new comers/tourists and working class local people. Recreation #18 pointed out as local people do not interact among social classes, tourists who settle in Peterborough can only increase the polarization among economic classes.

3. Discussion and Conclusions

The goal of this study was to examine how local people in a small town perceive the impacts of tourism on their lives. In-depth unstructured interviews were conducted with people in seven categories of local residents. The study found that people in Peterborough perceive both positive and negative economic and social impacts of tourism. Most interviewees, regardless of group, have a strong attachment to their community and do not want to change their town for increased tourism development even if it results in increased revenue. They care how the town is developing. While the importance of the tourism industry for the local economy is recognized, they do not want Peterborough to be dominated by tourism. Although insufficient overnight accommodations were identified as hindering further tourism development, most people were wary of major infrastructure development for tourists which may negatively affect their way of life. A number of interviewees mentioned that the current balance between tourism development and local people's lives is acceptable and Peterborough has not reached the point that locals and their space are overwhelmed by tourists.

Interviewees can be divided into three groups whose attitudes can be summarized as: 1) tourism industry people: we need tourism for our businesses but personally have very little interest in it; 2) affluent locals: tourism is fine if it does not change our town but improves our quality of life; and 3) working locals: tourism contributes to creating a polarized economy and divided social class.

Although tourism industry people see both the positive and negative economic impacts of tourism on their businesses, they perceived the positive as larger than the negative. Jurowski *et al*. [4] found that the potential for economic gain has a direct and positive affect on resident support for tourism and influences the way residents evaluate the impacts of tourism. Similar results were found by Milman and Pizam [35], Davis *et al*. [36], Ap [12] and Prentice [37]. When interviewees from the tourism industry were speaking as locals, they spoke about the negative impacts of tourism in the same way as other locals.

Local non-industry people perceive both negative and positive impacts from tourism with the positive impacts mostly related to improved quality of life for the wealthier locals and some economic improvement overall. Allen *et al*. [38] found that positive tourism development is perceived as primarily economic and not quality of life by local populations and discussed correlations between community economic activity and tourism development which influence residents' attitudes toward tourism development in rural areas. They concluded that communities with low tourism development and low economic activity as well as communities with high tourism development and high economic activity are most favorable toward tourism development. Conversely, low tourism and high economic activity communities as well as high tourism low economy communities do not have favorable views on tourism. Peterborough can be regarded as being a high economic active but low tourism community as the town has a well diverse economic base of which tourism, while important, accounts for just over 5% of the total employed population, although its contribution to the local economy is larger. Allen *et al*. [38] found that communities with high economic activity and low tourism development are economically stable and their residents do not see the need for further tourism development. This situation can apply to Peterborough with the majority of interviewees not perceiving tourism as needed for economic growth. Since the need for tourism in the town's economy is not high, people might be more critical about the tourism industry and tourists than people in a town which relies on tourism and sees the industry as vital for their economy, i.e. a high tourism and low economic activity community.

Smith [39] mentioned that negative impacts are only tolerated for economic gain and Easterling [40] found that locals' support for tourism development is directly related to the degree to which they economically benefit. It can be said that the higher the needs of tourism for a town's economic welfare, the more negative social and cultural impacts are tolerated. In Peterborough's case, most interviewees perceived some benefits from tourism for the town's economy and quality of life but these were often not essential to many locals' personal lives. Easterling [40] found that while the majority of residents recognize the economic potential of tourism, most deny personally benefiting from it. This point is applicable to Peterborough.

Hernandez *et al*. [32] found that the anxiety of local residents in respect to how tourism development may affect their lives is often more important than the actual consequences of tourism. Many people in Peterborough expressed concern about the continuation of tranquility if more tourists come. The article of the Budget Travel [31] represented Peterborough's attitude toward tour-

ism. A restaurant owner said: "The nod paid to Peterborough by Budget Travel would be a welcome boost for businesses in the area, though he (the restaurant owner) said he hopes the magazine's readers won't come all at once. Peterborough's a small town. I don't think we could handle all 600,000 at one time, he joked." The Budget Travel article may have increased the expectations of tourists and the anxiety of locals.

While today Peterborough's population is fairly uniform in their attitudes toward the positive and negative impacts of tourism, opinions about further tourism development vary depending on an interviewee's values and economic situation. Similar results were found by Ap and Crompton [22], Ryan and Montgomery [41], Haralambopolous and Pizam [14], Lawson *et al*. [42] and Mason and Cheyne [29]. Jurowski *et al*. [4] found that the perception of tourism's impacts is a result of assessing benefits and costs and that the evaluation is influenced by residents' values. In Peterborough, many young people strongly believe that there exists a polarized economy and different economic and social classes. Whether this is true or because many young people tend to see the world in black and white we could not determined, nevertheless the belief is real. The more affluent, older population, while it says it is strict about preserving their current lifestyle and Peterborough's character, are willing to accept tolerable levels of price increases due to tourism for more and improved options in their daily lives.

Regarding the balance between local people's lives and tourism development, the current balance appears to be acceptable to most people who do not want tourism development to drastically change their lives. Most do not want to see local stores driven out by big-box stores and "high-brow" tourism-oriented shops. However, several people mentioned that the downtown area is being transformed from the heart of the town toward the center of the affluent local community and tourists. Their statements contain a degree of anxiety that Peterborough might be changing towards a high-end tourism oriented direction. Local people, especially working locals, think the town's shift toward affluent locals and tourists would be accelerated by further tourism development.

The anxiety expressed by the working locals of a polarized economy and social classes due to tourism is worrying. Their emphasis of increasing prices combined with low salaries and unsustainable jobs created by tourism may be a warning sign that a segment of Peterborough's population, especially the young, may no longer view Peterborough as their future and perceive tourism as a catalyst for creating an affluent/tourists oriented community. They want a community which provides jobs that they can provide a living and afford having a family but they do not expect tourism to do this in Peterborough. Interestingly, industry people and affluent locals did not emphasize a polarized economy and limited social interactions among locals. Rather their concern is to preserve the town as it is. They support the present situation that the downtown has no fast food chains but high-end small cute shops and restaurants which makes Peterborough attractive to tourists. Industry people and affluent locals would not mind "high-end, tourism-oriented" as it provides them with more options and a better quality of life. As one of the interviewees mentioned, Peterborough's tourism is changing to immigration based tourism (tourists are often becoming part-time or full-time residents), and this immigration based tourism is influencing economic and social structure of Peterborough and a possible cause for the perceived economic polarization and divided social class.

We found two important, almost contradictory, sentiments towards tourism development (Table 4): 1) people do not want to change their life style or the town for tourism; and 2) people want to have the income and increased options that tourism can provide.

A key question for the future is can these two sentiments be combined into a new consensus for tourism development. Two possible outcomes are: 1) maintaining the status quo and continue the current tourism di-

Table 4. Interviewees opinions on further tourism development

Against tourism development:	For tourism development:
• Affluent locals who want to preserve the town over increased options. • Working locals who are aware of tourism influence on more polarized economy and divided social class. • Small shop owners who are worried about influence of large retail chain stores on their business.	• Affluent locals who appreciate more options in restaurants and shops. • Industry people who want more tourists' money for their business.

Table 5. Economic and social cycle of Peterborough's tourism development

(1) local people preserve their town's character;
(2) the attractiveness of the town for tourists increases;
(3) more tourists who are relatively wealthy come and love the town;
(4) more affluent people purchase homes and businesses in town;
(5) percentage of relatively wealthy local population increases in Peterborough;
(6) businesses in town change to cater to wealthy locals and tourists;
(7) businesses become higher-end and more expensive as the town is becoming more affluent people oriented;
(8) local people in working class and relatively young people can no longer afford to live in town;
(9) a gap appears between the affluent locals/newcomers/tourists and working locals;
(10) the more tourists who come, the more the economic and social polarization increases.

rection without major infrastructure development which may increase the town's polarization. If Peterborough continues its current tourism direction, primarily day tourism with tourist attracted by its quaint New England atmosphere and high-end shops, the negative affects of building more hotels and increasing tourism infrastructure development would be avoided. However, the emerging economic polarization and divided social classes could increase as Peterborough keeps going "high-brow" to preserve its unique and cute New England town and thus limiting economic opportunities for many young and poorer people; and 2) increasing the pace of tourism development in order to have more tourists which will transform the town physically but possibly provide more job options for the young and poorer members of town. If hotels are built and public transportation improved, the type of tourism in Peterborough may change from day tourism to overnight tourism. If this happens, the number of tourists may increase and more tourist dollars will be spent. However in order to accommodate the larger number of tourists Peterborough may face the necessity of transforming their town physically and culturally, which many interviewees do not want.

Local people perceive the growing economic gap between affluent locals/ tourists and working locals as a negative economic impact and are concerned about the existing tourism development cycle which is further accelerating economic polarization (Table 5). How Peterborough handles this cycle can be a model for other communities. Peterborough must decide in which direction it wishes to go.

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Evaluation and Analysis: Development Trend of China's Logistics Industry under Supply Chain Globalization Environments

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ABSTRACT

First in this paper a systematic and comprehensive hybrid index evaluation system of regional logistics competitiveness is designed according to the characteristics of China's regional logistics system under supply chain globalization environments, and systematic analysis and discussion of the connotation of the various factors in the index evaluation system are made. Then based on hierarchy analysis thought and fuzzy decision-making principles, the development trend of China's regional logistics industry is assessed systematically and comprehensively. With the result of the above assessment, the key factors and the gradual evolution process of promoting regional logistics industry competitiveness under supply chain globalization environments are discussed. Also, in this paper it points out that enhancing the strength of urban logistic enterprises will promote the competitiveness of regional logistics industry. And the logistics competitiveness of a few major economic zones in China is discussed with conclusion that discrepancy exists in terms of China's provincial capital city's logistics development. At last, development strategies for regional logistics are put forward aimed at the west regions of China which have weak competitiveness in logistics industry.

Keywords: *supply chain globalization environment, regional logistics, developmental trend, evaluation and analysis*

1. Introduction

From the late 1990s, a new round of international industrial transfer, which is characterized by the transfer of manufacturing industry from developed countries to China as well as other eastern Asian countries, has been on the increase with the rise of knowledge economy and the acceleration of global economy. This has accelerated the globalization of supply chains, and hence has made regional logistics more demanding [1]. The level of logistics industry development has become an important indicator, which is used to measure the quality of the regional investment environment, but also becomes an accelerator to the regional economy. To enhance the capability of regional logistics system under supply chain globalization environments and to improve the investment environment so that to attract more investment capital, each region should accelerate the construction of infrastructure investment, based on the scientific and rational planning of the regional logistics development, and integrate and optimize the traditional logistics industry and improve the concentration of regional logistics industry, which plays an important role in enhancing the regional comprehensive competitiveness and the sustainable development of regional economy under supply chain globalization environments.

Based on the statistical data of China's four municipalities and 27 provincial capital cities related to the logistics industry in 2007 and a tentative construction of the assessment index system for regional logistics development, applying the thought of hierarchy analysis [2] , fuzzy pattern recognition principles and fuzzy consistent judgment matrix [3,4,5,6], the article offers the hybrid index hierarchy fuzzy decision-making method to synthetically analyze and evaluate the development trend of Chinese regional logistics.

2. The Construction of Evaluation Index and the Data Standardization Processing

2.1 The Construction of Evaluation Index

The competitiveness of area logistics is the joint force from the interplay of various factors. According to the

characteristics of regional logistics and following some principles about evaluation index, the paper summarizes the evaluation index system into 12 index of first class M_i (for i=1,2,….,12), including such elements as economic situation, the logistics volume, the logistics industry practitioners, the logistics facilities and equipments, the logistics industry costs, postal communications status, foreign investment, the standard of education, science and technology, trade status, information status, geographical situation and industrial policy environment. Those first class index elements include 22 second class index which is indicated by S_{ij}^k (represent the **j**th second-degree index about the **i**th first class index in the **k**th evaluated region), and all these elements compose a three-tier system of mixed indicators, as shown in Figure 1.

(1) Economic situation M_1: including the monthly average wage of all workers and the employment staff in per 10,000 people. These indicators comprehensively reflect the socio-economic basis of the regional logistics development.

(2) The logistics volume M_2: mainly includes the goods turnover per capita. The indicator reflects the demand of the situation and the scale in the regional logistics services.

(3) The logistics industry practitioners M_3: mainly includes Logistics industry practitioners in per 10,000 employment staff. The indicator reflects the needing situation of the human resources in the regional logistics industry development.

(4) The logistics facilities and equipments M_4: mainly includes per capita area of the road, per 10,000 people the number of having transport vehicles, per capita investment of the logistics industry, per 10,000 people the number of having public transport vehicles. These indicators reflect the infrastructure conditions of a regional logistics industry development from different angles.

(5) The logistics industry costs M_5: mainly includes per 10,000 people the output of logistics industry, per 10,000 people the increase amount in the inventory, and the two indicators reflect the effectiveness of the regional logistics industry from different perspectives.

(6) Postal communications status M_6: mainly includes per 10,000 people the number of owning Mobile Phone, per 10,000 people the number of having Internet, per 10,000 people the number of having sub-post office. These indicators reflect the information infrastructure status of the regional logistics development from different perspectives.

(7) Attract foreign investment status M_7: mainly includes per 10,000 people the amount of having foreign capital investment, the indicator reflects the vitality and attractive situations of the regional logistics industry development.

(8) The standard of education, science and technology M_8: mainly includes per 10,000 people the number of having college students in school, per capita the amount of education expenditure spending, logistics and information industry technology professionals in per 10,000 employment staff, these indicators reflect trained personnel resources status of the regional logistics industry development from different perspectives.

(9) Trade status M_9: mainly includes per capita the wholesale/retail trade amount of year-end inventory, per capita total import/export amount of goods, the two indicators reflect the needs conditions and needs scale of the regional logistics service from trade perspectives.

(10) Information Condition M_{10}: indicates by information index, the information index is an important indicator, which reflects the competitiveness of a region in the information age. It is comprehensively calculated by 20 indicators of six aspects, which includes the development and utilization of resources, information network construction, the application of information technology,

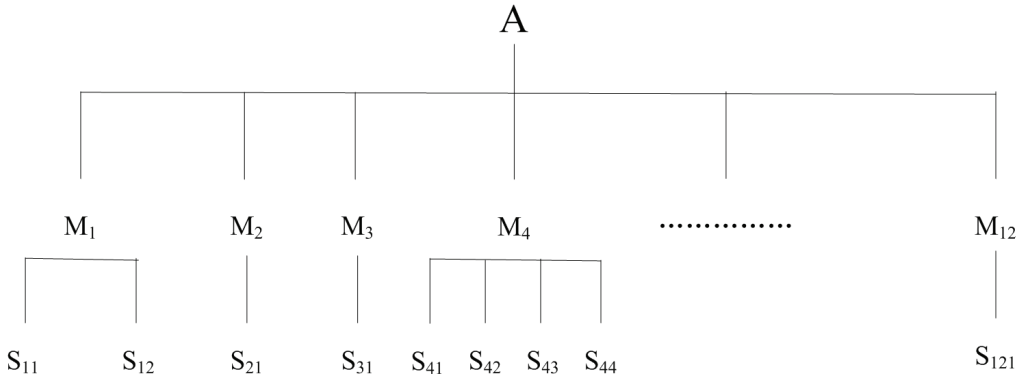

Figure 1. Regional logistics system evaluation index system

information products and services, information human resources and the development environment of information.

(11) Geographical condition M_{11}: geographic location is obviously one of the important factors influencing the development of the logistics industry.

(12) Industrial policy environment M_{12}: the local industry system, industrial policies and market economy atmosphere and the idea and consciousness of the local people have a wide impact on the development of logistics industry, so industrial policy environment also affects the development of the logistics industry as one of the important factors.

2.2 Determine Evaluation Index Set

According to AHP, Figure 1 shows the evaluation index system, which consists of the target layer A, middle layer (first class index) M_i,and the bottom layer (second-degree index) S_{ij}^k (represent the **j**th second-degree index about the **i**th first class index in the **k**th evaluated region). A is the set of first class index M_i, of which the notation is $A=\{M_1,M_2,.....,M_m\}$. M_i (for i=1,2,…,m) is the set of second-degree index S_{ij}^k (for $j=1,2,...,n_i$, and n_i is the number of second-degree index in the i[th] first class index) , and use the set $M_i=\{S_{i1}^k,S_{i2}^k,.....,S_{in_i}^k\}$ to represent. Then

$$A=\bigcup_{i=1}^{m} M_i \qquad M_i \cap M_j=\phi, i\neq j \tag{1}$$

$$S_{ij_x}^k \cap S_{ij_y}^k=\phi, j_x\neq j_y$$

$$j_x=1,2,....,n_i \qquad j_y=1,2,....,n_i \tag{2}$$

2.3 Handle the Mixed Indicator S_{ij}^k

Let's suppose that the number of evaluated region is *n* and the number of first class index is *m*. For an evaluated region *k*, $f_{ij}^k(x)$ ($k=1,2,\cdots,n$) is the j[th] value of the second-degree index S_{ij}^k in the i[th] first class index M_i. Now define the target characteristic matrix of the i[th] first class index by $X_i=(f_{ij}^k(x))_{n_i\times n}$.

We compute quantitative indexes by basic date. As for the qualitative index in the article, the set of fuzzy language is defined as L = {EG,VG,G,F,P} , in which, EG=extremely good, VG=very good, G=good, F=fair, P=poor. The definite value is determined by experts giving a mark according to actual circumstance. Fuzzy value is indicated with (0, 1). In the article, the "geographic situation" and the "industrial policy environment" are two qualitative indicators in first class index, and the definition of evaluation indicators for the assessment as VG value of 0.95, evaluation indicators assessed as G value 0.85, evaluation indicators assessed value of 0.75 for F and evaluation indicators for the assessment of P value was 0.65, for the VP to inform the evaluation index value of 0.55. The final value of each qualitative index is the average points of all the experts' points.

2.4 The Data Standardization Processing

To eliminate the effect of different indexes unit, and to integrate quantitative indexes and qualitative indexes, we need to process all indexes data so that they are standardization data.

For each index S_{ij}^k, $\varphi_{ij}^k(x)$ is the standardization value of the **j**[th] second-degree index about the **i**[th] first class index in the **k**[th] evaluated region .When the index original data is $f_{ij}^k(x)$, the definition of standardization value $\varphi_{ij}^k(x)$ is determined by the following equation

$$\varphi_{ij}^k(x)=\frac{f_{ij}^k(x)-\overline{f_{ij}^k(x)}}{s}$$
$$i=1,2,....,m$$
$$j=1,2,....,n_i \tag{3}$$
$$k=1,2,\cdots,n$$

In the equation,

$$s=\sqrt{\frac{\sum_{k=1}^{n}(f_{ij}^k(x)-\overline{f_{ij}^k(x)})^2}{n}} \tag{4}$$

$$\overline{f_{ij}^k(x)}=\frac{\sum_{k=1}^{n} f_{ij}^k(x)}{n} \tag{5}$$

From Formula (3), the standardization evaluation matrix of all indexes is obtained. This is written as follows: $R_i=(\varphi_{ij}^k(x))_{n_i\times n}$.

Applying Formulae (3), (4) and (5), the original data of China's four municipalities and 27 province capital cities can be processed and standardized. The processing results are shown in Table 1.

3. Fuzzy Subset of Index Weight

To avoid the problem of poor uniformity of judgment matrix in the process of computing weight in AHP, we use fuzzy consistent judgment matrix G which exist in fuzzy consistent relations to obtain weight. Suppose that

Table 1. The results of data standardization processing

Region	φ_{11}	φ_{12}	φ_{21}	φ_{31}	φ_{41}	φ_{42}	φ_{43}	φ_{44}	φ_{ij}
Peking	2.29	0.70	-0.63	-0.21	0.36	0.09	-0.34	3.25	…
Tianjin	0.91	-0.82	2.70	-0.19	-0.03	-0.38	-0.59	0.09	…
Shanghai	2.70	-0.06	3.79	0.01	1.76	0.86	0.37	1.47	…
Nanjing	0.30	1.29	0.09	-0.40	2.28	0.98	2.97	-0.31	…
Hangzhou	1.47	0.20	0.24	-0.29	1.91	3.42	1.62	0.19	…
Hefei	-0.76	0.00	-0.15	-0.31	0.45	-0.99	-0.29	-0.49	…
Fuzhou	0.01	-0.05	-0.21	-0.36	0.25	-0.82	-0.07	0.10	…
Nanchang	-0.77	-0.44	-0.46	-0.22	-0.35	-1.19	0.25	-0.39	…
Jinan	-0.35	2.15	1.27	-0.36	0.82	-0.27	0.05	-0.73	…
Zhengzhou	-0.72	1.76	0.16	-0.31	-0.37	-1.17	1.51	-0.43	…
Wuhan	-0.74	0.75	-0.21	-0.18	-0.06	-0.88	0.56	-0.39	…
Changsha	-0.42	0.24	-0.14	0.58	-0.47	-0.98	0.33	-0.25	…
Guangzhou	1.19	2.16	0.85	-0.24	0.20	0.34	2.51	-0.70	…
Chongqing	-0.38	-0.73	-0.68	-0.12	-1.47	0.64	-0.66	-0.50	
k	…	…	…	…	…	…	…	…	…

Note: The source of statistical original data is rooted in the reference literature [7], [8] and [9] which were computed simply. Because there were a large number of statistical indexes and original data, but the paper length is limited, so only part of the results of data standardization processing was shown in table1 in the article.

ω_i (for $i = 1,...,m$) is first class indexes weight, and ω_{ij} (for $i = 1,..,m$, and $j = 1,2,....,n_i$) is second-degree index weight; We have

$$\sum_{i=1}^{m} \omega_i = 1 \quad \sum_{j=1}^{n_i} \omega_{ij} = 1 \tag{6}$$

Computing the index weight process is as follows:

Step 1 Establish optimal choice relationship matrix $F = (\sigma_{pq})_{n_i \times n_i}$

The value of σ_{pq} in this matrix separately is 0.5 (the importance of the two indexes is on the same level), 0.0 (one index is less importance than another), 1.0 (one index is more importance than another). The relative importance degree of the index is given by the experts beforehand.

According to the relevant data and the experts' judgment, establish the optimal choice relationship matrix F of the first class indexes are shown as follows:

$$F = \begin{pmatrix} 0.5 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0.5 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.5 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0.5 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0.5 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.5 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0.5 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 0.5 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0.5 & 1 & 1 & 1 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 0.5 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0.5 & 1 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 0.5 \end{pmatrix}$$

In addition, according to the actual situation of evaluation indexes design, the second class indexes which are related with a first class index are of same importance, that is, the value of σ_{pq} in optimal choice relationship matrix $F = (\sigma_{pq})_{n_i \times n_i}$ is 0.5. Thus the optimal choice relationship matrix of the second class index is omitted.

Step 2 Establish fuzzy consistent judgment matrix $G = (r_{pq})_{n_i \times n_i}$

$$r_p = \sum_{k=1}^{n_i} \sigma_{pk}, p = 1, 2, \cdots n_i$$
$$r_{pq} = \frac{r_p - r_q}{2n_i} + 0.5 \quad \textbf{(7)}$$

From the literature [10] we know that G meets fuzzy consistent relationship. Thus, according to Formula (7) and optimal choice relationship matrix F, we could establish fuzzy consistent relationship matrix G of the first class index as follows:

$$G = \begin{pmatrix} 0.5 & 0.792 & 0.875 & 0.542 & 0.833 & 0.917 & 0.958 & 0.583 & 0.625 & 0.75 & 0.667 & 0.708 \\ 0.792 & 0.5 & 0.583 & 0.25 & 0.542 & 0.625 & 0.667 & 0.292 & 0.333 & 0.458 & 0.375 & 0.417 \\ 0.875 & 0.583 & 0.5 & 0.167 & 0.458 & 0.547 & 0.583 & 0.208 & 0.25 & 0.375 & 0.292 & 0.333 \\ 0.542 & 0.25 & 0.167 & 0.5 & 0.792 & 0.875 & 0.917 & 0.542 & 0.583 & 0.708 & 0.625 & 0.667 \\ 0.833 & 0.542 & 0.458 & 0.792 & 0.5 & 0.583 & 0.625 & 0.25 & 0.292 & 0.417 & 0.333 & 0.375 \\ 0.917 & 0.625 & 0.547 & 0.875 & 0.583 & 0.5 & 0.542 & 0.167 & 0.208 & 0.333 & 0.25 & 0.292 \\ 0.958 & 0.667 & 0.583 & 0.917 & 0.625 & 0.542 & 0.5 & 0.125 & 0.167 & 0.292 & 0.208 & 0.25 \\ 0.583 & 0.292 & 0.208 & 0.542 & 0.25 & 0.167 & 0.125 & 0.5 & 0.542 & 0.667 & 0.583 & 0.625 \\ 0.625 & 0.333 & 0.25 & 0.583 & 0.292 & 0.208 & 0.167 & 0.542 & 0.5 & 0.625 & 0.542 & 0.583 \\ 0.75 & 0.458 & 0.375 & 0.708 & 0.417 & 0.333 & 0.292 & 0.667 & 0.625 & 0.5 & 0.417 & 0.458 \\ 0.667 & 0.375 & 0.292 & 0.625 & 0.333 & 0.25 & 0.208 & 0.583 & 0.542 & 0.417 & 0.5 & 0.542 \\ 0.708 & 0.417 & 0.333 & 0.667 & 0.375 & 0.292 & 0.25 & 0.625 & 0.583 & 0.458 & 0.542 & 0.5 \end{pmatrix}$$

Step 3 Computes the largest eigenvalue of G, after Normalization of the corresponding vector, we can get ω_i and ω_{ij}.

Applying the tool of MATLAB or SPSS, we can easily obtain the greatest eigenvalue $\lambda_{\max} = 0.6148$ about G, and the largest eigenvalue corresponding eigenvector as follows:

$$\xi_{\lambda_{\max}} = (0.4019 \quad 0.2776 \quad 0.2498 \quad 0.3345 \quad 0.2919 \quad 0.2879 \quad 0.2895 \quad 0.2382 \quad 0.2471 \quad 0.2839 \quad 0.2517 \quad 0.2712)^T$$

After eigenvector $\xi_{\lambda_{\max}}$ normalized, we get the weight about first class index as follows:

$$\omega = (0.117 \quad 0.081 \quad 0.073 \quad 0.098 \quad 0.085 \quad 0.084 \quad 0.085 \quad 0.070 \quad 0.072 \quad 0.083 \quad 0.074 \quad 0.080)^T$$

The weights about second-degree index are shown in the Table 2.

4. Comprehensive Evaluation

Suppose $u_i^k(x)$ is the first class index evaluation value of the $\mathbf{k}^{\text{th}}$ evaluated region, $U_A^k(u_i^k(x))$ is the evaluation value for overall objective A of the different first class index of the $\mathbf{k}^{\text{th}}$ evaluated region, so $u_i^k(x)$ and $U_A^k(u_i^k(x))$ can be computed by following:

$$u_i^k(x) = \sum_{j=1}^{n_i} \omega_{ij} \varphi_{ij}^k(x) \qquad i = 1, 2, ..., m \quad \textbf{(8)}$$

Table 2. The weights about second-degree index

S_{ij}^k	s_{11}	s_{12}	s_{21}	s_{31}	s_{41}	s_{42}	s_{43}	s_{44}	s_{51}	s_{52}	s_{61}
ω_{ij}	0.5	0.5	1	1	0.25	0.25	0.25	0.25	0.5	0.5	0.33
S_{ij}^k	s_{62}	s_{63}	s_{71}	s_{81}	s_{82}	s_{83}	s_{91}	s_{92}	s_{101}	s_{111}	s_{121}
ω_{ij}	0.33	0.33	1	0.33	0.33	0.33	0.5	0.5	1	1	1

$$U_A^k(u_i^k(x)) = \sum_{i=1}^{m} \omega_i u_i^k(x) \quad \textbf{(9)}$$

applying Formulae (8) and (9), we can get the overall objective vector $U = (U_A^1, U_A^2, \cdots U_A^k \cdots, U_A^n)$ of Chinese evaluated 31 regions. Sorting each components of the vector U from large to small, we get the sort order of different region logistics development trend, as shown in Table 3.

5. Analysis of the Evaluation Results

We could roundly analyze to the evaluation results shown in the Table 3 as the following:

(1) Urban logistics industry competitiveness are closely related with the economic situation of the whole city, logistics facilities and equipment, logistics industry costs, attractiveness of foreign investment, trade and information etc.. Competitive cities are superior to weak competitiveness cities in these indexes in Table 3. In addition, in the process of evaluation, the use of fuzzy consistent judgement matrix to calculate the weights of these indexes is also larger than other. Therefore, the various decision-making which are about the regional logistics industry development should be focused on these indexes. It is necessary to point out that the regional economic conditions are closely related to the level of the regional logistics industry development. The regional logistics industry development has a strongly pulling effect for the regional economic development, and the regional economic development has a reverse effect on the regional logistics system, which can promote its development. Thus the two aspects are interdependent and mutually prerequisite.

(2) It is a step-by-step process that the development of the urban logistics industry and enhancing the overall competitive strength of the city. Because it involves many factors, and in particular the construction of logistics infrastructure needs huge amount of investment, based on their own status of the logistics industry competitive strength which compared with surrounding areas, every region should think carefully, and rationally analyze and make a strategic decision. In working out various policy measures about the regional logistics development planning, firstly, it must be identified that their own strengths and weaknesses of the logistics industry, and it should have a systematic and in-depth analysis to these factors such as production conditions, supply and demand conditions, and support industries and so on, which are related with logistics industry development so that it can be located accurately that the development of the urban logistics industry. At the same time, it should pay attention to the coordination between the regions and attach importance to the complementary and sharing of logistics resources in the same economic, and avoid the mechanical and blind and redundant construction of logistics projects in the same economic region. If that's the case, it might make these logistics projects no joint forces and have no characteristics or competitive advantages, even idle.

(3) Logistics enterprises are the main part of urban logistics industry, therefore the key measures and strategies of promoting the competitiveness of the logistics

Table 3. Sort order of different region logistics competence

Region	U_A^k	Region	U_A^k	Region	U_A^k
Shanghai	3.500	Zhengzhou	0.081	Yinchuan	-0.241
Peking	3.185	Chengdu	0.072	Lanzhou	-0.283
Guangzhou	1.355	Harbin	0.045	Nanning	-0.309
Hangzhou	0.957	Changsha	0.014	Haikou	-0.331
Nanjing	0.548	Xi'an	0.003	Guiyang	-0.417
Tianjin	0.498	Changchun	-0.007		
Jinan	0.444	Taiyuan	-0.116		
Shenyang	0.382	Chongqing	-0.119	*Urumchi	0.010
Shijiazhuang	0.337	Kunming	−0.154	*Xining	-0.148
Fuzhou	0.135	Hefei	−0.164	*Lhasa	-0.082
Wuhan	0.103	Nanchang	-0.236	*Hohhot	-0.009

Note: The statistical original data of partial indexes of Xining, Lhasa, Urumchi and Hohhot were incomplete, so the result of sort order about these cities have windages in Table 3.

industry is to increase the strength of urban logistics enterprises. The evaluation results indicate that if the competition of city is strong, the number and overall strength of its logistics business are also strong. It is necessary to give priority to cultivate some logistics enterprises which have characteristics, brand effects and strong exemplary role in urban development of the logistics industry. The world famous logistics companies such as UPS, FedEx, DHL, and APL are positioning their own different characteristics, thereby forming its own unique, differentiated competitive advantage. Therefore, local governments should not only innovate in logistics management mechanism, but also strengthen macro guidance to the logistics enterprises, and make efforts to cultivate logistics enterprise groups which have different core business capabilities. All of these are of great significance to promote the regional logistics competitiveness.

(4) The evaluation results show that the Beijing-Tian jin-Hebei Economic Area with Beijing and Tianjin as the representative, the Yangtze River Delta Economic Area with Shanghai and Nanjing as the representative, and the Pearl River Delta Economic Zone with Guangzhou and Shenzhen as the representative are relatively developed and have stronger competitive power in the logistics industry. This is mainly because these three economic zones have stronger economic strength, and the development of the logistics industry has a stronger economic base. In addition, the geographical position and macroeconomic environment of these three economic zones are better, and these provide unique favorable conditions for the development of the logistics industry. We discuss these three economic zones respectively as follows:

1) Beijing-Tianjin-Hebei Economic Area: The Beijing-Tianjin-Hebei Economic Area is located in the heartland of the around Bohai sea economic circle, and it is one of the most intensive areas of the Chinese city zones, industrial parks and port area. In the coastline of Beijing-Tianjin-Hebei Economic Area, Tianjin port is in the middle, and the Huanghua Port, Jingtang Port and Qinhuangdao Port respectively are in the left and right, the throughput of Tianjin and Qinhuangdao Port are more than 100 million tons. Around the four major ports, there are vertical and horizontal cutting railway and highway traffic net. Through these transportation network, Beijing-Tianjin-Hebei Economic Area and its surrounding areas are closely related. The Beijing International Airport and Tianjin international airport have become the Beijing-Tianjin-Hebei Economic Areas' international air cargo centre. Therefore, the Beijing-Tianjin-Hebei Economic Area has developed economy and talents. It is relatively perfect in logistics infrastructure. Also the Beijing-Tianjin-Hebei Economic Area is the heartland of China and northeast Asia's junction, and it connect the north and northwest China, and face the Pacific, therefore, it has geographical superiority to develop modern logistics industry in the Beijing-Tianjin-Hebei Economic Area. Also because of the 2008 Beijing Olympic Games, the Beijing-Tianjin-Hebei Economic Area has brought further development and new opportunities and has injected new vitality for the logistics industry. The logistics industry of the Beijing-Tianjin-He bei Economic Area is expected to achieve greater development.

2) The Yangtze River Delta economic zone: The Yangtze River Delta economic zone is located in the entrance of the Yangtze river to the sea. It is one of the largest core economic zones in China. There are 600 km coastline and many ports like Shanghai, Ningbo, Hong Kong, Nanjing, Zhenjiang which can reach more than 160 countries and regions by sea in the Yangtze River Delta economic zone. The air and land transport are also highly developed, the Shanghai Pudong Airport and Hongqiao Airport have become the international air cargo centre of the Yangtze River Delta economic zone. Advanced highway and the railway network are also excellent in China. In the Yangtze River Delta economic zone, the integrated transport system has been preliminarily formed through the common development of the various modes of transportation such as highways, waterways, rail, air, pipeline and other transportation mode, coupled with favorable natural conditions and obvious geographical advantages, the Yangtze River Delta Economic Zone has become one of the most dynamic economic regions of China's logistics industry development.

3) The Pearl River Delta Economic Zone: The Pearl River Delta Economic Zone is the first known to the Chinese economic region, one of the earliest beneficial areas of the policy of reform and opening-up in China. The obvious geographical advantages and preferential policies have brought unprecedented prosperity. In the economic area, we can find intensive industries, capital-intensive and talent-intensive. Like the Yangtze River Delta economic zone, the superiority of transportation system is prominent in the Pearl River Delta Economic Zone. There are five big ports like Guangzhou Port, Shenzhen Port, Zhanjiang Port, Shantou ports and Zhuhai port. It has five big airports such as Hong Kong, Shenzhen, Guangzhou, Zhuhai and Macao. Beijing-Guangzhou, Beijing-Kowloon, and Beijing-Zhuhai Railway all pass through Pearl River Delta Economic Zone. And its internal, high-speed transportation network is also developed. The PRD has formed the three-dimensional, international and all-round development traffic patterns, and the logistics industry has become the powerful backing of the regional economic development in the Pearl River Delta Economic Zone.

(5) The evaluation results show that: Imbalance marks the development of the logistics industry in the provin-

cial capital cities of China. The development of the logistics industry has a strong gap between the Chinese northwest and southwest cities and the cities in the three major economic regions. In the three major economic regions, the urban logistics industry is more competitive, while in the northwest and south-western cities, the logistics industry is less competitive, especially in the north-western cities, logistics industry is in the weak position. The natural and social environments jointly lead to the imbalance of logistics industry development, and also the unbalanced problems of economic development urgently need to be solved in China.

In China's western regions there are 10 provinces, municipalities, and autonomous regions. It has a total land area of about 5.4 million square kilometres, accounting for 56% of China's total land area, but the geographical location disadvantage is obvious, with its fragile ecological environment, low industrial intensity, and economic underdevelopment. Also its logistics infrastructure construction is lagging behind. Although there are the Eurasian continental bridge, the Southern Xingjian Railway, the Lanzhou-Kunming railway, the Lanzhou-Xingjian double-track railway in these regions, and in recent years some of the high-level road network construction has provided a solid foundation for the western China logistics industry development, however, compared with the economically developed eastern and south-eastern coastal areas who own three-dimensional, international and all-round development traffic patterns, the gap is still large, and the gap is expanding year by year. At the same time, as the regional logistics industry main part, the logistics enterprises have a lot of problems such as shortage of funds, single mode of services, inflexibility mode of operation, lack of understanding of logistics services, small enterprises scale, the low level of information processing methods, and backward knowledge of modern logistics, shortage of logistics personnel and so on, all of which have made it hard for many of the western region logistics enterprises to achieve greater development in short term. Essentially, it is the main reason that the regional economy is underdeveloped, which leads to the issues of western logistics industry development backwardness. Based on the above analysis, some suggestions on the development of the logistics industry in the west regions can be made as follows:

1) In the long run, we should improve and protect the ecological environment, and create a good environment for the economy and sustainable development of society. In the western regions, especially in the north-west regions, great importance should be attached to the protection of the ecological environment from strategic perspective, and great effort should be made to change the phenomena of high input, low output and, the excessive cost of raw materials and energy so as to achieve the benign circulation of regional economic development and improvement of the ecological environment. This will substantially benefit the development of regional logistics and relevant industries.

2) Continue to enhance the construction of logistics infrastructure in the western region such as railways, highways, airports, river ports, communication and so on in order to provide good hardware environment for the regional economic development.

3) In order to create logistics demand, it is crucial that logistics industrial intensity be improved. In the west regions we should strengthen urban industrial technology, promote industrial upgrading, improve the industrial intensity. PRD model has provided a useful example for the western regions to improve their industrial intensity.

4) The reasonable logistics system planning is necessary. Based on the planning, gradually standardize regional logistics market, integrate and coordinate the regional logistics resources, improve the technical level and efficiency of the logistics operation, seek the process of high value-added logistics, the aim is to reduce regional logistics costs and increase market competitiveness. At the same time, the western regions need to strengthen the cooperation and exchange with the other three major economic regions in the development of the logistics industry, and borrow their successful experiences.

5) Pay attention to the construction of the soft environment during the development of regional economy and regional logistics industry, which includes the conversion of concept, the upgrading of the ability of independent innovation, system innovation and the introduction and training of human resources, so as to enhance the development of the inherent strength and power.

In short, the development of the logistics industry and the improvement of competitiveness in the west regions involve many disadvantageous factors, which makes it hard and a long way to go to attain the current status of the developed regions in east China.

6. Concluding Remarks

In this paper a systematic and comprehensive hybrid index evaluation system of regional logistics competitiveness is designed according to the characteristics of China's regional logistics system under supply chain globalization environments, and systematic analysis and discussion of the connotation of the various factors in the index evaluation system are made. Also a comprehensive evaluation of the development trend of logistics industry of China's four municipalities, and 27 provincial capital cities have been done on base of hierarchy analysis thought and fuzzy pattern recognition principles accord-

ing to 2007 Statistical Yearbook of the National Bureau of Statistics data. The results showed that:

1) Urban logistics industry competitiveness is closely related with the economic situation of the whole city, logistics facilities and equipment, logistics industry costs, attractiveness of foreign investment, trade and information etc.

2) Overall, the regional logistics industry in China has made gratifying development in recent years, but the development level of logistics industry in the provincial capital cities in China remain seriously unbalanced. The Beijing-Tianjin-Hebei Economic Area with Beijing and Tianjin as the representative, the Yangtze River Delta Economic Area with Shanghai and Nanjing as the representative, and the Pearl River Delta Economic Zone with Guangzhou and Shenzhen as the representative are relatively developed and have stronger competitive power in the logistics industry, but in the cities in northwest and southwest regions, the logistics industry is less competitive. And especially in those cities in the northwest regions, logistics industry is in the weakest position.

3) The regional economic development is increasingly dependent on the development level of the regional logistics industry system. To enhance the competitiveness of the regional logistics industry has an important strategic significance for improving the ability to cope with the rising cost and boosting the regional economic development.

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Research on Urban Logistics Infrastructure: An Empirical Study of China

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ABSTRACT

Urban Logistics Infrastructure (ULI) is an important area of urban competition capability. The connotation of Urban Logistics Capability (ULC) is analyzed in this paper. Compared with the extensive research on ULC in developed world, empirical work is still rare in China. In this paper the theory of ULC is firstly overviewed. Then a new evaluation index system for ULC evaluation is set up which contains factors that reflect the market supply and demand, economic development and transportation accessibility. Secondly, an empirical study is carried out by using Hierarchical Cluster Analysis (HCA) and Principal Component Analysis (PCA) method to classify ULC into 3 clusters for 30 cities in People's Republic of China. Thirdly, according to the characteristics of the 3 clusters, suggestions are proposed for improving their ULI. Finally, after comparing different ULC of 30 cities in People's Republic of China, this paper focuses on that different logistics infrastructure including Hub, Central Distribution Center & Cross Docking Center, Regional Distribution Center or Distribution Center should be build reasonably in order to meet the customer's requirement in the 3 different cluster cities.

Keywords: *urban logistics, performance, hierarchical cluster analysis, principal component analysis*

1. Introduction

With the accession into the WTO, modern logistics in China possess the great development opportunity [1]. Shanghai, Hong Kong and Guangzhou, some of the major gates to the outside world in China, plan to build themselves into major international logistics center in 5 to 10 years [2]. Therefore the research of Urban Logistics Infrastructure (ULI) has recently become a hot topic in the logistics area.

Urban Logistics Infrastructure (ULI) including Logistics Hub, Central Distribution Center, Cross Docking Center, Regional Distribution Center and Distribution Center is an important area of Urban Logistics Capability (ULC) [3]. Mentzer and Konrad reviewed urban logistics performance measurement practices from an efficiency and effectiveness perspective [4]. Much more attention is paid to freight transport on an interurban level, due to the evolution of supply chain analysis, but this attention is basically devoted to cost factors, which are to be minimized in order to improve the efficiency of the urban logistics system. However, ULI which is an important component of ULC should be re-engineered in order to improve the effectiveness of the urban logistics system [5]. From 1952 to 2003, the large-scale city has increased from 9 to 49. Therefore, we need to construct different ULI according to each city's logistics capability.

This paper is organized into 5 sections. In Section 1, a brief description of logistics for metropolitan cities in China is introduced. Hierarchical Cluster Analysis (HCA) and Principal Component Analysis (PCA) method are explained in Section 2. After comparing and analyzing different evaluation system of ULC and overview of ULC theory, a new ULC evaluation system is proposed in Section 3, which is composed of market supply and demand, economic development and transportation accessibility. In Section 4, ULC is classified into 3 clusters for 30 sample cities in China using Hierarchical Cluster Analysis (HCA) and Principal Component Analysis (PCA) method. In the final section conclusions of the study is summarized, and further research for this study is suggested.

2. Research Methodologies

2.1 The Method of Hierarchical Cluster Analysis

Clustering is one of the most important and primitive activities of human beings, dating back to Aristotle.

Given a set of data objects (also known as patterns, entities, instances, observances, or units), cluster analysis aims to explore natural and hidden data structure and to provide insights to the questions such as, "Are there any clusters (groups, subsets, or categories) in the data, and if yes, how many clusters are in the data?" More specifically, supposing we have a set of N data objects with d features (attributes, dimensions, or variables) $\mathrm{X}=\{\mathrm{x}_1,\ldots,\mathrm{x}_j,\ldots,\mathrm{x}_N\}$, where $\mathrm{x}_\mathrm{j}=(\mathrm{x}_{j1},\mathrm{x}_{j2},\ldots,\mathrm{x}_{j\mathrm{d}})\in\Re^d$, we have the following mathematical descriptions of two types of clustering [6]:

1) Hard partitional clustering attempts to seek a K-partition of X, $C=\{C_1,\ldots,C_K\}$ $(K\le N)$, such that:

$$C_i\neq\phi,\quad i=1,\cdots K;$$

$$Y_{i=1}^{K}C_i=\mathrm{X};$$

$$C_i\cap C_j=\phi,\quad i,j=1,\cdots K,\quad i\neq j.$$

2) Hierarchical clustering attempts to construct a tree-like nested structure partition of X, $H=\{H_1,\ldots,H_Q\}$ $(Q\le N)$, such that $C_i\in H_m$, $C_j\in H_l$, and m>l imply $C_i\subset C_j$ or $C_i\cap C_j=\phi$ for all $i,j\neq i,m,l=1,\ldots,Q$.

As aforementioned, clustering is generally classified as partitional clustering or hierarchical clustering based on the properties of clusters generated [7]. Partitional clustering directly partitions data objects into some pre-specified number of clusters, while hierarchical clustering groups data with a sequence of nested partitions, either from singleton clusters to a cluster including all individuals or vice versa. The former is known as agglomerative hierarchical clustering, and the latter is called divisive hierarchical clustering. As the binary division of data is computationally expensive, we will focus on agglomerative hierarchical clustering, which is more commonly used in practice.

Agglomerative hierarchical clustering generates a result, which is depicted by a binary tree or dendrogram, based on the proximity matrix. The root node of the dendrogram represents the entire data set, and each leaf node is regarded as a data object. The intermediate nodes thus describe the extent to which the objects are proximal to each other, and the height of the dendrogram usually expresses the distance between each pair of data objects or clusters, or a data object and a cluster. The ultimate clustering results can be obtained by cutting the dendrogram at different levels. This representation provides very informative descriptions and visualizations for the potential data clustering structures, especially when real hierarchical relations exist in the data.

More specifically, for a data set with N samples, general agglomerative hierarchical clustering can be summarized by the following procedure:

1) start with N singleton clusters C_i (i=1,…,N) and calculate the proximity matrix for these N clusters;

2) in the proximity matrix, search the minimal distance $D(C_i, C_j)=\min D(C_m, C_l)$ $(1\le m,l,\le N,\ m\neq l)$, where $D(\cdot\,,\cdot)$ is the distance function, and combine cluster C_i and C_j to form a new cluster C_{ij};

3) update the proximity matrix by computing the distances between the cluster C_{ij} and the other clusters; and

4) repeat steps 2~3 until only one cluster remains.

2.2 The Method of Principal Component Analysis

The method used to derive the component scores using ten indicators for reflecting Urban Logistics Capability (ULC) is Principal Component Analysis (PCA). PCA transforms the original set of variables into a smaller set of linear combinations that account for most of the variations of the original set. The principal components are extracted so that first principal component denoted by PC(1) accounts for the largest variation in the data.

Let us consider the variables X_1, X_2, ..., X_p. A principal component analysis of this set of variables can generate p new variables, known as the principal components, PC_1, PC_2, ... , PC_p. The principal components can be expressed as follows:

$$PC_1 = b_{11}X_1 +\ldots+ b_{1\mathrm{p}}X_\mathrm{p}=X\mathrm{b}_1$$

$$\vdots$$

$$PC_\mathrm{p}=b_{\mathrm{p}1}X_1 +\ldots+ b_{\mathrm{pp}}X_\mathrm{p}=Xb_\mathrm{p}$$

or, in general,

$$PC=Xb$$

where *b's* are the coefficients for principal component and each column of b contains the coefficients for one principal component. Here, the coefficient for PC_1 is chosen such that it's variance is the largest, and PC_2 is chosen to have the second largest variance subject to the condition that PC_1 and PC_2 are uncorrelated, and so on. For any principal component, the coefficients of principal components are chosen such that $\sum_{i=1}^{p}b_{ij}^2=b_j{}'b_j=1$. Now, if we consider that the sample variance-covariance matrix of the original variables, X, is S_x then the coefficient vector, b_j, can be obtained by solving the following equations:

$$\left|S_x-\lambda I\right|b=0$$

where λ is the vector of characteristic roots and b is a matrix comprising of the characteristic vectors corre-

sponding to each characteristic root [8]. There may be p characteristic roots, some of which may be zero if there are linear dependence among the original variables, X. It may be noted here that PC_1 is computed by using the characteristic vector corresponding to the largest characteristic root, λ_1, similarly, PC_2 is computed by using characteristic vector corresponding to the second largest characteristic root, λ_2, and so on.

It must be stressed that a principal component analysis does not always work in the sense that a large number of original variables are reduced to a small number of transformed variables. Indeed if the original variables are uncorrelated then the analysis does absolutely nothing. The best results are obtained when the variables are correlated, positively or negatively [9]. One merit of PCA is that an increase in the number of variables that one may wish to include for deriving a composite index imposes very little cost on the analysis and one can include many related variables for deriving the principal components [10].

3. Evaluation System of Urban Logistics Capability

Lu and Yang identified the key logistics capabilities indicator for international distribution center operators, based on five key logistics capabilities including customer response, innovation, economic scale, flexible operation and logistics knowledge [11]. Zhang researched the theory of the location planning for logistics park and set up a new index system for logistics park performance evaluation [12].

The comprehensive evaluation on Urban Logistics Capability (ULC) needs a synthetic evaluation system that takes factors as much as possible into consideration to release the objective evaluation for different impacts of different factors on selection of the logistics facility location, i.e. the planning of Urban Logistics Infrastructure. In general, we select 10 factors which are grouped and stated as the following:

3.1 Supply and Demand Capability

3.1.1 Overall Economy Level

Here we adopt Gross Domestic Product (GDP) for this factor. GDP refers to the final products at market prices produced by all resident units in the region during a certain period of time. Generally the higher this factor is in a given region, the more feasible a synthetic logistics facility locates in this region.

3.1.2 Industry Developing Level

Here we adopt Number of State-owned and state-holding Enterprises (NSSE) for this factor. NSSE refer to state-owned enterprises plus state-holding enterprises. State-owned enterprises (originally known as state-run enterprises with ownership by the whole society) are non-corporate economic entities registered in accordance with the Regulation of the People's Republic of China on the Management of Registration of Legal Enterprises, where all assets are owned by the state.

3.1.3 Retail Market Level

Here we adopt Consumption Expenditure of Urban Households (CEUH) for this factor. CEUH refers to total expenditure of the sample households for consumption in daily life, including expenditure on eight categories such as food, clothing, household appliances and services, health care and medical services, transport and communications, recreation, education and cultural services, housing, miscellaneous goods and services.

3.1.4 Foreign Trade Developing Level

Here we use the Number of Foreign Funded Enterprises (NFFE) for this factor. Foreign trade enterprise is the main participator of logistics out-sourcing service in China, which associates with a huge amount of international logistics service, thus the higher this factor is in a given region, the more feasible a synthetic logistics facility locates in this region.

3.1.5 Urban Freight Traffic and Turnover Volume Level

Here we adopt Freight Traffic (FT) for this factor. FT refers to the volume of freight transported with various means within a specific period of time. This indicator reflects the service of the transport industry towards the national economy and people's living conditions, as well as an important indicator used in formulating and monitoring transport production plans and research into the scale and pace of transport development. Freight transport is calculated in tons. Freight transport is calculated in terms of the actual weight of the goods and takes no account of the type of freight and distance of travel. Generally, the huger the volume is in a given region, the more feasible for a synthetic logistics facility locates in this region.

3.2 Economic Development Capability

3.2.1 Average Economy Level

Here we adopt GDP per capita (GDPpC) for this factor. GDPpC refers to the GDP of the region divided by the population of the region. Generally the higher this factor is in a given region, the more feasible a synthetic logistics facility locates in this region.

3.2.2 Social Reproduction

Here we adopt Total Investment in Fixed Assets in the region (TIFA) for this factor. TIFA refers to the volume of activities in construction and purchases of fixed assets and related fees, expressed in monetary terms. It is a

comprehensive indicator which shows the size, structure and growth of the investment in fixed assets, providing basis for observing the progress of construction projects and evaluating results of investment. Total investment in fixed assets in the whole country includes, by type of ownership, the investment by the state-owned units, collective units, individuals, joint ownership units, shareholding units, as well as investment by businessmen from foreign countries and from Hong Kong, Macao and Taiwan, and by other units.

3.3 Transportation Development Level

3.3.1 Accessibility of Railway

Here we adopt Railway Density (RWD) for this factor. RWD is computed by Length of Railway (LRW) divided by area of the region. LRW refers to the total length of the trunk line under passenger and freight transportation (including both full operation and temporary operation). The calculation is based on the actual length of the first line even if this line has a full or partial double track or more tracks, excluding double tracks, station sidings, tracks under the charge of stations, branch lines, special-purpose lines and the non-payable connecting lines. The length of railway in operation is an important indicator to show the development of the infrastructure for the railway transport, and also the essential data to calculate volume of passenger freight transport, traffic density and utilization efficiency of the locomotives and carriages. RWD is a better way to indicate the accessibility of given region. Because different level logistics facilities need a excellent transport network to facilitate its logistics service, railway density index is feasible for this purpose, which is calculated by length of railroad lines in service divides the region total land area.

3.3.2 Accessibility of Roads

Here we adopt Highway Density (HWD) for this factor. HWD is computed by Length of Highway (LHW) divided by area of the region. LHW refers to the length of highway which are built in conformity with the grades specified by the highway engineering standard formulated by the Ministry of Communications, and have been formally checked and accepted by the departments of highway and put into use. HWD is another better way to indicate the accessibility of given region, Because different level logistics facilities need an excellent transport network to facilitate its logistics service: highway network density index is feasible for this purpose, which is calculated by total length of highway network in service divides the region total land area.

3.3.3 Transportation Capacity

Here we adopt Possession of Civil Motor Vehicles (PCMV) for this factor. PCMV refer to the total numbers of vehicles that are registered and received vehicles license tags according to the Work Standard for Motor Vehicles Registration formulated by transport management office under department of public security at the end of reference period. They are divided into following categories according to the structure of motor vehicles: passenger vehicles, trucks and others; and private vehicles and vehicles for units use according to ownerships; working vehicles and non-working vehicles according to kind of usage; large passenger vehicles, medium passenger vehicles, small passenger vehicles and mini passenger vehicle, heavy trucks, light-heavy trucks, light trucks and mini trucks according to sizes of vehicles.

Based on above analysis, we may obtain ULC evaluation index system for macro level logistics facility planning, as showed in Table 1.

4. Classification of ULC

4.1 Sample Cities Selection and Data Statistics

Due to imperfect evaluation index system for logistics

Table 1. Evaluation index system for ULC

First-grade factor	Second-grade factor	Indicator	Abbreviation
Supply and demand capability	Overall economy level	X_1－Gross Domestic Product (billion yuan)	GDP
	Industry developing level	X_2－Number of State-owned and State-holding Enterprises (unit)	NSSE
	Retail market level	X_3－Consumption Expenditure of Urban Households (billion yuan)	CEUH
	Foreign trade developing level	X_4－Number of Foreign Funded Enterprises (unit)	NFFE
	Urban freight traffic and turnover volume level	X_5－Freight Traffic (million tons)	FT
Economic development capability	Average economy level	X_6－GDP per Capita (yuan/person)	GDPpC
	Social reproduction	X_7－Total Investment in Fixed Assets (billion yuan)	TIFA
Transportation accessibility level	Accessibility of railway	X_8－Railway Density (km/1,000km^2)	RWD
	Accessibility of roads	X_9－Highways Density (km/1,000km^2)	HWD
	Transportation capacity	X_{10}－Possession of Civil Motor Vehicles (1,000 unit)	PCMV

Source: Stanley E.Fawcett (1997) [13]; David J. Closs, Thomas J. Goldsby and Steven R. Clinton (1997) [14]; Edward A. Morash, Cornelia L.M. Droge, Shawnee K. vichery (1996) [15]; Daniel F.Lynch, Scott B.Keller, John Ozment (2000) [16], arranged by author.

static in China, and the statistical indicators are inadequate in Urban Statistical Yearbook of China, it is impossible for the sample we selected to contain all the influence indicators, i.e. to take factors from the available statistical data into consideration to covering influence indicators that we discussed as much as possible.

According to the difference inherent attributes of different city and distribution channel, 30 major cities in China are selected, which exclude Hong Kong, Macao, Taiwan and Lhasa for Statistical Indicator and method difference. 30 major cities include:

(1) North China economic region with Beijing as the center, covering Tianjin, Shijiazhuang, Taiyuan, Hohhot;

(2) Northeast China economic region with Shenyang as the center, covering Changchun, Harbin;

Table 2. Synthetic scores of 30 cities in China

City	Indicator									
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8[a]	X_9[b]	X_{10}
Beijing	428.3	4324	197	696	299.9	37058	252.8	68.7	893.7	176.9
Tianjin	293.2	5378	105	1010	372.8	31550	125.9	57.0	905.9	119.3
Shijiazhuang	163.3	1555	53	504	117.5	17871	71.7	25.0	375.3	706.4
Taiyuan	64.0	521	23	12	166.8	18804	33.5	20.1	420.9	324.4
Hohhot	51.2	203	16	17	55.4	26321	31.5	5.5	66.3	240.6
Shenyang	190.1	1836	81	309	150.4	27487	97.1	28.7	360.8	388.9
Changchun	153.5	580	50	90	115.8	21285	46.0	18.7	245.6	172.1
Harbin	168.0	765	71	49	99.4	17463	53.3	12.4	148.5	239.3
Shanghai	745.0	12316	245	2938	687.1	55307	308.5	41.8	1237.7	188.2
Nanjing	191.0	2165	71	272	169.4	33050	120.2	15.9	775.2	443.6
Hangzhou	251.5	5607	70	413	189.0	38858	120.5	12.2	459.9	518.6
Hefei	59.0	492	24	135	57.7	13378	36.1	16.8	511.3	298.3
Fuzhou	154.8	2345	58	406	90.4	23444	52.7	11.9	461.1	221.8
Nanchang	77.0	632	23	38	42.0	17238	35.2	13.6	369.8	181.0
Jinan	161.9	1510	69	107	150.3	27610	65.1	21.3	506.9	721.7
Zhengzhou	137.8	1801	56	51	86.7	21233	61.3	24.7	457.2	473.1
Wuhan	195.6	1403	96	94	170.5	24963	82.2	13.4	481.7	297.9
Changsha	113.4	1149	53	48	110.7	18036	66.8	13.4	413.7	295.5
Guangzhou	411.6	4727	168	541	352.0	56271	134.9	12.3	629.4	1010.7
Nanning	58.9	561	24	22	67.9	9126	26.1	11.6	252.1	184.3
Haikou	25.3	231	10	60	34.7	17928	11.9	11.3	614.3	54.4
Chongqing	266.5	2634	106	120	381.7	9608	162.2	8.7	391.9	146.2
Chengdu	218.6	1872	88	123	181.7	20777	108.5	6.1	233.4	406.6
Guiyang	44.4	674	18	31	57.4	12683	29.3	10.7	261.7	145.7
Kunming	94.2	672	37	11	116.5	18773	43.5	6.1	435.1	359.8
Xi'an	109.6	776	51	64	110.0	14081	64.0	15.3	256.0	190.2
Lanzhou	50.5	950	23	9	57.9	16479	23.2	5.7	100.6	88.8
Xining	17.5	163	7	7	23.7	8484	9.9	1.5	39.2	43.9
Yinchuan	18.9	226	7	14	20.1	17668	17.2	15.3	240.2	57.8
Urumqi	48.4	301	20	16	120.8	22820	17.6	1.7	53.2	201.5

Note: [a] computed by Total Length of Railways divide by area of the province and, [b] computed by Total Length of Highways divide by area of the province.

Source: National Bureau of Statistics of People's Republic of China (2005); China Statistical Yearbook (2005); China City Statistical Yearbook (2005), arranged by author.

(3) East China economic region with Shanghai as the center, covering Nanjing, Hangzhou, Hefei, Fuzhou, Nanchang, Jinan;

(4) Central China economic region with Guangzhou as the center, covering Zhengzhou, Wuhan, Changsha, Nanning, Haikou;

(5) Southwest China economic region centered in Chongqing, covering Chengdu, Guiyang, Kunming, Lhasa excluded;

(6) Northwest China economic region centered in Xi'an, covering Lanzhou, Xining, Yinchuan, Urumqi.

Based on National Bureau of Statistics of People's Republic of China (2005), China Statistical Yearbook (2005) and China City Statistical Yearbook (2005), ten indicators of the evaluation index system is analyzed above as statistical variables, we have the data showed in Table 2.

4.2 Hierarchical Cluster Analysis of ULC

Hierarchical cluster analysis is a statistical method for finding relatively homogeneous clusters of cases based on measured characteristics. The aim is to maximize between-group variance and to minimize within-group variance. It starts with each case in a separate cluster and then combines the clusters sequentially, reducing the number of clusters at each step until only one cluster is left. In this paper, we apply the Hierarchical cluster method in Statistical Package for Social Sciences to analysis the 30 major cities. The final result is showed in Figure 1.

According to Figure 1, Shanghai and Guangzhou are in one cluster district with rescaled distance cluster combine between 7 and 24, i.e. these two cities have the first cluster with high logistics capacity, and the rest cities are in the other cluster. For rescaled distance cluster combine between 4 and 7, these 30 cities can be classified into 3 clusters, Shanghai and Guangzhou as the first cluster, Beijing, Hangzhou, Tianjin and Nanjing as the second cluster, and the 24 rest city as the third cluster. And for rescaled distance cluster combine as 3, the third cluster can be classified into 2 clusters, and then the 30 sample city can be classified into 4 clusters.

4.3 Principal Component Analysis of ULC

Since most of the indicators suffer from simultaneity and multi-colinearity, Principal Component Analysis (PCA) is best suited for removing such difficulties because it maximizes the variance rather than minimizing the least square distance where any other technique (such as regression analysis) fails to do so.

In this paper, we apply the "Factor Analysis" method in Statistical Package for Social Sciences (SPSS) to analysis the 30 major cities. The results shown in Table 3 suggest a two-factor solution. The eigenvalues clearly show that only two common factors are present by using the criterion of "eigenvalue greater than 1" and it is further confirmed by the fact that the break point occurs at the three eigenvalue of the scree plot (see Figure 2). This being the case, the two-factor solution would appear to be acceptable. Table 4 shows the two Component loadings. From Table 4 we see that RWD and PCMV carried less weight than the others in case of ranking of cities. We also find that the first component explains 73.550%, and the second component explains 11.692% of the total variation in the data. Since both the eigenvalue of the first component and the second component (in case of ten variables) are greater than 1, in the present case the two components are used to calculate component score for each city to determine the ranking of selected cities. The two Principal Components (PC) explain about 85.242% of the variations in the level of ULC. The variables like GDP, NSSE and CEUH played a major role in classifying the cities in terms of ULC compared to the variables such as RWD and PCMV.

In order to calculate the ranking of the selected cities, the principal components can be expressed as follows:

$$PC_1 = 0.362*X_1 + 0.351*X_2 + 0.351*X_3 + 0.332*X_4 + 0.345*X_5 + 0.308*X_6 + 0.35*X_7 + 0.258*X_8 + 0.318*X_9 + 0.093*X_{10}$$

$$PC_2 = 0.039*X_1 - 0.032*X_2 + 0.053*X_3 - 0.172*X_4 - 0.042*X_5 + 0.34*X_6 - 0.067*X_7 - 0.31*X_8 - 0.097*X_9 + 0.859*X_{10}$$

$$PC = 0.317*X_1 + 0.298*X_2 + 0.31*X_3 + 0.263*X_4 + 0.292*X_5 + 0.313*X_6 + 0.293*X_7 + 0.18*X_8 + 0.261*X_9 + 0.198*X_{10}$$

Based on the Hierarchical Cluster Analysis and Principal Component Analysis of ULC mentioned above, we can calculate the ranking of the selected cities. Table 5 shows the ranking of the selected cities based on Principal Component (PC) scores as well as ranking based on GDP. Figure 1 shows the result of the hierarchical cluster analysis.

From Figure 1 and Table 5, We can classify ULC into 3 clusters among the selected cities in People's Republic of China. For the purpose of analysis conveniently, here we define the first cluster as the high LIC cities, the second cluster as the medium ULC cities, the third cluster as the low ULC cities. The high ULC cities including Shanghai, Beijing, Guangzhou and Tianjin, the medium

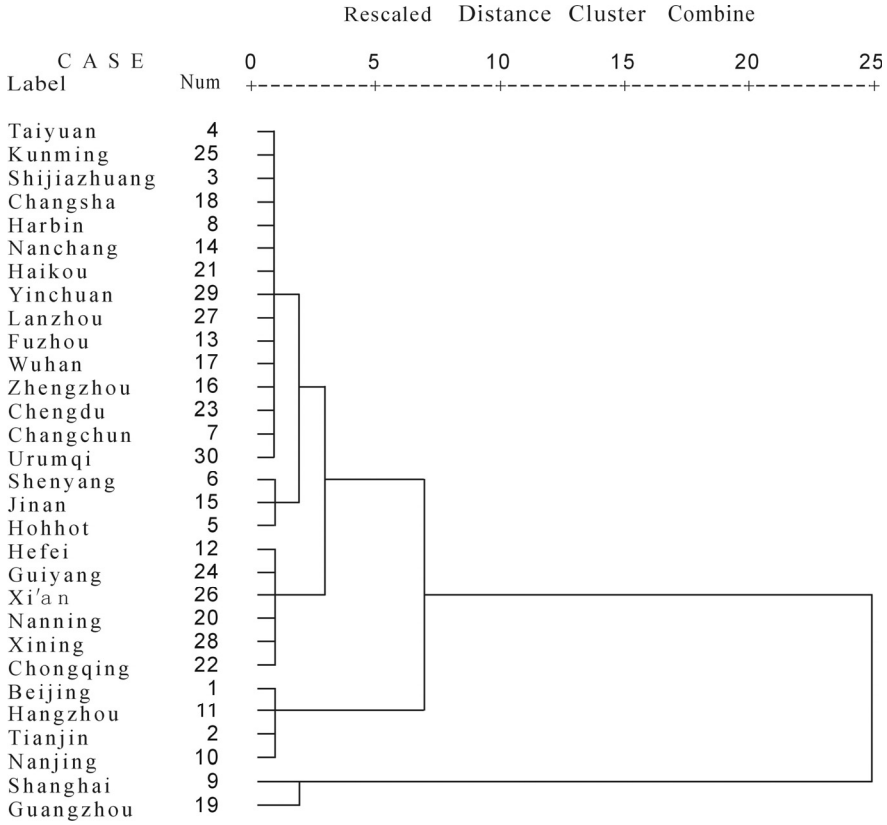


Figure 1. Hierarchical cluster analysis of 30 major cities

Table 3. Eigenvalues of the correlation matrix (ten variables)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.355	73.550	73.550	7.355	73.550	73.550
2	1.169	11.692	85.242	1.169	11.692	85.242
3	.608	6.082	91.324			
4	.343	3.430	94.754			
5	.206	2.058	96.813			
6	.159	1.590	98.403			
7	.078	.785	99.187			
8	.052	.517	99.705			
9	.026	.257	99.962			
10	.004	.038	100.000			

Source: Calculated by the author.

ULC cities including Hangzhou, Nanjing, Chongqing, Shenyang, Jinan, Wuhan, Shijiazhuang and Chengdu. the low ULC cities including Zhengzhou, Fuzhou, Changsha, Changchun, Harbin, Taiyuan, Kunming, Xi'an, Hefei, Nanchang, Haikou, Hohhot, Urumqi, Guiyang, Nanning, Lanzhou, Yinchuan and Xining.

From Table 5, we see that, Shanghai topped the list in terms of ULC followed by Beijing and Guangzhou. For the rate of GDP and PC score are quite high, Shanghai is the front runner among the selected cities. The high ULC cities are almost in Bohai Bay region (including Beijing and Tianjin), Yangtze River Delta Region (Shanghai) and Pearl River Delta Region (Guangzhou). The low ULC cities are almost among the Northwest China economic region (including Urumqi, Lanzhou, Yinchuan, Xining, etc.). as illustrated in Table 6 and Figure 3.

Table 4. Component loadings (Eigenvectors)

	Component	
	PC_1	PC_2
GDP	0.981	0.042
NSSE	0.952	-0.035
CEUH	0.953	0.058
NFFE	0.901	-0.186
FT	0.935	-0.046
GDPpC	0.836	0.367
TIFA	0.949	-0.073
RWD	0.698	-0.335
HWD	0.862	-0.105
PCMV	0.252	0.929

Source: Calculated by the author

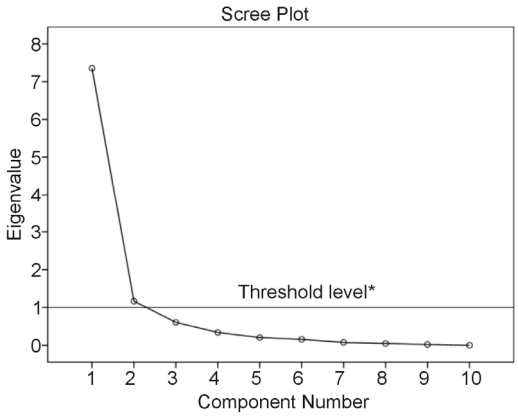


Figure 2. Scree plot of eigenvalues

Note: * Only factors with eigenvalues > 1 are retained

Table 5. Ranking of 30 cities in China on indicators of environment (using 10 variables)

name	PC_1 score	PC_1 ranking	PC_2 score	PC_2 ranking	*PC* score	*PC* ranking	*GDP*	*GDP* ranking
Shanghai	10.209	1	-1.310	28	8.629	1	745	1
Beijing	5.041	2	-1.483	29	4.146	2	428.3	2
Guangzhou	3.891	3	3.731	1	3.869	3	411.6	3
Tianjin	3.659	4	-1.760	30	2.916	4	293.2	4
Hangzhou	1.607	5	1.311	3	1.566	5	251.5	6
Nanjing	1.100	6	0.736	5	1.050	6	191	9
Chongqing	0.886	7	-0.840	25	0.649	7	266.5	5
Shenyang	0.536	8	0.273	10	0.500	8	190.1	10
Jinan	0.254	9	1.765	2	0.461	9	161.9	13
Wuhan	0.199	10	0.212	11	0.201	10	195.6	8
Shijiazhuang	-0.001	11	1.258	4	0.172	11	163.3	12
Chengdu	-0.033	12	0.712	6	0.069	12	218.6	7
Zhengzhou	-0.325	14	0.567	7	-0.203	13	137.8	16
Fuzhou	-0.284	13	-0.194	16	-0.272	14	154.8	14
Changsha	-0.815	15	0.014	13	-0.701	15	113.4	17
Changchun	-0.960	16	-0.405	18	-0.884	16	153.5	15
Harbin	-1.091	17	-0.055	15	-0.949	17	168	11
Taiyuan	-1.104	18	0.003	14	-0.952	18	64	21
Kunming	-1.208	20	0.451	8	-0.980	19	94.2	19
Xi'an	-1.197	19	-0.498	20	-1.101	20	109.6	18
Hefei	-1.400	21	-0.229	17	-1.239	21	59	22
Nanchang	-1.614	22	-0.424	19	-1.451	22	77	20
Haikou	-1.785	23	-0.943	27	-1.670	23	25.3	28
Hohhot	-2.008	24	0.351	9	-1.685	24	51.2	24
Urumqi	-2.077	27	0.175	12	-1.769	25	48.40	26
Guiyang	-2.025	25	-0.606	23	-1.830	26	44.4	27
Nanning	-2.038	26	-0.560	22	-1.836	27	58.9	23
Lanzhou	-2.183	28	-0.542	21	-1.958	28	50.5	25
Yinchuan	-2.232	29	-0.877	26	-2.046	29	18.90	29
Xining	-2.999	30	-0.832	24	-2.702	30	17.50	30

Source: Calculated by the author

Table 6. Profile of LIC

Region	High $PC \geq 2.90$	Medium $0.00 \leq PC < 2.90$	Low $PC < 0.00$
North China economic region	Beijing, Tianjin	Shijiazhuang	Taiyuan, Hohhot
Northeast China economic region		Shenyang	Changchun, Harbin
East China economic region	Shanghai	Jinan, Hangzhou, Nanjing	Fuzhou, Hefei, Nanchang
Central China economic region	Guangzhou	Wuhan	Zhengzhou, Changsha, Haikou, Nanning
Southwest China economic region		Chongqing, Chengdu	Kunming, Guiyang
Northwest China economic region			Xi'an, Urumqi, Lanzhou, Yinchuan, Xining

Source: Arranged by the author

The result of classification shows that there are three basic logistics capacity clusters, which is useful for application in China. The between-group variance of the third and fourth cluster is the smallest, i.e. logistics capacities in cities belong to these two clusters are similar to each other and can be modified as one cluster. While the between-group variance of the first, second and third cluster have significant difference, i.e. cities belong to these three clusters, respectively, are different in the logistics capacity.

For the purpose of analysis conveniently, here we define the first cluster city as the Hub/CDC (Hub/ Central Distribution Center & Cross Docking Center) city, the second cluster as the CDC/RDC (Central Distribution Center & Cross Docking Center / Regional Distribution Center) and the third cluster as the RDC/DC (Regional Distribution Center / Distribution Center) city, as illustrated in Figure 3.

5. Urban Logistics Network Structure

Logistics network is an integration of organizations and facilities within the logistics procedure, and also is an integration network that consists of physical network of product that flows between facilities such as hub, central distribution center, regional distribution center and other kinds of logistics facility, and network of information that flows parallel with the product flow. The aims of urban logistics network structure is to define the location and number of logistics facilities and control the systematic cost with certain service supply level by network analysis and optimal methods.

5.1 Category of Urban Logistics Facility

There are four categories urban logistics facility in China, such as hub, central distribution center, regional distribution center and distribution center.

5.1.1 Hub

According to DOD in USA, hub refers to an organization that sorts and distributes inbound cargo from wholesale supply sources (airlifted, sealifted, and ground transportable) and/or from within the theater. Suppliers can arrange material and product in hub to supply the large hub or logistics center in service destination by long distance transportation to concentrate the supply, take advantage of common transport and combined loading, improve the logistics active efficiency and productivity, and decrease the procurement and supply cost.

5.1.2 CDC (Central Distribution Center & Cross Docking Center)

Cross Docking Center is the facility where the material or products are received from suppliers, sorted directly to be shipped to a consolidated batch (often including other orders from other suppliers) to the customers by the same vehicle or different without putting them in storage. Its particular advantages reside at the minimization of warehousing and economies of scale in outbound flows (from the distribution center to the customers), and it helps reduce operating costs, increase throughput, reduces inventory levels, and helps in increase of sales space. The material or products handled in CDC are usually of large-size, small-item, and low-frequency.

5.1.3 RDC (Regional Distribution Center)

A Regional Distribution Center (RDC) is a collection and consolidation center for finished goods, components and spare parts to be distributed to the distribution center belongs to dealers, importers or other unrelated organizations within or outside the region. Among the functions involved are information network service, repackaging and labeling, and distribution. The material or products handled in CDC are usually of small-size, mul-

tiple-item, and personality.

5.1.4 DC (Distribution Center)

Distribution Centers are foundation of urban logistics network, which usually is a model "warehouse" or other specialized building which is stocked with products to be re-distributed to retailers or wholesalers. In the urban logistics network discussed in this paper, up-level facilities will ship truckloads of products to the distribution center, and then the distribution center will store the product until needed by the retail location and ship the proper quantity to the retails, stores, even the final consumers.

5.2 Planning of Urban Logistics Facility

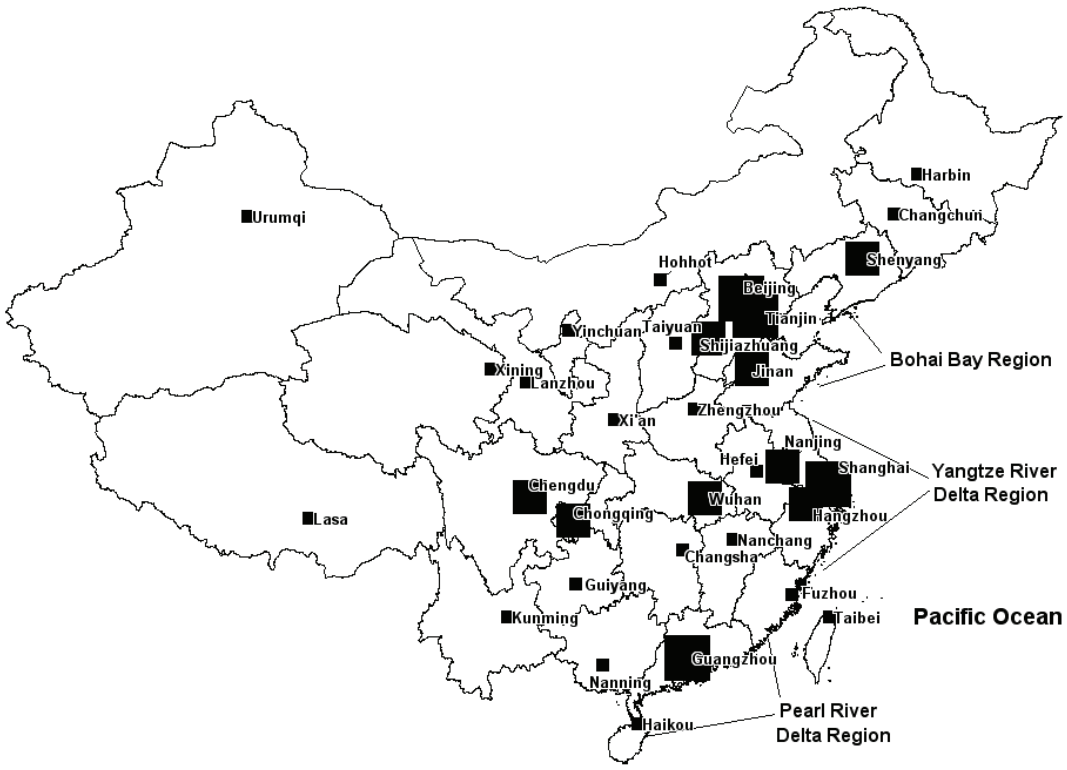
Based on above quantitative analysis of the sample data, and qualitative analysis of four categories urban logistics facility, we locate different facility in different city clusters, and draw up different developing policy respectively.

5.2.1 Developing Policy for Hub/CDC City

In Hub/CDC city, four tier logistics network is designed, in which goods is transported from the Hub to the CDC, and then distributed to RDC, finally reaches DC, as illustrated in Figure 4.

There is a relatively perfect operation system in Hub/CDC city, the focus of urban logistics infrastructure planning is on enhancing the improvement and integration of the logistics systematic function, strengthening the mechanization, automatization and informationization, improving the capacity of handling and efficiency of different logistics facility, developing multimode transportation, facilitating efficient connection between facilities and transport line, optimizing operation process to control the cost.

In practice, advanced operation model should be introduced, i.e. synthetic logistics facility should be built to attract supplier of components and spare parts, and integrated operation system with supply-produce-sale and quick response should be instructed.



Note: cluster 1: Hub/CDC city, includes 4 cities: Shanghai, Beijing, Guangzhou and Tianjin;

cluster 2: CDC/RDC city, includes 8 cities: Hangzhou, Nanjing, Chongqing, Shenyang, Jinan, Wuhan, Shijiazhuang and Chengdu;

cluster 3: RDC/DC city , includes 18 cities: Jinan, Hohhot, Harbin, Urumqi, etc.

Figure 3. Classification of 30 major cities in China according to ULC

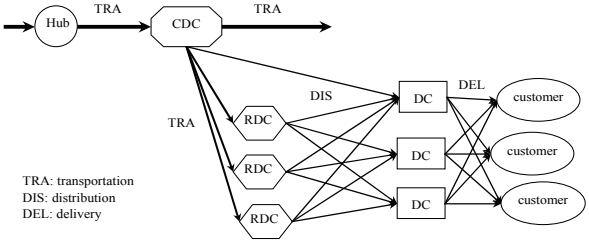


Figure 4. Logistics network for Hub/CDC city

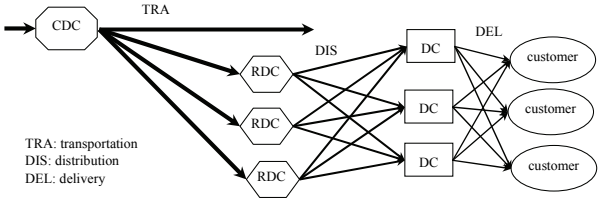


Figure 5. Logistics network for CDC/RDC city

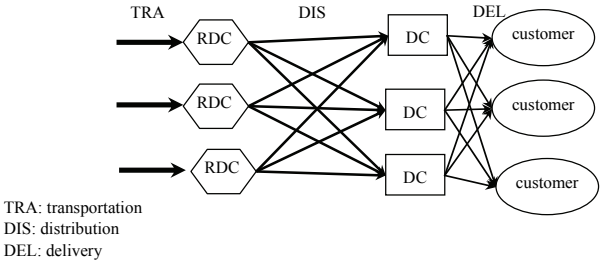


Figure 6. Logistics network for RDC/DC city

5.2.2 Developing Policy for CDC/RDC City

In CDC/RDC city, three tier logistics network is designed, in which goods is transported from the CDC to the RDC, and then distributed to DC, as illustrated in Figure 5.

In this system, larger RDCs should be built for outboard transport, which should be located around the industry park with convenient transportation network with the surrounding area, i.e. goods or material can distributed to the surrounding area directly through this facility. And lager DC should be built for distributing goods to retails, stores, even the final consumers.

For transportation network constructing, it is the long distance transportation system that should be constructed with urban distribution network improvement as a supplement, i.e. to construct a smooth outboard transport system.

5.2.3 Developing Policy for RDC/DC City

In RDC/DC city, two tier logistics network is designed, in which goods is distributed transported from the RDC to the DC, as illustrated in Figure 6.

In this system, DCs should be built to enforce the capacity of small-size, multiple-item, and high-frequency goods order-picking, to improve the capacity of automatic handling, and to quick the response activity. And RDCs should also be built to accept the goods supplied by surrounding area and distribute the goods to DCs timely.

For transportation network constructing, it is the l urban distribution network that should be constructed by expansion of traffic road network and traffic capacity improvement, thus a distribution channel, in which the routing optimization within urban area is the focus and long distance transportation is a supplement, should be setup based on urban GIS and freight characters.

6. Conclusions

The empirical evidence presented in Section 4 gives a better method of classifying ULC. The following conclusions can be drawn:

(1) 30 sample cities' ULC in China are classified into 3 clusters based on hierarchical cluster analysis method.

(2) We find that China has two Hub/CDC cities including Shanghai and Guangzhou, four CDC/RDC cities including Beijing, Tianjing, Nanjing and Hangzhou, and the other 24 RDC/DC cities including Jinan, Hohhot, Harbin, Urumqi, etc.

(3) The Hub/CDC and CDC/RDC cities are in coastland area including Bohai Bay region (Beijing), Yangtze River Delta Region (Shanghai, Nanjing and Hangzhou) and Pearl River Delta Region (Guangzhou). The RDC/DC cities are almost among inland area (Changsha, Guiyang, Harbin, Urumqi, etc.).

(4) The evaluation framework of ULC is partly tested by empirical study and needs further and deeper research.

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An Improved Simultaneous-Revelation Resolution Procedure that Induces Truthfulness

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ABSTRACT

Alternating-offer bargaining protocol is the most predominant way for solving bilateral bargaining problem in daily life. However, alternating-offer consumed more time and caused a lower efficiency in some cases. One proposed solution is called simultaneous-revelation resolution by which both parties reveal their reservation prices at the same time. But most simultaneous-revelation resolution procedures are inefficient because they encourage exaggerations. But it is fast and uncomplicated, this resolution procedure still has merit¬especially if the parties can refrain from undue exaggeration. The paper designs a truthful mechanism for simultaneous-offer bargaining negotiation. In this mechanism, a rule manipulator can induce buyer and seller both to reveal their real prices by introducing suitable adjustment functions. And we show the honest revelations are in Nash equilibrium.

Keywords: *mechanism design, simultaneous-offer, bargaining, truthfulness, nash equilibrium*

1. Introduction

Agent mediated negotiation has received considerable attention in the field of electronic commerce [1,2]. The simplest form of negotiation involves two agents and a single-issue. Negotiation is a process that allows disputing agents to decide how to divide the gains from cooperation [3,4]. The face-to-face, open-ended bargaining is the most commonly used way for solving the problems. Bargaining is normally studied using either the axiomatic approach introduced by Nash [5], or the strategic approach, for which Rubinstein's [6] alternating offer model is probably the most influential [7]. However, alternating-offer consumed more time and caused a lower efficiency in some cases. Informal bargaining, without any imposed structure for negotiations and without tight time constrains, leads to more efficient outcomes than do most formal methods. One proposed structured alternative to informal bargaining is the procedure by which both parties reveal their reservation prices at the same time. If the buyer's bid is at least as large as the seller's ask, then the item is sold at a price between the two offers and the agreement will be settled. The conflicts between parties are resolved and the parties' payoffs both are better off [8]. If the offers do not overlap, then no trade takes place and the negotiations are broken off.

This mechanism was first modeled by Chatterjee & Samuelson [9], and then studied in more details by Myerson and Satterthwaite [10], Leininger et al. [11]. This alternative, though appealing, does not work very well [12]. According to a commonly proposed symmetric resolution procedure, the parties simultaneously submit their reservation prices to the mediator. Let these disclosed values be s' (not necessarily the true reservation price s) for the seller, and b' (not necessarily the true reservation price b) for the buyer. If $b' < s'$, then the negotiation is broken off ; If $s < b$, the final contract will be $x^* = (b' + s')/2$, the midpoint between b' and s' (see Figure 1).

When this simultaneous-revelation resolution procedure was tried, most parties gave truthful revelations: s' equaled s, and b' equaled b [12]. However, in some cases s' was greater than s (because the seller want the midpoint drift right), and b' less than b (because the buyer want the midpoint drift left); indeed, in some of

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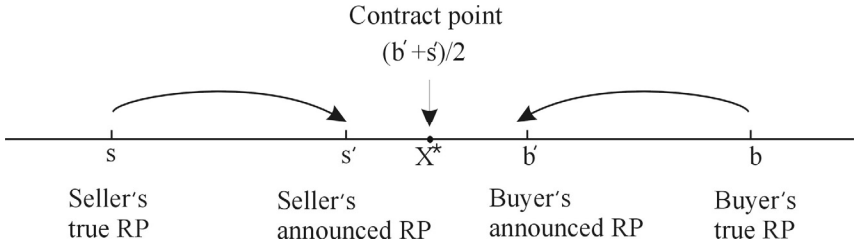

Figure 1. The simultaneous revelation produce

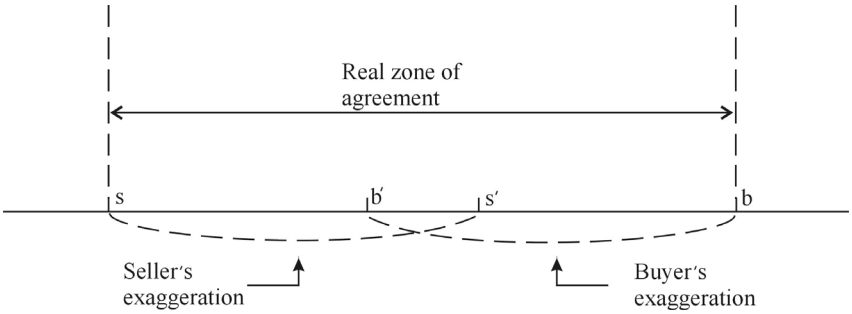

Figure 2. Case in which there is a Zone of Agreement in real but not in revealed values

these cases, there was in fact a zone of agreement (s was less than b) but the parties did not detect it (s' was greater than b') and an inefficiency resulted. If both parties exaggerate a lot, then the chances for an agreement are very poor (see Figure 2).

Thus, the simultaneous-revelation resolution procedure is inefficient because it encourages exaggerations; but it's fast and uncomplicated. If time is at a premium or if one is engaged in many such bargaining problems, then this resolution procedure still has merit –especially if the parties can refrain from undue exaggeration. Perhaps the most interesting questions are those that game theoretic ones. Possibly the most central problem of this form is the difficulty of getting efficient truthful mechanisms. The basic game-theoretic requirement in mechanism design is that of "truthfulness" (incentive compatibility), i.e. that each participating agent is motivated to cooperate with the protocol and to report his true valuation [13].

This paper gives an improved simultaneous-revelation resolution procedure that can engender truthfulness. In this mechanism, rule manipulator can induce buyer and seller both reveal their real prices with suitable adjustment functions. And we show honest revelations are in Nash equilibrium [14].

The rest of this paper is structured as follows. In Section 2 we formally present our model and notations. In Section 3 we show three propositions about honestly revelation. Section 4 concludes.

2. Negotiation Model and Discussions

We formally present our model: the mechanism under consideration, its basic components and the assumptions on the parties.

2.1 Bargaining Rules

Suppose that there is a seller *S*, a buyer *B*, and a rules manipulator *M*. Before bargaining starts, *S* and *B* must submit their reservation prices and the sincerity prices (price constraints that a trader considers the opponent's offer have to satisfy) to *M*. These valuations are their private information. Let s_1 and b_1 denote the reservation price and the sincerity price of *S* respectively; Let b_2 and s_2 denote the reservation price and the sincerity price of *B* respectively. They must satisfy the relation $b_1 \le s_1 \le b_2 \le s_2$. Let s and b denote the offer of *S* and *B* respectively. *M* stipulates: s and b must satisfy $b_1 \le b \le b_2$ and $s_1 \le s \le s_2$; otherwise considers they does not have the sincerity and does not permit the transaction. If $s \le b$, then the final contract will be the midpoint $x^* = (b+s)/2$. In addition, both the parties may obtain an adjusted amount that the opponent will

pay them that depends on the price they announce. If $b \le s$, they can't get anything from disagreement.

2.2 Assumptions

It's important to keep in mind that the parties must agree to the payoff procedure before they begin to bargain. The adjusted amount is extracted according to following adjusted function respectively. We express the adjusted function of *S* and *B* with $f(s)$ and $g(b)$ respectively as follows:

$$f(s)=\begin{cases}(b_2-b)(b-s)/\left(2(b_2-b+s-s_1)\right), s\neq s_1\\ (b_2-s_1)/2 \qquad\qquad\qquad\quad s=s_1\end{cases}$$

$$g(b)=\begin{cases}(s-s_1)(b-s)/\left(2(b_2-b+s-s_1)\right), b\neq b_2\\ (b_2-s_1)/2 \qquad\qquad\qquad\quad b=b_2\end{cases}$$

Notice that the number s is bigger, the function value of $f(s)$ is smaller, namely the higher s the lower the adjusted payment *S* will receive from *B*. Similarly, the number b is smaller, the function value of $g(b)$ is smaller, namely the lower b the lower the adjusted payment *B* will receive from *S*. Hence, there is less incentive for *S* to exaggerate and for *B* to lessen with the adjustment. We will prove the adjusted functions can induce *S* and *B* to make honest revelations: $s=s_1, b=b_2$, and honest revelations are in Nash equilibrium. All this assumes that they are trying to maximize their utility and they both are risk neutral.

2.3 Main Results

According to the rule, we know that the utility function of seller S and buyer B respectively is:

$$U_S=(b+s)/2-s_1+f(s)-g(b),$$
$$U_B=b_2-(b+s)/2+g(b)-f(s).$$

We could obtain the following proposition.

Proposition 1. No matter the buyer whether to offer honestly, $s=s_1$ is optimal for the seller.

Proof. Considering the following two cases:

1) $b\neq b_2$: in this case, if $s=s_1$, we have

$$U_{S1}=(b+s_1)/2-s_1+(b_2-s_1)/2=(b+b_2)/2-s_1.$$

If $s\neq s_1$, we have

$$U_{S2}=(b+s)/2-s_1+(b-s)/2-(s-s_1)(b-s)/(b_2-b+s-s_1)$$
$$=b-s_1-(s-s_1)(b-s)/(b_2-b+s-s_1).$$

From the relation $s_1<s\le b<b_2$, we have

$(s-s_1)(b-s)/(b_2-b+s-s_1)\ge 0$.

Then we have $U_{S2}\le b-s_1<(b+b_2)/2-s_1$, i.e., $U_{S2}<U_{S1}$. Therefore, against $b\neq b_2$ the optimum response of seller *S* is $s=s_1$.

2) $b=b_2$: in this case, if $s=s_1$,we have

$$\overline{U}_{S1}=(b_2+s_1)/2-s_1=(b_2-s_1)/2.$$

If $s\neq s_1$, we have

$$\overline{U}_{S2}=(b_2+s)/2-s_1-(b_2-s_1)/2=(s-s_1)/2.$$

According to the relation $s\le b_2$, we have $(s-s_1)/2\le (b_2-s_1)/2$, i.e., $\overline{U}_{S2}\le\overline{U}_{S1}$. Therefore, against $b=b_2$ the optimum response of seller *S* is $s=s_1$.

Thus, no matter buyer B whether to offer honestly, $s=s_1$ is optimal for seller *S*.

Proposition 2. No matter the seller whether to offer honestly, $b=b_2$ is optimal for the buyer.

Proof. Considering the following two cases:

1) $s\neq s_1$: in this case, if $b=b_2$, we have

$$U_{B1}=b_2-(b_2+s)/2+(b_2-s_1)/2$$
$$=b_2-(s+s_1)/2.$$

If $b\neq b_2$, we have

$$U_{B2}=b_2-\frac{b+s}{2}+\frac{b-s}{2}-\frac{(b_2-b)(b-s)}{b_2-b+s-s_1}$$
$$=b_2-s-\frac{(b_2-b)(b-s)}{b_2-b+s-s_1}.$$

According to the relation $s_1<s\le b<b_2$, we have $(b_2-b)(b-s)/(b_2-b+s-s_1)\ge 0.$

Then we have $U_{B2}\le b_2-s<b_2-(s+s_1)/2$, i.e., $U_{B2}<U_{B1}$. Thus against $s\neq s_1$ the optimum response of buyer B is $b=b_2$.

		Buyer B: B_1	Buyer B: B_2
Seller S	S_1	U_{S2}, U_{B2}	$\overline{U}_{S2}$, U_{B1}
	S_2	U_{S1}, $\overline{U}_{B2}$	$\overline{U}_{S1}$, $\overline{U}_{B1}$

Figure 3. The strategic form game of the buyer and the seller

2) $s = s_1$: in this case, if $b = b_2$, there is

$$\overline{U}_{B1} = b_2 - \left(b_2 + s_1\right)/2 = \left(b_2 - s_1\right)/2.$$

If $b \neq b_2$, there is

$$\overline{U}_{B2} = b_2 - \left(b + s_1\right)/2 - \left(b_2 - s_1\right)/2 = \left(b_2 - b\right)/2.$$

According to the relation $s_1 \leq b$, we have the relation $\left(b_2 - b\right)/2 \leq \left(b_2 - s_1\right)/2$, i.e., $\overline{U}_{B2} \leq \overline{U}_{B1}$. Therefore, against $s = s_1$ the optimum response of buyer B is $b = b_2$.

Thus, no matter seller *S* whether to offer honestly, $b = b_2$ is optimal for buyer *B*.

Let S_1 and S_2 denote two strategies of *S*: $S_1 : s \neq s_1, S_2 : s = s_1$. Let B_1 and B_2 denote two strategies of B: $B_1 : b \neq b_2, B_2 : b = b_2$. This strategic form game is available from Figure 3. According to the following four inequalities:

$$U_{S2} < U_{S1}, \overline{U}_{S2} \leq \overline{U}_{S1}, U_{B2} < U_{B1}, \overline{U}_{B2} \leq \overline{U}_{B1},$$

We could obtain the following proposition.

Proposition 3. Strategy combination (S_2, B_2) forms a Nash equilibrium, and in this case, $U_S = U_B = \left(b_2 + s_1\right)/2$, the net side payment of the seller and the buyer both are zero, i.e., $f(s) - g(b) = 0$.

Proof. The first half part is obvious, we prove the second half. When $s = s_1$ and $b = b_2$, we have $f(s) = g(b) = (b_2 - s_1)/2$. Then we have $f(s) - g(b) = 0$, and

$$U_S = \left(b + s\right)/2 - s_1 + f\left(s\right) - g\left(b\right) = \left(b_2 - s_1\right)/2,$$
$$U_B = b_2 - \left(b + s\right)/2 + g\left(b\right) - f\left(s\right) = \left(b_2 - s_1\right)/2.$$

i.e., $U_S = U_B = \left(b_2 + s_1\right)/2$. The proof is completed.

3. Conclusions

In this study, our results have important constructions for procedure design of a simultaneous-offer bargaining system that can engender truthfulness. But in order to implement this scheme, the seller and the buyer have to approve of the rules manipulator before they start the agreement. It is rather restrictive, but the result is so appealing that it should not be lightly dismissed. With suitable adjustment functions, honest revelations are in Nash equilibrium: each party should tell the truth if the other does. It would be wonderful if someone could apply this scheme to real-world situations. This is also the direction we will study diligently in the future.

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Applying the Service-Profit Chain to Internet Service Businesses

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ABSTRACT

Service-profit chain (SPC) is a powerful tool for evaluating the relationship between the degree of service effort and profit. This framework has been empirically tested in the banking, hospital, retail, and other brick and mortar service verticals. This paper extends the applicability of SPC to Internet-based businesses. The paper also investigates the moderating roles of customer satisfaction and advertising spending on the service operation efficiency (SOE) and profit relationship. Analysis of U.S. Internet service providers during a seven year period from 2000 to 2006 indicates that service operations efficiency is positively associated with a firm's profit. However, the customer satisfaction and advertising spending constructs are negative moderators of the relationship between service operations efficiency and profit.

Keywords: *service-profit chain, service operations efficiency, customer satisfaction, data envelopment analysis*

1. Introduction

Service-profit chain (SPC) is a useful framework in explaining the relationship between service operation and a firm's profit. From the SPC literature, a service firm's profit can be improved by effective service operational input through customer perception and actual behavior [1]. SPC has been empirically tested with bank service [2,3,4], retail chain [5], and business market [6] verticals. SPC can provide a useful integrated foundation for measuring service improvement effort as it relates to ultimate management goals.

Given that prior empirical testing of this framework has focused on brick and mortar services, there is an opportunity to extend the framework to Internet-based businesses. Moreover, the moderating roles of customer satisfaction and advertising spending have not been fully addressed in the SPC model. Prior research in the field of SPC omits the roles of strategic levers such as customer satisfaction and advertising expenditures in transferring service improvement effort to profitability. Little attention has been paid to how customer satisfaction and advertising expenditures moderate the relationship between the degree of service effort and the firm's profit. Motivated by this research gap, the study investigates these moderating variables using U.S. Internet service business data.

For this paper, a research framework is developed based on extant theory. Next, a methodology description section addresses the research setting and data available for the analysis. U.S. Internet service business data regarding service operations efficiency, customer satisfaction, advertising spending and real profit are utilized. For this analysis, Data Envelopment Analysis (DEA) is utilized to determine the service operations efficiency by integrating the operations input and outcome. Then, regression analysis is conducted to shows that Internet service operations efficiency is related to real profit. In the analysis and discussion section, the results are interpreted and some theoretical and managerial insights are presented.

2. Research Framework

As mentioned earlier, prior research tends to focus on the service quality assessment of individual consumers using traditional brick and mortar retail and banking services. In this study, Internet service operations efficiency is considered as an independent variable and profit as the dependent variable. Two possible moderators, customer satisfaction and advertising expenditures, are added to the SPC framework as shown in Figure 1.

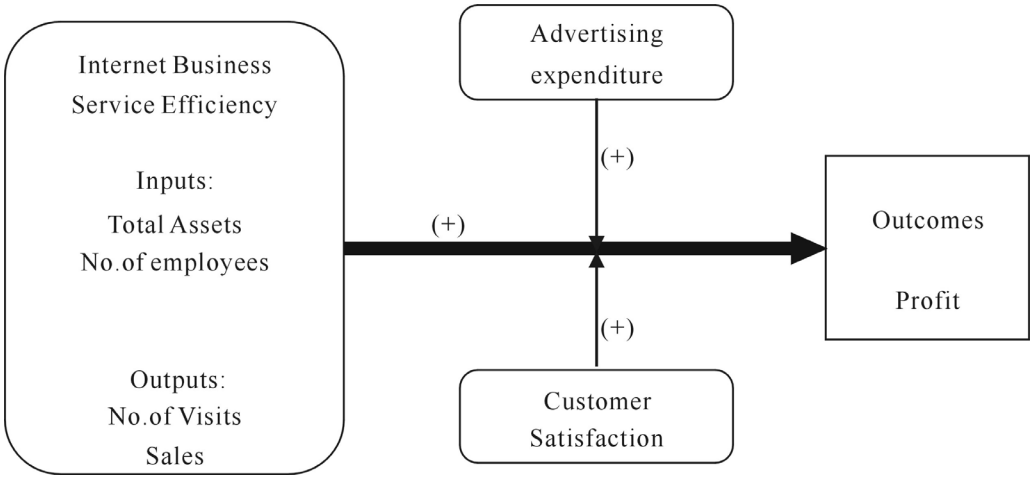

Figure 1. Research framework

2.1 Impact of Service Operations Efficiency on Firm's Profit

Service operations efficiency is expected to lead to an increase in a firm's profit. There is often a time lag for this relationship to become evident [7]. Linking the constructs of service operations, employee assessments and customer assessments to profit was proposed from the empirical evidence derived from 20 large service organizations [1]. A modified version of the service profit chain was employed to take into account the employee and customer assessments relationship to profit [8].

Loveman and Heskett (2008) updated the SPC model by adopting employee capability and external service quality. Basically, there are four principal components of the service profit chain: internal service quality, external service quality and service value, target market of customers, and financial performance [9]. In the same manner, the SPC framework can be applied to Internet businesses.

2.2 The Moderating Role of Customer Satisfaction

SPC is a valuable framework that offers insights to make it possible observe service related issues in an integrative perspective [4]. The comprehensive SPC framework models processes and constructs between service quality and profit, indicating that operating strategy and service delivery system could lead to employee satisfaction, customer satisfaction and customer loyalty [9]. In prior research, customer satisfaction is expected to moderate the relationship between corporate social responsibility and market value. This result can be attributed to customer satisfaction, which makes it possible to convert corporate social responsibility to financial value [10].

In this sense, service improvement effort will have an impact on profit after it interacts with customer satisfaction. When a firm with high customer satisfaction employs a strategy to improve service quality, net income will increase. If consumer does not notice the service effort, changes in profit will be stable or only marginally improved. However, if the customer recognizes the increased SOE, the firm can realize the more profit. Therefore, customer satisfaction will play a moderating role between service quality effort and firm's profit. Service improvement effort without customer recognition of the improvement will not be effective.

2.3 The Moderating Role of Advertising Expenditures

Advertising has often been treated as an input variable of marketing credibility and advertising efficiency [11,12, 13,14]. In this expanded SPC model, advertising expenditures will be examined as a moderator of the relationship between service efforts and profit. Information on service improvement can be delivered to customers by advertising and other promotion activities. Therefore, advertising expenditures are expected to positively moderate the relationship between service effort and profit.

This proposition is based on advertising effects over times. Even though advertising effects will increase to an initial peak but decrease due to time passage, advertising amount and cost will be a moderating effect regardless of this factor. All the advertising does not have a positive impact on customer satisfaction and profit. Advertising will increase customer awareness of the level of service effort generated by the firm, and ultimately, the level of the firm's profit [15].

3. Research Setting and Data Description

The analysis for this application consists of two steps as seen in the Figure 2. Multiple input and outputs are se-

lected to represent the service operations efficiency construct. After defining these inputs and outputs, SOE is estimated using Data Envelopment Analysis (DEA). This technique is one of the most popular management science tools used to determine a firm's efficiency level from multiple inputs and multiple outputs. A quick background of the DEA technique is provided in the Appendix. From this first step, the SOE estimates will be the regressor and the firm's profit will be the response in the regression equations.

3.1 Measuring Service Operations Efficiency

The concept of service operations efficiency can be a very useful indicator that focuses on "Do things in the right manner" rather than "Do the right things." Since the early 1990's, many researchers have started to study service quality and assessment from a macro-economic point of view. The DEA technique has become a useful management science tool, in which multiple inputs and multiple outputs can be involved simultaneously, whereas regression cannot include multiple responses [16]. In particular, DEA is a tool for evaluating marketing's credibility [13], retail productivity [17,18], sales force performance [19,20], and advertising efficiency [11,12,14]. Also, DEA is used to compute efficiency of supply chain processes [21,22] and operations efficiency [23].

The efficiency of one DMU_1 can be obtained as a solution to maximize its efficiency subject to the efficiency of all DMUs being less than or equal to 1. The solution produces the weights which are most favorable to the DMU_1 and provides a measure of efficiency for that DMU_1. The solution produces the weights which are most favorable to the DMU_1 and provides a measure of efficiency for the DMU_1. The algebraic model is as follows:

$$Max \quad h_0 = \frac{\sum_r weight_r Output_r DMU_1}{\sum_i weight_i Input_i DMU_1}$$

$$\text{subject to} \quad \frac{\sum_r weight_r \ Output_r \ DMU_j}{\sum_i weight_i \ Input_i \ DMU_j} \le 1 \quad \text{for each } DMU_j,$$

$$weight_r, \ weight_i \ge \varepsilon$$

Several studies have examined efficiency measures of on-line businesses by using the DEA methodology. The efficiency of service delivery processes was computed based on a survey of 135 large U.S. retail banks holding more than 75% of the total assets in the industry in 1994. Activity time (minutes), technology, and functionality were regarded as multiple inputs and check cycle time (day), ATM cycle time (day), and customer time (minutes) were considered as multiple outputs [24].

The efficiency of several search engines was investigated by using a query search as a production process and compared to each other by employing a simple data envelopment analysis model. The seven primary search engines utilized were Alta Vista, Excite, Lycos, Infoseek, Open Text, Hotbed, and Web Crawler. Intermediate inputs included the number of pages, update freshness, time for data retrieval, and feature on fourteen information retrieval items. Output variables included precision and circulation. A survey conducted by Internet media companies provided fifteen queries that are submitted to each engine and then the first twenty returned results were considered in calculating the values [25].

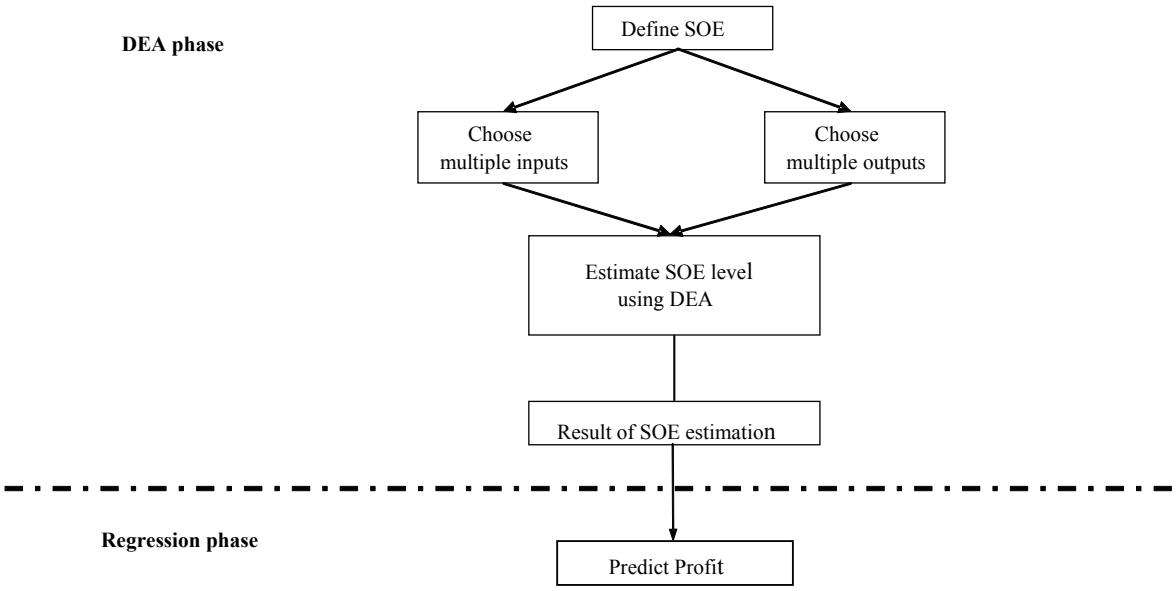

Figure 2. Research process

The concept of 'customer efficiency' was established and linked to e-business management practices. For this purpose, purchase activity time and non-purchase activity time were used as multiple inputs and number of informational transactions, number of service transactions, and number of purchases were considered as multiple outputs for computation of the efficiency construct [26].

Given this, service operations efficiency is measured with two inputs and two outputs in this study. From Resource Based View (RBV) theory, total assets and number of employees are considered as inputs. Multiple outputs include total number of visit and total sales. Suppose that the Amazon's total asset and number of employees are 5 and 6, and total number of site visits and total sales are 7 and 8 while eBay's input values are 5 and 8, and output values are 3 and 4. The efficiency of Amazon (h_0) can be obtained by solving the following model:

$$Max \quad h_0 = \frac{weight_{asset}\,7 + weight_{employee}\,8}{weight_{visit}\,5 + weight_{sales}\,6}$$

subject to

$$\frac{weight_{asset}\,7 + weight_{employee}\,8}{weight_{visit}\,5 + weight_{sales}\,6} \le 1 \qquad \text{(Amazon)},$$

$$\frac{weight_{asset}\,3 + weight_{employee}\,4}{weight_{visit}\,5 + weight_{sales}\,8} \le 1 \qquad \text{(eBay)},$$

……. for remaining DMUs

and

$$weight_{asset},\ weight_{employee}\quad weight_{visit}\ \ weight_{sales} \ge \varepsilon$$

If h_0 is equal to 1 then Amazon is efficient relative to other DMUs but if h_0 is less than 1, some other DMU is more efficient than Amazon.

3.2 Predicting Firm's Profit

After SOE is computed, several multivariate regression analyses were conducted to grasp the effects of SOE and other factors on firm's profit as the following:

Model 1 $Profit_t = a + b1\ SOE_t + b2\ AD_t + b3\ CS_t$

Model 2 $Profit_t = a + b1\ SOE_t + b2\ AD_t + b3\ CS_t + b4\ ASSET_t + b5\ SALES_t + b6\ EMPL_t + b7\ SOE_t{*}AD_t + b8\ SOE_t{*}CS_t$

Model 3 $Profit_t = a + b1\ SOE_t + b2\ ASSET_t + b3\ SALES_t + b4\ EMPL_t + b5\ SOE_t{*}AD_t + b6\ SOEt{*}CS_t + b7\ YEAR\_1 + b8\ YEAR\_2 + b9\ YEAR\_3 + b10\ YEAR\_4 + b11\ YEAR\_5 + b12\ YEAR\_6 + b13\ INDUSTRY\_1 + b14\ INDUSTRY\_2 + b15\ INDUSTRY\_3$

Model 4 $Profit_t = a + b1\ SOE_t + b2\ AD_t + b3\ CS_t + b4\ ASSET_t + b5\ SALES_t + b6\ EMPL_t + b7\ SOE_t{*}AD_t + b8\ SOE_t{*}CS_t + b9\ YEAR\_1 + b10\ YEAR\_2 + b11\ YEAR\_3 + b12\ YEAR\_4 + b13\ YEAR\_5 + b14\ YEAR\_6 + b15\ INDUSTRY\_1 + b16\ INDUSTRY\_2 + b17\ INDUSTRY\_3$

One year-lagged impact of SOE on profit was analyzed using multivariate regression as following:

Model 5 $Profit_{t+1} = a + b1\ SOE_t + b2\ AD_t + b3\ CS_t$

Model 6 $Profit_{t+1} = a + b1\ SOE_t + b2\ AD_t + b3\ CS_t + b4\ ASSET_t + b5\ SALES_t + b6\ EMPL_t + b7\ SOE_t{*}AD_t + b8\ SOE_t{*}CS_t$

Model 7 $Profit_{t+1} = a + b1 SOE_t + b2\ AD_t + b3 CS_t + b4\ ASSET_t + b5\ SALES_t + b6\ EMPL_t + b7\ SOE_t{*}AD_t + b8\ SOE_t{*}CS_t + b9\ YEAR\_1 + b10\ YEAR\_2 + b11\ YEAR\_3 + b12\ YEAR\_4 + b13\ YEAR\_5 + b14\ YEAR\_6 + b15\ INDUSTRY\_1 + b16\ INDUSTRY\_2 + b17\ INDUSTRY\_3$

3.3 Data Description

This study obtains data on total assets, total number of employees, total number of visits to web sites, total sales, customer satisfaction levels, advertising expenditure sand profitability for 70 observations of U.S. Internet-based business firms. For example, Amazon, Yahoo, Travelocity and NewYorkTimes.com are included to represent retail, portal, travel and news service firms, respectively. The data are obtained from various secondary sources. The multiple inputs and outputs chosen in this study are shown in Table 1.

For computation of SOE, total annual assets and total

Table 1. Measures and operationalization

Variable	Measure	Operationalization	Data Source
Independent variable	SOE	Service operations efficiency	Calculated by DEA
DEA Inputs	ASSET	Annual total assets (10 Thousand dollars)	COMPUSTAT North America (http://wrds.wharton.upenn.edu/ds/comp/inda/)
	EMPL	Total number of employee (persons)	COMPUSTAT North America
DEA Outputs	VISIT	Total number of visit to web site	MediaMetrix:ComScore (http://www.comscore.com)
	SALES	Annual total sales (10 Thousand dollars)	COMPUSTAT North America
Moderator	AD	Advertising expenditure (10 Thousand dollars)	COMPUSTAT North America
	CS	Customer satisfaction score	ACSI (http://www.theacsi.org/index)
Dependent Variable	PROFIT	Annual Profit (10 Thousand dollars)	COMPUSTAT North America
Control Variables	YEAR	Six annual dummies	2000 ~ 2006
	INDUSTRY	Three industry dummies	News, Portal, Travel, Retail

number of employees are considered as DEA inputs and total sales and total number of web visit are taken into account as DEA outputs. Total number of web visits, one of the DEA outputs, utilizes MediaMetrix ComScore results for the Top 50 Web and Digital Media Properties. A customer satisfaction score is provided by the American Customer Satisfaction Index. To capture the effect of year and industry types, six and three dummy variables are utilized by the regression equation, respectively. The data were examined for completeness and outliers. After data cleansing, data from 2000 to 2006 were merged to provide the final dataset with 70 observations.

4. Analysis & Discussion

The service operations efficiency variable is computed by DEA, and then a regression procedure is conducted to test the main effect of service operations efficiency on profit and the moderating effects of customer satisfaction and advertising expenditures on the service-profit chain. Table 2 displays the correlation matrix between variables and shows that some variables are positively or negatively related to each other.

4.1 Results of SOE

Unlike regression, DEA does not impose any particular functional form on the data, creating a more flexible piecewise linear function. Also, unlike total factor productivity indexes, DEA gives each of the observations its own set of weights. This efficient frontier line provides a more realistic benchmark because the decision-making units (DMUs) are compared to best practices rather than to average performance [27,28].

Table 2. Correlation matrix

	SOE	CS	ASSET	SALES	PROFIT	EMPL	AD	VISIT
SOE	1							
CS	.375	1						
ASSET	-.351	-.362	1					
SALES	-.352	-.311	.953	1				
PROFIT	-.275	-.331	.901	.915	1			
EMPL	-.485	-.401	.749	.829	.600	1		
AD	-.413	-.408	.879	.824	.644	.833	1	
VISIT	.123	.046	.526	.490	.594	.112	.312	1

Table 3. Input oriented SOE

DMU Name	Input-Oriented Efficiency	DMU Name	Input-Oriented Efficiency
2000 Amazon.com	0.21098	2003 NYTimes.com	0.13394
2000 barnesandnoble.com	0.19039	2003 Orbitz Worldwide	1.00000
2000 eBay	0.21376	2003 Yahoo	0.50792
2000 Ask.com	0.06937	2004 Amazon.com	0.33998
2000 Microsoft	0.17061	2004 ABCNEWS.com	0.09009
2000 priceline.com	1.00000	2004 eBay	0.23426
2000 CNN.com	0.13340	2004 Expedia	0.16024
2000 Travelocity.com	0.32821	2004 USATODAY.com	0.07569
2000 Yahoo! Inc.	0.42136	2004 Google	0.66749
2001 Amazon.com	0.34563	2004 Ask.com	0.06921
2001 ABCNEWS.com	0.09131	2004 Microsoft News	0.18779
2001 eBay	0.26161	2004 CNN.com	0.14406
2001 USATODAY.com	0.07650	2004 Yahoo	0.41334
2001 Ask.com	0.08376	2005 Amazon.com	0.36273
2001 Microsoft News	0.15443	2005 ABCNEWS.com	0.09489
2001 NYTimes.com	0.13850	2005 eBay	0.18532
2001 Travelocity.com	0.43571	2005 Expedia	0.15167
2001 Yahoo! Inc.	0.56876	2005 USATODAY.com	0.07622
2002 Amazon.com	0.35086	2005 Google	0.52688
2002 barnesandnoble.com	0.75451	2005 Ask.com	0.07423
2002 ABCNEWS.com	0.07992	2005 Microsoft News	0.18954
2002 eBay	0.23832	2005 NYTimes.com	0.15993
2002 Expedia	0.26294	2005 CNN.com	0.14439
2002 USATODAY.com	0.07385	2005 Yahoo	0.37270
2002 Ask.com	0.05788	2006 Amazon.com	0.38766
2002 Microsoft News	0.16322	2006 ABCNEWS.com	0.09023
2002 NYTimes.com	0.13380	2006 eBay	0.21310
2002 Yahoo	0.59576	2006 Expedia	0.13320
2003 Amazon.com	0.43322	2006 USATODAY.com	0.07819
2003 ABCNEWS.com	0.08548	2006 Google	0.39674
2003 eBay.	0.30988	2006 Ask.com	0.11476
2003 USATODAY.com	0.07206	2006 Microsoft News	0.18124
2003 Google	1.00000	2006 NYTimes.com	0.21718
2003 Ask.com	0.07155	2006 CNN.com	0.13863
2003 Microsoft News	0.17006	2006 Yahoo	0.34974

The DEA results were computed by DEA Excel Solver to obtain overall efficiency scores for U.S. Internet service providers from 2000 to 2006. DEA analysis provides the service operations efficiency for all companies based on each company's combination of inputs and outputs compared to those of others in the sample. For calculation of the overall SOE of each company, seven years data are combined as one dataset. Given this, the

Table 4. Regression result (DV=Profit$_t$)

	Model 1		Model 2		Model 3		Model 4	
	Beta	P-value	Beta	P-value	Beta	P-value	Beta	P-value
(Constant)	19.703	.041	1.685	0.763	0.418	0.414	2.316	0.71
SOE	-.143	.965	37.149	0.092	29.509	0.05*	24.707	0.25
SOE*CS			-4.216	0.101	-3.44	0.046	-2.867	0.256
SOE*AD			-2.591	0.101	-2.333	0.051	-2.149	0.152
AD	2.309	.000**	-0.707	0.098			0.18	0.69
CS	-.231	.067	-0.018	0.814			-0.025	0.76
Asset			0.013	0.656	-0.01	0.501	-0.02	0.455
Sales			0.556	0**	0.41	0**	0.423	0**
Employee			-0.857	0**	-1.218	0**	-1.275	0**
Year1					0.662	0.297	0.646	0.327
Year2					0.701	0.254	0.713	0.269
Year3					1.145	0.105	1.168	0.122
Year4					0.513	0.464	0.536	0.457
Year5					1.403	0.07	1.404	0.077
Year6					1.339	0.099	1.343	0.106
Industry1					7.372	0**	7.628	0**
Industry2					0.23	0.615	0.231	0.716
Industry3					-0.395	0.552	-0.403	0.565
Adjusted R^2	0.415		0.956		0.973		0.97	

* significant at 0.05
** significant at 0.01

same company from 2000 to 2006 is regarded as different DMUs. An input-oriented constant return to scale (CRS) DEA model was used to compute service operation efficiency.

Table 3 shows that the least efficient company is-Ask.com in the year 2002 with a 0.05788 SOE score. Three DMUs, priceline.com in the year 2000, Orbitz Worldwide in the year 2003, and Google in the year 2003 are identified as most efficient with an SOE score of 1 based on input-oriented CRS DEA method.

4.2 Results of Regression

Regression considering only three factors including SOE, customer satisfaction, and advertising expenditure is conducted to provide a preliminary result. The regression result shows that only AD_t is positively associated with $profit_t$ (p<0.001). Then, SOE impacts on profit are analyzed by the same regression method using control variables including each year and the type of Internet service. Table 4 shows the results of regression taking parallel data into account. As stated, the service operations efficiency appears to have a positive impact on the firm's profit. In particular, Model 3, one of four regressions using SOE as an independent variable and profit as the dependent variable, results in a main effect of SOE on profit (b=29.509, p<0.05), suggesting that SOE_t has a significantly positive influence on $profit_t$.

As tested in the previous studies, customer satisfaction can be an indicator to predict the changes in a firm's profit. Many empirical studies have examined this relationship [29,30,31]. In the long term, customer satisfaction is an ultimate goal of the firm and profit can be viewed as a satisfaction input. However, the significant interaction between SOE and customer satisfaction is observed in Model 3 (b= -3.44, p<0.05) but the sign of effect is not positive. That means there might be a negative moderating effect of customer satisfaction in the service profit chain.

In addition, the research framework posits that advertising expenditure moderates the relationship between SOE and profit. Result shows that the relationship between SOE and profit is moderated by advertising ex-

penditure but that the moderation effect is unexpectedly negative (b= -2.333, p<0.1). Total sales as a control variable have a significantly positive impact on profit in all models. In contrast, the number of employee is negatively associated with profit. Industry 1 is positively related to profit but other control variables are not.

Next, this paper addresses the relationship between SOE and subsequent period profit. If the firms maintain a high level of service efficiency, the firms are expected to realize more profits. However, the previous service operations efficiency level does not influence subsequent period profit as seen in Table 5, indicating that there is no lagged effect of service operations efficiency. No interaction effects are found in Model 6 and Model 7. Only similar effects of sales and employees are observed as in Model 3.

5. Conclusions & Future Research

This paper attempts to examine whether or not SPC is applicable to Internet business models. It also investigates the moderating effect of customer satisfaction and advertising expenditures in the service profit chain. The research results are summarized in Table 6. In summary, a firm's service improvement efforts are expected to facilitate positive evaluation of the firm by its customers. Service operations efficiency will create more customer satisfaction, demonstrating if a firm employs a service operations strategy to improve the service quality, more profit can be realized.

Given these results, SOE is one of the best ways to improve a firm's short-term profit, but the lagged impact of SOE on subsequent period profits is not shown by this research. As an example, the news and information category has a relatively high contribution to profit. This can be attributed to unique service delivery characteristics of Internet news services.

The research verifies that service operations efficiency has a relationship with a firm's profit but fails to show a positive moderating effect of customer satisfaction and advertising expenditures in SPC. Unexpectedly, negative moderating effects of those two variables are observed in the regression results. In this sense, if the Internet service providers want to realize more profits, they should place emphasis on service operations efficiency rather than customer satisfaction and advertising spending. As this

Table 5. Regression result (DV=Profit$_{t+1}$)

	Model 5		Model 6		Model 7	
DV=Profit$_{t+1}$	Beta	P-value	Beta	P-value	Beta	P-value
(Constant)	20.037	.061	3.945	0.542	6.882	0.311
SOE	-.328	.925	21.859	0.377	-5.464	0.821
SOE * CS			-2.432	0.399	0.659	0.816
SOE * AD			-1.423	0.425	0.141	0.934
AD	2.339	.001**	-0.908	0.081	-0.179	0.752
CS	-.231	.097	-0.049	0.566	-0.086	0.325
Asset			0.007	0.871	0.006	0.879
Sales			0.619	0**	0.316	0.01**
Employee			-0.883	0**	-1.217	0**
Year1					0.231	0.736
Year2					0.536	0.448
Year3					0.334	0.694
Year4					1.129	0.17
Year5					1.652	0.068
Industry1					9.809	0
Industry2					0.223	0.758
Industry3					-0.659	0.418
Adjusted R^2	0.389		0.952		0.971	

* significant at 0.05
** significant at 0.01

moderating effect of advertising expense and customer satisfaction on SPC is not supported, other possible moderators should be identified for future research [32].

Theoretically, this paper contributes to both operations management and marketing scholars by helping focus attention to Internet service operations efficiency, profit, and customer satisfaction. From a practitioner perspective, management can recognize the importance of service operations efficiency in their business practices as a key driver of profitability. One weakness of this paper is the small sample size, which somewhat limits the generalizable nature of the findings. As more data become available, this limitation can be mitigated.

Table 6. Result summary

IV	DV	Expected	Result	Significant
SOE(t)	Profit(t)	+	+	$p<0.1$
SOE(t)	Profit(t+1)	+	+/-	n.s.
SOE(t)*CS(t)	Profit(t)	+	-	$p<0.05$
	Profit(t+1)	+	+/-	n.s.
SOE(t)*AD(t)	Profit(t)	+	-	$p<0.1$
	Profit(t+1)	+	+/-	n.s.

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Appendix. Background and Applications of DEA

Building on the ideas of Farrell (1957), the seminal work "Measuring the Efficiency of Decision-Making Units" by Charnes, Cooper & Rhodes (1978) applies linear programming to estimate an empirical production technology frontier for the first time [33, 34]. Since then, there have been a large number of books and journal articles written on DEA or applying DEA to various sets of problems. In addition to comparing efficiency across DMUs within an organization, DEA has been used to compare efficiency across firms. There are several types of DEA methodologies, with the most basic being CCR based on Charnes, Cooper & Rhoades. However there are also more sophisticated DEA methodologies which address varying returns to scale, either CRS (constant returns to scale) or VRS (variable returns to scale) [27].

Grounded in microeconomic theory, DEA efficiency provides guidelines and benchmarks for both public and private enterprises to achieve maximized desirable ends at minimized costs. DEA measurement has been used to evaluate and compare educational departments (schools, colleges and universities), health care (hospitals, clinics) prisons, agricultural production, banking, armed forces, sports, market research, transportation (highway maintenance), courts, benchmarking, index number construction and many other applications.

In addition, DEA optimizes on each individual observation and provides a ratio score to indicate the relative efficiency performance against the set of Pareto-efficient frontiers. An efficient observation is one for which no other observations, or linear combination of observations in the sample, generate as much as or more outputs given the level of inputs (or consume as much as or less inputs given the level of outputs). DEA is best characterized by the following [16]:

- A focus on individual observations in contrast to populations average
- Production of single aggregate measure for each decision making unit (DMU) in terms of its input factors (independent variables) to produce desired outputs (dependent variables)
- Simultaneous use of multiple outputs and multiple inputs, where each is stated in different units of measurement
- Ability to adjust to exogenous variables
- Ability to incorporate categorical (dummy) variables
- No required specification or knowledge of a priori weights or prices for the inputs or outputs and value free
- No restrictions on the functional form of the production relationship
- Ability to accommodate judgment when desired
- Production of specific estimates for desired changes in inputs and/or outputs for projecting DMUs below the efficient frontier onto the efficient frontier
- Pareto optimal
- A focus on the revealed best-practice frontier rather than on the central tendency properties of frontier
- Satisfaction of strict equity criteria in the relative evaluation of each DMU
- Relationship with performance evaluation and benchmarking

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Access Control for Manufacturing Process in Networked Manufacturing Environment

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ABSTRACT

The deficiencies of current access control techniques in solving the problems of manufacturing process access conflict in networked manufacturing environment were analyzed. An information model of manufacturing process was constructed, and a case XML Schema of manufacturing task model was given. Based on the characteristic analysis of the access control for the information model, an improved access control model of manufacturing process was constructed, and the access control model based on manufacture tasks, roles and time limits and the relationships among the elements were defined. The implementation mechanisms for access control model were analyzed, in which the access case matching strategy based on manufacture tasks and time limits, the authorization assignment mechanism based on manufacture tasks, roles, correlation degrees and time limits, XML based access control for transaction security and integrity were included. And the two-level detection architecture of transaction conflict was designed to find the conflicts both in application and in the database. Finally the prototype system was developed based on these principles. Feasibility and effectiveness of the method were verified by an enterprise application.

Keywords: *networked manufacturing, manufacturing process, access control, conflict resolution*

1. Introduction

Networked manufacturing is an advanced manufacturing mode. It is implemented by enterprises in order to response quickly to the market requirements and to promote the competition ability in the environment of knowledge economy and global manufacturing [1]. Access control is one of the most pervasive security mechanisms in use today [2]. It concerns whether specific users or processors can access specific system resources or not and which operation types they are allowed.

Many issues in access control are studied in order to implement information interaction in multi-user system. Some control models are put forward, such as Access Control Lists (ACLs) [3], Access Control Matrixes (ACM) [4], Discretionary Access Control (DAC) model [3], Role-Based Access Control (RBAC) model [5], Task-Based Access Control (TBAC) model [6], Task-Role-Based Access Control (TRBAC) model [4]. Although these models have been widely discussed and applied in various fields [7−10], detailed discussion is needed in order to provide an effective access control mechanism for manufacturing process in networked manufacturing environment.

Present access control strategies applied in networked manufacturing were focused on access issues for public information, such as resource information, process planning information, design information, product data information, etc. The access control for manufacturing process has not been studied intensively yet. There are two reasons for it. One is that there are too much data about manufacturing process, and many of them are very hard to be collected because of the old machine tools. The other one is that the access to manufacturing process is much more flexible because of the multitudinous constraints between users and access objects, after manufacturing process is split and manufacturing tasks are merged in networked manufacturing environment. That makes the access control more difficult. Real-time manufacturing process supervision becomes more executable as the technology of digital supervision, remote control and network is developed. Data of manufacturing process would be quite open to numerous users in networked manufacturing environment. That means effective access control is completely necessary to protect manufacturing process data and ensure the fluent execution of networked manufacturing.

The eXtensible Markup Language (XML) [11] has emerged as the defacto standard for storing and exchanging information in the Internet Age. Several attempts are being made to ensure security over the Internet, especially for web services, including confidentiality, integrity, authentication, authorization, key management and security enforcement mechanism. Row-level security (RLS) feature provides fine-grained access control (FGAC) which means the control is at the individual row level. Virtual private databases (VPD) security provides a whole new way to control access to Oracle data.

In this paper, based on the characteristic analysis of the access control for manufacturing process in networked manufacturing environment, an access control model of manufacturing process was constructed, and the access control model based on manufacture tasks, roles and time limits and the relationships among the elements were defined. The implementation mechanisms for access control model were analyzed, in which the access case matching strategy based on manufacture tasks and time limits, the authorization assignment mechanism based on manufacture tasks, roles and time limits, the resolution mechanism of concurrent operation conflicts were included. Then the problem of manufacturing process access among allied enterprises was solved.

2. Related Work

ACLs and ACM [3,4] is earlier access control model. The two models are simple and intuitive. But the disadvantage is that they can't deal with large amount of data. When the number of subjects and objects becomes huge, the cost of managing ACLs or ACM multiplies. Therefore, they are not suitable for large enterprises. In DAC model [3], the owner of computer resources or anyone authorized decide who can access these resources. Among the above methods, the subjects they face are only single user. And the security administration and review is very complicated [3]. The concept of RBAC began with multi-user and multi-application on-line systems pioneered in 1970s [12]. The central motion of RBAC is that permissions are associated with roles, and users are assigned to appropriate roles. Roles are created for the various job functions in an organization and roles are assigned to the users according to their responsibilities and qualifications. In RBAC, roles can be easily reassigned from one user to another, which greatly simplifies the management of permissions. But the method doesn't support the active access control in workflow environment. TBAC [6] considers workflow as a set of tasks that are linked to achieve a common goal. The model dynamically manages the permissions through the tasks and tasks' states. It distinguishes the access right assignment and access right activation. And it supports dynamic activation of access right needed in workflow systems. But it is difficult to combine with roles. T-RBAC [4] is based on RBAC model, and therefore it contains the basic features of RBAC. However, it is more than RBAC. It analyzes the types of task in enterprise organization, and connects the users with permission through role and task. It supports task level access control, both active and passive access control, different access control strategy according to task class, and partial inheritance of access rights in the role hierarchy. However, it doesn't support the object hierarchy and operation hierarchy. The TRBAC model in paper [13] can meet the need to manage and enforce the strong and efficient access control technology in large-scale Web environments. The implementation of TRBAC on the Web is also illustrated. Finally, the Web application adopting the TRBAC model, called E-Government Official Document Flow & Processing System, is given to demonstrate the feasibility.

EXtensible Markup Language (XML) specification [14] is the work of the World Wide Web Consortium (W3C) Standard Generalized Markup Language (SGML) Working Group. It is designed as a meta-language for Internet use. Its objectives are to overcome the rigid HyperText Markup Language (HTML) tagging scheme while providing Web users with a means for defining their own domain specific tags and attributes. XML is used in the integration of applications which makes data sharing and communication within applications easier and uniform. Security is an important aspect of web services. Securing XML data is critical to the success of any web based applications or web services. Some practical concepts that can be employed in an enterprise environment for managing security policies using XML are described. An example is given using the proposed concepts with Java and Role-Based Access Control (RBAC) policies [15]. In paper [16], the context-aware access control architecture is present in order to support fine-grained authorizations for the provision of e-services, based on an end-to-end web services infrastructure. Access permissions to distributed web services are controlled through an intermediary server, in a completely transparent way to both clients and protected resources. The access control mechanism is based on RBAC model, which incorporates dynamic context information, in the form of context constraints. Context is dynamically updated and provides a high level of abstraction of the physical environment by using the concepts of simple and composite context conditions. In paper [17], they focus on XML-based access control languages and, in particular, on the eXtensible Access Control Markup Language (XACML), a recent OASIS standardization effort. XACML is designed to express authorization policies in XML against objects that are themselves identified in XML. XACML can represent the functionalities of most policy representation mechanisms.

Row-level security (RLS) feature is introduced in Oracle8i. It provides fine-grained access control (FGAC) which means the control is at the individual row level. Virtual private databases (VPD) security provides a whole new way to control access to Oracle data. Most interesting is the dynamic nature of a VPD. At runtime, Oracle performs these near magical feats by dynamically modifying the SQL statement of the end user [18]. Rather than opening up an entire table to any individual user who has any privileges on the table, row-level security restricts access to specific rows in a table. The result is that any individual user sees a completely different set of data, only the data that person is authorized to see. In paper [19], the limitations and shortcomings of security design of the traditional database access control model are analyzed. Projects of VPD design based on role access control are presented [19,20]. The question of the inconsistency of users' authority management for application system and database management system in ORACLE DB brings insecurity to database. RBAC technology is used to implement users' authority control for front and back system in paper [21].

3. Manufacturing Process in Networked Manufacturing Environment

3.1 Access Control for Manufacturing Process in Networked Manufacturing Environment

Manufacturing process of product is composed of a series of manufacturing tasks according to production flow in discrete manufacturing industry [22]. In networked manufacturing environment based on ASP, manufacturing process is split to a series of tasks after requirements are committed to Application Service Provider (ASP) by manufacturing requirement enterprises. Then manufacturing tasks are merged and distributed to execution enterprises. Therefore access to manufacturing process should be split into access to tasks and reorganized.

Real-time data of manufacturing process were transferred through network from manufacturing fields to manufacturing execution enterprises and manufacturing requirement enterprises to monitor the process and communicate. There are several characteristics in access control for manufacturing process in networked manufacturing environment.

1) Distribution of user privilege was constrained dynamically by manufacturing process. Access privilege distributed to user was not invariable, but varied with the change of manufacturing tasks. Following with the manufacturing process, access privilege of various roles would be changed with the flowing of workflow. And operations of access object were given different priorities.

2) User privileges were interdependent and mutually-restrained. Manufacturing information was shared by users in networked manufacturing through network to increase the resource utilization rate. Access to some information was limited of the number of visits. For example the application of the simulation software would be limited of point number purchased. It is the key of access control for manufacturing process that how to distribute the authority to the users to maximize the efficiency of limited resources.

3) Distribution of user privileges was constrained by time limits. High-quality product and delivery on schedule is the basis of long-term collaboration of enterprise. Adjusting of users' privileges was necessary based on time limits besides assigning authorization based on manufacturing tasks.

3.2 Information Model of Manufacturing Process

Manufacturing information flow in networked manufacturing environment was studied to make the manufacturing information model more reasonable. Products and process planning were designed by design department after the enterprise received orders. Then production was organized by production department according to process planning design information. Products were manufactured according to resource utilization information and production plan/schedule. Resource configurations were optimized by dispatching department according to the equipment utilization rates, site utilization rates and so on. Quality information was collected into the financial department after the products were manufactured. The quality-cost analysis information was put forward by the financial department which could be an index to optimize the designs, production planning and manufacturing processes. Every department could be in different places in networked manufacturing environment. Therefore the manufacturing information interaction was more difficult. A manufacturing information model was constructed to describe information interaction of design, manufacturing, quality inspection and resource utilization among allied enterprises.

As the object of access control, manufacturing processes information mainly includes information of manufacturing tasks, dispatching, quality of on line products, product quality inspection, machine tools, fixture tools, work-piece rough, product structure information and NC programs. Manufacturing tasks and dispatching organizes production by the ID of product resources (example as machine tool, fixture tool). Machining accuracy, economic parameter and utilization efficiency influences task allocation and dispatching making. Quality information of on line products, product quality inspection information and quality statistics information use manufacturing task information to trace and compute product

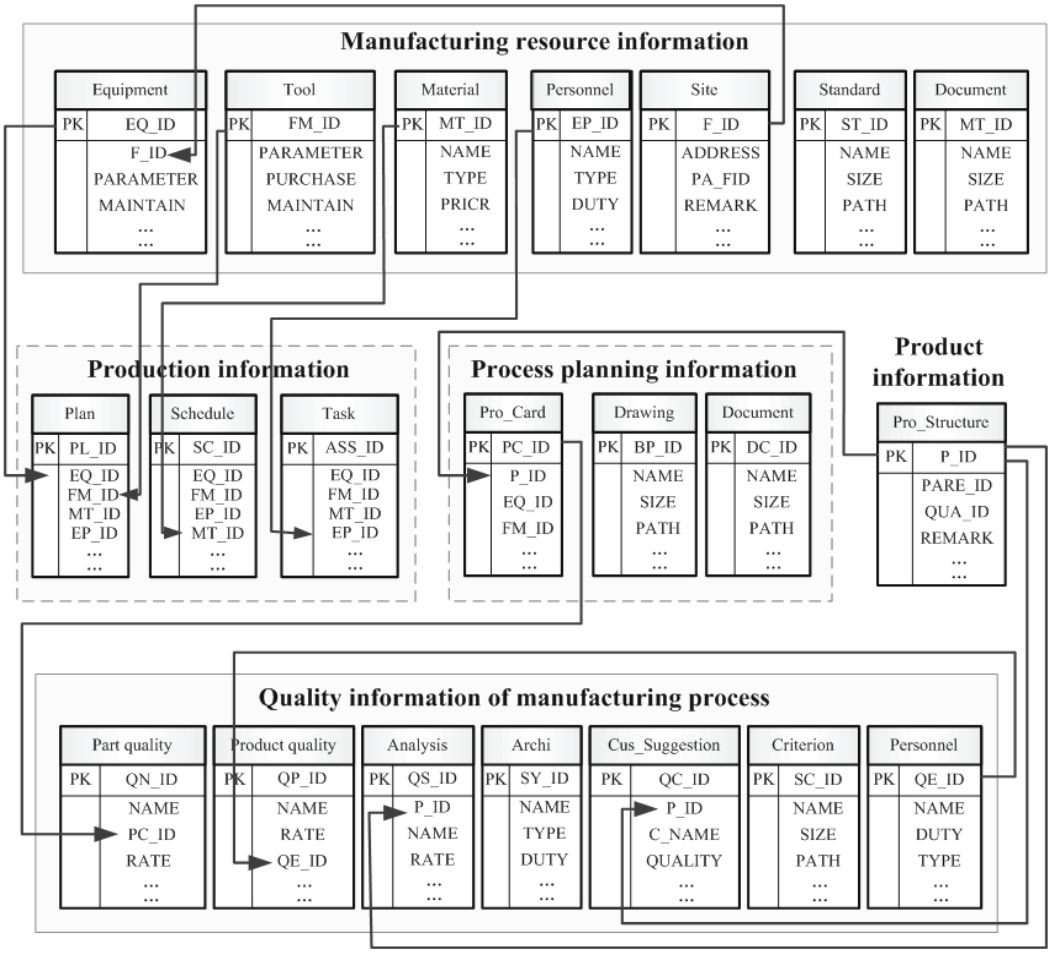

Figure 1. Partial information model of manufacturing process

```
<xsd : element name="MT">
    <xsd : complexType>
        <xsd : element name="Input" minOccurs="0"/>
        <xsd : element name="Output" minOccurs="0"/>
        <xsd : element name="Deadline"/>
        <xsd : element name="Status"/>
        <xsd : element name="Description "/>
    <xsd : attribute name="Id" type="xsd : NMTOKEN" use="required"/>
    <xsd : attribute name="Name" type="xsd : string"/>
    </xsd : complexType>
</xsd : element>
<xsd : element name="MT">
    <xsd : complexType>
        <xsd : element name="MT"
        minOccurs="0" maxOccurs="unbounded"/>
    </xsd : complexType>
</xsd : element>
<xsd : element name="Deadline" type="xsd : string"/>
<xsd : element name="Status" type="xsd : string"/>
<xsd : element name="Description" type="xsd : string"/>
```

Figure 2. The case XML Schema of manufacturing task model

quality. Meanwhile, feedback information of quality has influence on task dispatching. Partial information model of manufacturing process was showed in Figure 1. The case XML Schema of manufacturing task model is showed in Figure 2.

4. Access Control Model of Manufacturing Process

Objects and operations of access were controlled by users' roles in traditional Role-Based Access Control (RBAC) model. But there are other factors influencing access authorization in networked manufacturing environment, such as manufacture tasks, correlation degrees, time limits. Based on the characteristic of access control for manufacturing process, an improved access control model based on manufacture tasks, roles and time limits was constructed as showed in Figure 3. The elements and the relationships among the elements were defined as below.

Definition1. The access control model based on manufacture tasks, roles and time limits was a eleven-dimension array $\langle MT, R, U, Tl, W, S, O, OP, C, P, SP\rangle$, where:

Manufacture task sets (*MT*): the tasks in the manufacturing system. Task was a basic unit to accomplish one working target. There were five states in the task lifecycle: initial state, active state, suspensive state, terminative state and revocatory state. They were quantized respectively as 30, 40, 20, 10 and 0.

Role sets (*R*): A role was a group of interrelated authorizations. Usually one role delegated one work or position in an organization or a task. Roles could be administrative positions or technical roles in a manufacturing system.

User sets (*U*): the independent subjects that could access the information in the system.

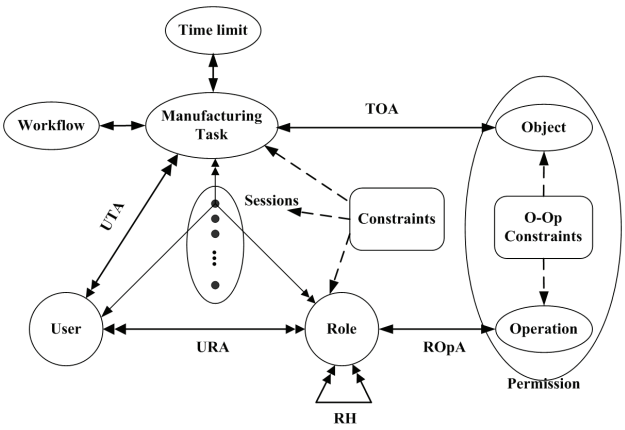

Figure 3. Improved access control model based on manufacture tasks, roles and time limits

Workflow sets (*W*): Manufacture tasks (*MT*) were split into subtasks and activities as workflows.

Time limit state sets (*Tl*): Let the time limit of a certain manufacture task be *th*, and the past time of the task be *tp*. Then the time limit state of the task was calculated by formula: $tl = 100 \times (tp - th) / th$.

Session sets (*S*): the corresponding relations of users, roles and tasks.

Object sets (*O*): the objects that were accessed and controlled.

Operation sets (*OP*): the minimum actions that accomplished some function to the controlled objects such as a query of data. The sets of operations which would not influence databases were recorded as OPN. And the sets of operations which would influence databases were recorded as OPE. $OP = OPN \bigcup OPE$, $OPN \bigcap OPE = \varnothing$.

Constraint sets (*C*): a series of constraint conditions in which constraints of task-role assignments, constraints of object-operation assignments and other constraints were included.

Permission sets (*P*): the sets of authorized operations to objects. $P \subset Op \times O$.

Security Policy sets (*SP*): the sets of security policies of users.

Definition2. MT-object assignments (*MTOA*): the corresponding relationship of manufacture tasks and objects. $MTOA \subset MT \times O$.

Definition3. User-MT assignments (*UMTA*): the corresponding relationship of users and manufacture tasks. $UMTA \subset U \times MT$.

Definition4. User-role assignments (*URA*): the corresponding relationship of users and roles. $URA \subset U \times R$.

Definition5. Role-operation assignments (*ROpA*): the corresponding relationship of roles and operations. $ROpA \subset R \times Op$.

Definition6. Hierarchical relations of roles (*RH*): the relations of roles' hierarchy which were showed in Figure 4. $RH \subset R \times R$.

Definition7. MT-workflow assignments (*MTW*): the corresponding relationship of manufacture tasks and workflows. $MTW \subset MT \times W$.

The access control model based on manufacture tasks, roles and time limits was constructed in definition 1. Some elements (such as *MT*, *Tl*, etc.) were extended on the basis of traditional RBAC. Therefore access authorization assignment would be adjusted based on manufacture tasks, roles, correlation degrees and time limits, when conflicts appeared. And matching operations to

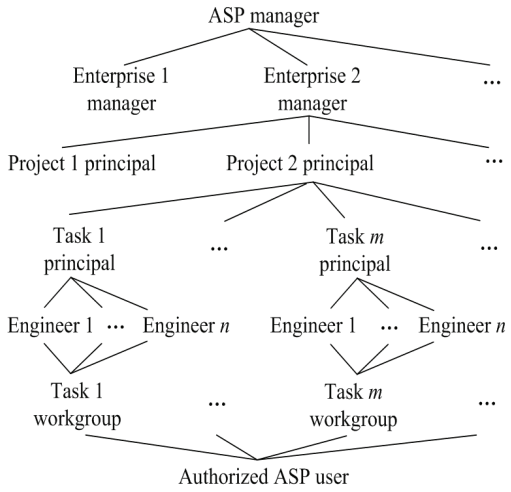

Figure 4. Hierarchy of roles

objects were reduced because of the relationship of objects, tasks, users and their roles. Then the efficiency of access control was increased.

5. Implementation Mechanisms for Access Control Model

As it described in Figure 5, access to manufacturing process would be controlled by following the steps as below after users log in the system.

Step 1: Get user's operation right ropa, corresponding security policy sp, authorized access object and task state tl according to definitions from 1 to 5 after task state and role of the user is identified automatically by the system.

Step 2: Start access matching mechanism based on manufacturing tasks, role and time limit to compute case similarity S.

Step 3: Compare maximum of case similarity (Max S) with ideal matching factor S_0. Users' permission would be obtained by reusing the corresponding access case if Max $S \geq S_0$. Compute users' priorities p by implementing authorization assignment mechanism based on manufacture tasks, roles and time limits if Max $S < S_0$.

Step 4: Generate access interface or windows with object lists, operation menus and function buttons according to p.

Step 5: Requirement for user's operation is sent from client to server, such as process checking, task editing, software calling and so on.

Step 6: Judge whether software/document is needed or not. Go to step 7 if it is, else go to step 11.

Step 7: Judge whether calling overruns the limit or not if it needs to call software. Judge whether the file is being edited or not if it needs to call document. The XML based access control for transaction security and integrity would be started if it is. Go to step 8 if it is not.

Step 8: Operations on objects are executed by users.

Step 9: Both access object and operation right of the user was released after the operation was sent from client to server.

Step 10: Go to step 4 if other objects will be visited. Exit the system if all operations are completed.

Step 11: Judge if user's operations need to edit data in database. Go to step 12 if it does. Go to step 8 if it does not.

Step 12: The XML based access control for transaction security and integrity will be started if the data are being edited. Go to step 8 if they are not.

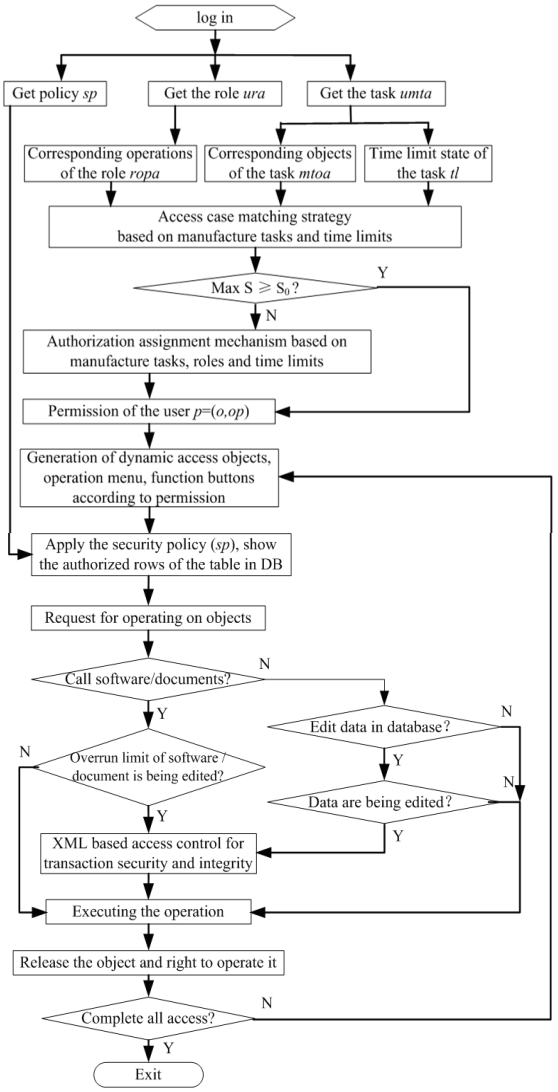

Figure 5. Access control for manufacturing process in networked manufacturing environment

5.1 Access Case Matching Strategy Based on Manufacture Tasks and Time Limits

Splitting of manufacturing process and merging of manufacturing tasks becomes more complicated as users increase in networked manufacturing platform. Then the calculation of access assignment is increasing with geometric series. That makes the efficiency of access control decrease. According to the characteristics of sufficient access cases and high reusability, the access case matching strategy based on manufacture tasks and time limits was implemented in order to assign access authorization quickly and increase the efficiency of access control for manufacturing process.

History of authorization assignments and access control cases was saved in databases as instance to provide references for next assignment. Weighted retrieval algorithmic based on similarity was adopted to search useful instances more rapidly and exactly.

Characteristic expression of access cases A was $A(C_i)$. The format of C_i (characteristic sets) was $\{C_1, C_2,\ldots, C_n\}$, $C_i (1 \le i \le n)$ meant a certain characteristic, such as role type, time limit state, task state, etc. Every characteristic had two parameters, characteristic value (p_i) and weight value (q_i). Suppose there were two access cases P_1 and P_2, their characteristic expression were $A_1(C_{i1})$ and $A_2(C_{i2})$ $(1 \le i \le n)$. Then the calculation formula of the dissimilarity $D(A_1, A_2)$ was as below.

$$D(A_1,A_2)=\sum_{i=1}^{n}\left|\frac{q_{i1}}{\sum_{i=1}^{n} q_{i1}} p_{i1}-\frac{q_{i2}}{\sum_{i=1}^{n} q_{i2}} p_{i2}\right|$$

Then the calculation formula of the similarity $S(A_1, A_2)$ was as below.

$$S(A_1,A_2)=1-D(A_1,A_2)=1-\sum_{i=1}^{n}\left|\frac{q_{i1}}{\sum_{i=1}^{n} q_{i1}} p_{i1}-\frac{q_{i2}}{\sum_{i=1}^{n} q_{i2}} p_{i2}\right|$$

Then, $0 \le S(A_1,A_2) \le 1$.

Users' permission would be obtained by reusing the corresponding access case if Max $S \ge S_0$. Users' priorities p would be computed by implementing authorization assignment mechanism based on manufacture tasks, roles and time limits if Max $S < S_0$.

5.2 Authorization Assignment Mechanism Based on Manufacture Tasks, Roles and Time Limits

Authorization assignment mechanism based on manufacture tasks, roles and time limits would be started when similarity degrees between new case and each of the cases in the database did not satisfy ASP manager which meant Max $S < S_0$. The rules listed below were followed in the authorization assignment.

Rule1. Permission was computed by p=(o,op) according to definition 1 – 5. And it was composed of access objects (o) and corresponding operations (op). Where, access object (o) was obtained by the task which was executed by the user (*umta*) and MT-object assignments (*mtoa*), and corresponding operation (op) was obtained by the role of user (*ur*a) and role-operation assignments (*ropa*).

Rule2. Operations which would not influence databases were opened to all the authorized users.

Rule3. The edit authorization was assigned to one user in one task in the same time.

Rule4. The edit authorization was assigned to the task first which was in the active state, when the same data was called by different tasks.

Rule5. The edit authorization was assigned to the task first which was in the exigent state, when the same data was called by different tasks which were all in the active state.

Rule6. The edit authorization would be canceled and assigned to the next user whose task was in the active state automatically when tasks, roles, or the roles to execute the task overran the limit of time.

Rule7. A user would be allowed to delete only if all correlative tasks were in the terminative state or revocatory state.

Rule8. A role would be allowed to delete only if the correlative user set was empty.

5.3 XML Based Access Control for Transaction Security and Integrity

5.3.1 Two-Level Detection Architecture of Transaction Conflict

XML based access control for transaction security and integrity is based on the transaction conflict detection. We designed a kind of two-level detection architecture of transaction conflict to find the conflicts both in application and in the database. The detection architecture is showed in Figure 6.

The application or data would be locked when a conflict is detected in order to assure the security and integrity of transaction. Resolution mechanism of access conflicts would be started when the access sequence should be adjusted. The mechanism was based on role's type, correlation degree, manufacture task state and its time

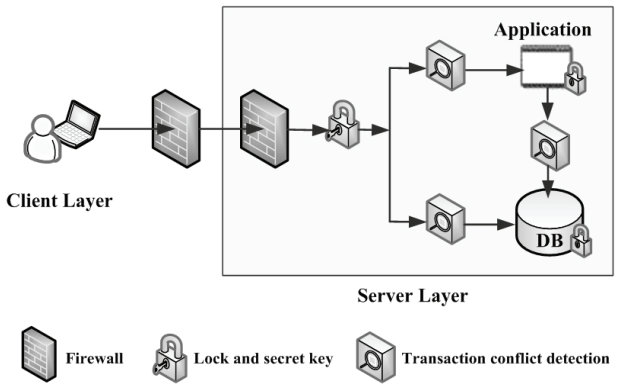

Figure 6. Two-level detection architecture of transaction conflict

limit in order to coordinate operations of users and resolve the access conflicts. The core of the mechanism was how to evaluate users' priorities, and how to adjust their authorities according to the priority sequence. Suppose there the users in some access to manufacturing process were U={u_1, u_2,…, u_n}, then the factor aggregate which will influence the priority of access degree was X={x_1, x_2, x_3, x_4}={ types of access, related degree of access object, task state, time limit state }. Quantization of priority factors, calculation of priority factor and steps of conflict resolution were included in the resolution mechanism.

5.3.2 XML-Based Security Standards

Several attempts are being made to ensure security over the Internet, especially for Web services. These approaches are XML-based, message-level security solutions, and can also be used for manufacturing process services based on Web services.

Confidentiality. When a sender transmits XBRL and XARL documents to a recipient through the Internet, the documents remain confidential. That is, only the sender and intended recipient can read the message.

Integrity. When a sender transmits XBRL and XARL documents to a recipient through the Internet, the documents have not been changed. In other words, XBRL and XARL documents received by the intended recipient are exactly the same as the documents transmitted by the sender.

Authentication. When XBRL and XARL documents are received by a user or system, the sender and receiver are who they claim to be. Non-repudiation When XBRL and XARL documents are sent to a receiver, the sender cannot later deny having sent the documents, and vice versa, the recipient cannot deny having received the documents.

Authorization (Access control). Only authorized users are able to access the XBRL and XARL documents.

Key management. Encryption is used to maintain confidentiality of information transmitted over the Internet. Encryption involves the use of private and/or public cryptographic "keys" to encipher transmissions. It is important to ensure proper creation, storage, use, and destruction of each cryptographic key. Audit trails are also needed to trace user accesses and actions. They also can be used to ensure system integrity through verification.

Security enforcement mechanism. Financial service providers can define a security policy with varying privileges and enforce it across various platforms. Audit trails Audits trails are a series of records of system events such as user accesses and user activities. Audit trails can enhance user accountability by tracing the user's activities, to reconstruct system events after a problem has occurred, to monitor problems, and to detect system intrusion.

6. Application of the System and Analysis of Cases

A prototype system of access control for manufacturing process in networked manufacturing environment was developed based on principles above. And it was applied in a steam turbine factory. Distributed computing architecture, Browser/ Server mode and J2EE structure criterion were adopted in this system considering some factors in networked manufacturing environment such as region and security. There were four layers in this system, client layer, interface expression layer, business logic layer and data service layer. The interface of messaging suspended operation to users was showed in Figure 7.

7. Conclusions

The proposed access control model of manufacturing process in networked manufacturing environment and the implementation mechanisms were applied in developing the access control system. The system was verified by the application in a networked collaborative design and manufacture platform of steam turbine factory. The results showed that the access conflicts were resolved by the implementation of mechanisms for the access control model, in which the access case matching strategy based on manufacture tasks and time limits, the authorization assignment mechanism based on manufacture tasks, roles, correlation degrees and time limits, XML based access control for transaction security and integrity were included. The results also indicated that by using the method the users' operations in the allied enterprises were coordinated, the resource configuration conflicts were reduced, and the resource utilization rate was increased. At the same time the efficiency of access control for manufacturing process was increased, and the manufacturing cycle time was shortened.

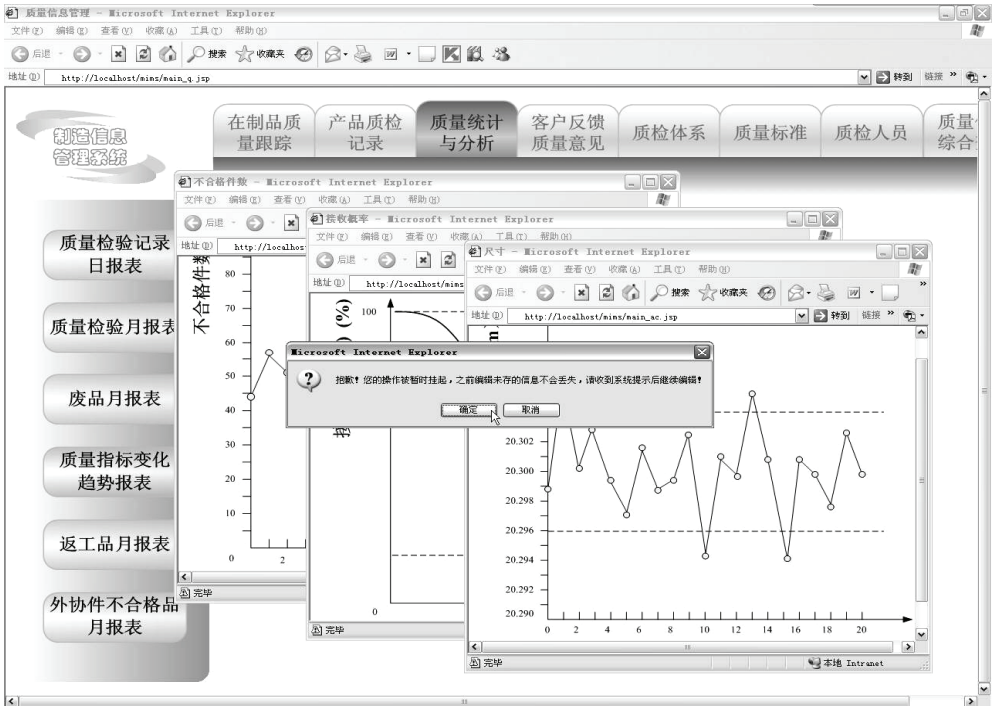

Figure 7. Interface of messaging suspended operation to users

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On Line Media Market and New Advertising Agencies: Analysis of an Italian Case

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ABSTRACT

This article focuses on the profile of agencies which offer communication services through new media related to the information role of the major search engines systems (like Google, Yahoo and others). In particular, attention is paid to firms operating in that context which are taking an innovative profile when compared to communication agencies linked to traditional media.

The article develops the following steps: in a first part the characteristics are taken into consideration through innovative communication systems search engines in relation to market trends and the latest configuration of actors linked to them; a second step considers the case of an Italian company acting as an agency in the so-called "online media market", highlighting the type of skills and relationships developed through this; finally in a third part some thoughts on the characteristics of the new communication agencies are proposed in comparison with those of the traditional advertising agencies operating with the help of the more traditional mass media.

At the conclusion of the article some implications of the analysis are developed and evaluations are made about the development of new business communication services object of our analysis.

Keywords: *search engines marketing, advertising agencies*

1. Introduction

Market trends and communication characteristics of the new media: In recent years the Internet advertising generated the entire growth of the advertising business at least in some major markets. The phenomenon of growth of advertising through search engines is obviously wider than Google and involves other actors[1]. Alongside these players there are others who take the auxiliary and intermediaries involved in the market between the "search engine" and communication needs expressed by actors who are often small or lacking the necessary skills. There are two areas of communication, one in which search engine operates and the other traditional media, which are in large part complementary, not least because search engines on the one hand and commercial television or print media on the other operate on advertising markets different in some respects, the first predominantly in the collection and classification (classified), the second in the exposure of companies, brands and products (displays). The growth of Google in other words also tends at least in part to increase the advertising pie, communicating in a different and complementary way compared to other players already present. So television and the print media may look like a "brand builder", while the search engine on the Internet is proposed mainly as a "brand finder" [1]. The same television also hosts in many cases advertising by operators who want to affirm on-line brands (as Ask.com or eBay).

Commercial television in many developed countries is losing advertising revenue, but its existence does not appear threatened in the near future. Since commercial television is conducting advertising campaigns for the same brands of companies based on the Internet, television operators move toward a complementary business, and only they have the opportunity to provide an audience of millions of people to advertisers in one fell swoop. It is also true, however, that Google wants to expand into video advertising and that the battle between television and the Internet for advertising business is still underway [2].

The global success of Google highlights the search engine business as a broad and expanding component of

[1]The most important U.S. players are Yahoo, Microsoft, Aol, Ask.

the advertising business, one of the traditionally largest and important in the field of marketing [3].

Information search is one of the main paths in consumer behaviour research, but the phenomenon of online research has only recently received more attention [4]. The consumers' search behavior has been deeply rooted in the information economics [5,6]. The cost-benefit structure derived from information theory is the basis of the explanation for the success of search engines in the functioning of the Internet as a tool of communication in general and especially in gathering information.

The search for information is an essential phase of the purchase process, and thus an object of attention in traditional marketing, as more generally in the social sciences [4]. In general terms, the perceived benefits and costs are the two main determinants of the process of seeking information put in place by the purchase decision. The benefits of research information are defined as the results that enhance usefulness or provide value by facilitating the achievement of objectives or a higher value level [7]. According to a model proposed in the literature [8], the benefits of research are to be linked to indicators including ease of use, effectiveness of research and satisfaction of the user. The perceived cost of information is measured in terms of the economic and psychological effort required in research, and is assessed in relation to factors such as the ability to research, and thus the experience, knowledge, education and preparation coming from people involved in the process [8]. Of course, other factors are of importance in the information acquisition process entering into relations with benefits and costs arising from this, such as purchasing strategies [9], situational factors, personal factors and motivation to search [10].

Search engines assist Internet users by filtering the excess information available on the world wide web through the concept of "relevancy ranking" (order of importance) in which the research results have been prepared in accordance with algorithms that determine how closely a document meets the query made by the user. The criterion used by these classification algorithms varies from case to case but typically is based on the characteristics of the document, such as the number and frequency of terms relevant to the question, the positions in the document and the structure of links [11].

When the world wide web matured, the search engine systems occupied a position of growing power, first in channelling the attention of millions of users, then in generating returns for websites through "contextual advertising programs" as in the case of Google AdSense [12]. Search engines are in a position of power in the online world, as witnessed by the fact that more than half of all visitors come to a website through them rather than a direct link to another web page [13], and taking into account that, together search engine systems processed in 2005 over 4.5 billion queries per month [14], becoming more than ten billion per month in the United States alone by the end of 2007 [15].

These figures explain why a fierce competition is taking place to understand the search behavior of users of search engines. Search engines may return many millions of documents for each possible question, but users are trying to select few of them. Some authors have highlighted this point through the development of empirical investigations. For example, according to Spink and Jansen [16] 73% of users of search engines never look beyond the first page of results. This explains the interest of advertisers to be included among the sites which are able to seize these positions, and therefore justifies the interest in understanding what factors may influence the "page ranking" in a search engine system, as a crucial factor for each website that wants to attract a large number of users [13]. That interest involves more than the advertisers or the actors who manage websites with the intent to optimize results from the search engine systems, or following a process of search engine optimization. The latter is defined as a process that seeks to place highest a web page or a domain for specific keywords that can be used in queries made by users.

The search engines importance creates considerable interest in the arrangements that determine the functioning and techniques that can be used to improve the effectiveness of the ranking of web pages. A study conducted by systems corresponding to InfoSeek, Excite, AltaVista and Lycos, at the end of the nineties [17] showed the importance assumed by the characteristics of informative title, headers, keywords and fields on this page. Recently, with the advent of a prominent position obtained by Google, and attention focused on the algorithms on which the function of this operator is based, and in particular on the algorithm of page ranking (PR) used by it [18,19].

The importance of communication in new media has led to the emergence of a new industry formed by companies operating in search engine optimization (Seo). These companies are trying to determine the most important factors that can be used to obtain a high ranking in search results on the SE systems and then applying these factors to the websites of customers in exchange for commissions [20]. Given the nature of consultants and agents of the operators of this industry, its importance to the process of marketing communications and, more generally, communications business, is that players can be seen in relation to traditional advertising agencies and how bidders services potentially substitute to the extent that the new media are substitutes for the traditional media. Despite their increasing number, these companies have only partial information on the heuristics used by search engine systems [13]. This informa-

tion is mainly gained through a process of "trial and error" [18].

The attention to the role of search engines is connected to the implications for marketing and sales techniques resulting from "page ranking" [21]. The development and impact of "page ranking" and in particular the "page ranking algorithm" used by search engines, as the "topic sensitive page ranking" (Tspr) allows a focused development of marketing strategies on the Internet under current conditions of the electronic marketplace. It is therefore important to understand search engine optimization systems (or Seo), because the Internet marketing approaches which are developed today are derived from the calculation, the implementation and the impact of these concepts. The phenomena of page ranking and topic sensitive page ranking algorithms obtained from the assessment of the structure of which are tied to major Seo strategies. The change in search engine technology shows how these algorithms are becoming increasingly complex, and the comparison to that evolution can take into account only some elements of a phenomenon of large-scale change [22].

The literature has identified several factors that may influence the positioning of a website on a search engine ranking system and distinguishes into two categories: 1) factors that refer to the web page, as the existence and frequency of keywords (query-factors); 2) factors which make reference to information from external the web pages that are connected by links to web page in question (query-independent-factors). The contribution of individual factors linked to both types are difficult to assess since the operators of search engine don't reveal what they use when determining the ranking of a webpage.

These considerations explain why it is difficult to identify the factors involved in an algorithm ranking without a large database of millions of "search engine results pages" (Serp) and without making use of extremely sophisticated data mining. Despite these difficulties, there are effective techniques that can be taken to achieve levels of high ranking sites and that have been identified from the best practices used by the most successful Seo [13].

The analysis process is generally applied to Google, for years the leader among the search engine systems, which already realized in 2005 the 46.2% of all questions of research (queries) produced by users worldwide [14]. This percentage has risen further in the last years to establish a market share for Google that represents the absolute majority of clicks made at the international level[2]. Of the parameters (estimated at over two hundred) that Google references in determining the rank of a page, some were indicated as more effective in recent studies [13]: 1) number of pages in a web site indexed; 2) the page rank of the site[3]; 3) the number of incoming links to a website (also defined as "inbound hyperlinks"); 4) the age of the domain name of the website; 5) a list of websites, other web engine systems and other social networks [23].

Search engines were classified in systems which prevail as "pay-for-performance" and other systems defined as "traditional" ones [11]. The pay-for-performance systems (Pfp) provide search services for documents on the Web giving a rank to documents not only on the basis of the characteristics of content, but also in agreement with investments that owners of a website intended to achieve. In other words, Pfp systems provide a service ranking of web pages in relation solely by the amount of money paid by advertisers for certain keywords and not as determined the relevance of the document itself compared to a given query. To make the listing of a site on a Pfp search engine the owner of the site proposed bids on keywords that describe properly the website. The amount will be paid each time a user visits the site when it appears in the list of search results produced by the Pfp system. Generally a higher offer corresponds to higher rankings for the site, and thus a greater probability that the user visits the web site as a result of a query[4]. The lists provided by Pfp systems are in this sense fully comparable to advertising since they represent an advertising product with specific characteristics but similar to others. Some studies have provided data to support that Pfp search engines were less effective in providing quality search results compared to the traditional ones, resulting in effects that are tainted by paid work [11]. In particular, these studies highlight how the services provided by Pfp systems respond to serve needs of users compared to traditional engine [11]. It follows that the rest of Pfp systems are somewhat controversial since the user may not be clear which site reported in a higher position in rank is not the most relevant site, but that for which advertisers are willing to pay a greater consideration [24,25]. This focuses on the pitfalls associated with new media that can recall nature, although not yet in the proportions, the fears related to forms of advertising proposals in the past by media which have today become traditional [26].

In any case the variety of search engines and the differentiation of algorithms accessible is itself a value.

[2]In the United States in February 2008 were carried out about 10 billion of questions, which the 59.2% (5.9 billion) carried out on Google, 21.6% (2.1 billion) implemented on Yahoo, and remainder on other search engine, the most important of which are Microsoft, Ask and Aol [15].

[3]In this case the term "page ranking" does not want to indicate the final result of indexation made by the search engine, but the result of a general algorithm which is known to staff area which is described in Rimbach et al. [22].

[4]Among the search engine systems returned to the Pfp model are mentioned in the literature cases of Overture, FindWhat, Sprinks, the first case is the subject of a comparison with Google, the latter interpreted by some authors as a search engine and not linked to models Pfp and in this sense "traditional" [11].

While the development of high quality pages is very good for users, this is not conducive to the appearance of diversification, which is itself an element of security for the user. In other words, the presence of several types of search engine systems goes against the homogenization trend of the available information, which could indicate sites actually more relevant but is not certain to be favorable to users who turn to search engines to acquire information [22].

2. The Case of the New Advertising Agency in the Italian On-Line Media Market

The importance of the new advertising and communication context above described is confirmed by the emergence of a new wave of companies that assume the role of intermediaries, auxiliaries and consultants in communication processes related to search engine systems (SE) and generally to the Internet advertising. These realities are now increasingly present and also relevant in Italy in addition to the international level. Search engines are working on two main objectives to support its development: 1) identify the optimum information for a search conducted by users; 2) effectively and efficiently manage the index produced by their algorithms and that translates in the "search engine ranking page" or Serp. While search engines used technologies with increasing success to identify complex web pages relevant to a question (query), all the strategies of the actors as agencies or as consultants for the optimization of the statement of advertisers on the Internet (or search engine optimisator – Seo) operate through heuristic tools to achieve this result, such as taking the initiative to build highly relevant web pages.

The case described in this paper is a SEO named "Alpha" for confidentiality reasons. This is a company founded in July 2006 with offices in an Italian city as well as in London, which has as its mission to "industrialize the processes of the value chain in on-line advertising for the benefit of all Internet users and quality of their research" coming to "implement the processes of global companies by world leaders which can be controlled to maximize the return on investment of advertisers… offering solutions and specific opportunities to each market"[5]. The definition of return on advertising spending (Roas) assumes the characteristic of key concept in justifying the presence of actors like Alpha. Alpha is one of the "optimizers, converters, distributors of information on behalf of advertisers in the on-line media market". This company is a strongly oriented to growth so that, despite the recent origin, it is expected by 2009 to speak "14 different languages, providing information as precise and ideal solutions to users, guiding them to investors as buyers of high potential purchase"[6].

The parameters of this agency have followed a trend of rapid growth. Created in July 2006, the company counts at the end of 2006 two employees and produces the first 500,000 euros of turnover. At the end of 2007 there are 6 full-time employees, plus some external consultants, and the share turnover reached 3.7 million euros. This dynamism is reflected in the values described in the documents of external communication, which include "transform ideas and opportunities in winning models, international business and change in speed, high enhancement of each individual user". The company is geared to achieve media planning and media buying on the Internet. According to business records the company is to monitor about 60 thousand potential customers, who are brought into contact with companies that provide goods or services they are looking for and with advertisers who spend over half a million U.S. dollars each month. Overall, the company operates in the field of "search marketing", the context in which the development of technology platforms with exclusive rights and the creation of high traffic portals gave quick access to international markets both in America and Europe. In this context Alfa operates as an agency engaged in a steady growth in partnerships with stakeholders in the sector, an aspect for which a significant dimension of the considerable financial credibility is assumed. Among the activities carried out by this company is including the creation of web platforms and e-commerce at local and global multi-language management, with direct relationships with agencies that were operating in early 2008 in six countries speaking four different languages. The firm tries to develop technologies for managing statistical and automated control of know-how around both qualitative and quantitative basic marketing.

Various sources testify to the growing importance that players offering "digital services" are to have in the formulation of new "communication systems" [27]. By digital services is meant the types of corporate services that are ordered, delivered, used and paid in full on the Internet (from logos and ring tones, lotteries, SMS, development of pages online…) up to the inclusion of competitive services for actors to other areas of communication as mobile call-by-call [27].

The product supplied by Alpha includes the development of lists of contextual inventories for individual markets, categories and products. The production of this database with characteristics of portfolio information is constantly being developed and updated with the idea of making the company a "dynamic zeitgeist and a constant mirror of the new trends of the moment". Potential cus-

[5]The considerations given in quotes are taken from "2008 company profile" of the company Alfa.

[6]The passages in quotes are taken from business records.

tomers are categorized in terms of geographic position thanks to a system of geo-targeting oriented to local advertisers with precision at the metropolitan level. Even on the basis of this activity the Alpha company, as reported by business records, "offers companies the management and development of advertising platforms on-line, the integration and marketing of pre-existing advertising, the placement in the organic results of the major search engines, including Google, Yahoo and Microsoft Live Search". Alpha offers to advertisers "a continuous exposure in the results of the major agencies PPC (pay per click) through a system of financial control consistently and continuously generated by specific algorithms", whereby "direct application program interface (API) with the major players and experts of search marketing continually updated… ensure returns on advertising spending (Roas)". On behalf of clients, the company is to provide services related to online advertising presence, such as 1) control of fraud and 2) verification of compliance with the prohibitions of certain communication notices. By the first is meant the activity to verify and neutralize the possibility that "actors who sell communication with pay-per-click formulas achieve flows in a fraudulent manner and not as result of the normal communication market". By the second is meant the verification of compliance with the marketing prohibitions in relation to on-line presence in markets which are sensitive to certain subject for religious, political or cultural reasons (alcohol, tobacco, pornography and other). One possible representation of the position of Alpha as communication agency and other players in advertising on the Internet is suggested by Figure 1.

The company Alpha manages over one hundred Internet portals with new openings every month, six million potential customers sent to advertisers. It is operating with Google Adwords certification. Alpha operates as a partner of actors representing an established presence in the "Internet-based" economy in Italy and abroad, particularly through its partnership with one of these, the largest corporate customer, which produced activities for 1.2 million US dollars in 2007 with a doubling to 2.5 million in 2008 expected. In the first three months 207thousand sign-ups were acquired for the U.S. subsidiary of this partner of reference, with a value generated in the sole distribution channel of about 3.5 million U.S. dollars. More generally, the network of partners includes search engines, directories, shopping engines and content sites. The company operates in a context of relations with actors of different types, both in a business-to-business, and in a business-to-consumer market. Alpha can play a role that span the entire supply chain, which can be defined as the type business-to-business-to-consumer. Relations with partners are distinct in "key strategic relationships", which include the relationship with Italian and British Internet organizations. In addition to strategic relationships with these companies, Alfa has developed relations with other leading companies in SE systems, including those between Google, Yahoo, Microsoft AdCenter, and with a pool of other firms of the Internet advertising business (Ebates and others) with which it is oriented to develop co-marketing projects. A simplified representation of this network of relationships in which the company builds its market reference [28] is described in Figure 2.

The international expansion of an operator of this kind only marginally requires the physical presence in different places, occurring primarily through the use of virtual media. On this basis, Alfa can boast at the end of 2007 the active presence in three countries, which are the United Kingdom (where it also has a physical office), the United States and Brazil. During 2008 the expansion of activities in other markets including Australia, France, Holland, Spain, Germany is planned as well as in other countries such as China, Japan, Singapore and Korea. Turning to the sector landscape, the process of info-mediation [29] made through onlinemedia market interested in "25 different product categories, among which finance, banking and insurance products, travel, shopping, motors, mobile phones, electronics, food, health & beauty and entertainment".

From an organizational point of view, the company is leaning toward a growth model that wants to be based, as can be seen by business records "on creating a corporate culture that puts every member or employee as a customer and leader of another member according to an internal marketing approach in order to obtain excellence in internal processes". Alpha's management considers

Figure 1. The position of communications on-line media market in the relationship with advertisers and other actors

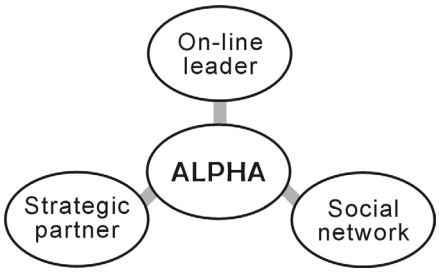

Figure 2. The network of relationships in which the agency Alpha builds its market reference

that "the central unit contributes to the systematic control and strategic development management and planning in support of operations of trading on-line on an industrial scale, implementing a policy of risk control-oriented lobbying for new partnerships, in the maintenance of operating margins in each operation". In this context the organization, young and still small, is experiencing an elaborate articulation of business functions and organizational responsibility.

In the managers' view the large sized actors are able to directly apply to the major search engines like Google to propose its own advertising budget and directly manage an optimization process of the contacts with users moving on the Internet. For smaller actors with limited budgets, direct contact with Google could be more difficult, especially because the latter actor could not find interest in a direct relationship. Nonetheless, these players can conveniently produce communication through search engines, working relationship with agencies that can interface and above all have the know-how to assess the performance and then optimize the conditions for the cost of communication through the new media. When it comes to optimizing it refers to the conversion of contacts in purchases of product, and then calculate the cost of acquisition (Coa). Some operators may in fact simply navigate to define a margin on each unit of product / service sold as a result of the communication system built by the search engine. As highlights one of the co-founders of Alpha there "may have operators who establish how much they can spend on each unit of product sold through the search engine advertising … for example, an advertiser can define a Coa of 4 U.S. dollars and declare they can spend on advertising up to that amount for each unit of output sold…". Having said that the actor who holds himself out as an advertising agency or should orient itself to respond to the advertiser tracking in almost instantaneous terms which is his return on advertising spending (Roas). To achieve its role as the optimizer, the online communication agency must act by developing and verifying knowledge on the conversion rates of exhibitions in clicks and clicks in acquisitions. According to one of the co-founders of Alpha "… if on 500 users which have clicked there are ten of them who bought, this element gives us information on the relationship between cost-per-click and cost-per-acquisition which is vital to the relationship with the advertiser… performance is not so easily measurable as described in this example …". The fact that the commission on request (through systems SE) generates by definition higher conversion rates does not mean that the communication is higher than that achieved with traditional media. Indeed, the conversion rate of contacts in return in terms of sales "depends on factors such as timing and brand image, even and especially through other means". The leaders of Alpha confirm the perception that the traditional ways and forms of online advertising are often complementary in nature, and as such it is appropriate to analyse not as an alternative, but as an integrated effort. If the product and brand doesn't mature through communication that produces awareness, even the possibility of converting leads into sales appears conditioning. The weight of the media and traditional models of communication don't lose importance as the techniques traditionally used in communication such as marketing color, attention to the intercultural dimension in communication through a global potential.

3. The Profile of the New Advertising Agency Integrated in the New Media Market

The level of success of an advertising campaign in the on-line context is an issue which was the subject of much attention from academics and operatives, even with reference to specific issues such as brand tracking [31]. Not surprisingly, some authors detect a strong interest from advertising agencies facing the possibility of judging the effects of marketing and metric marketing for Internet advertising [32], especially in some countries [33], as emerges from research about the opportunities to identify how client marketers are evaluating its effectiveness [34,35]. The rise of importance of marketing metrics and accounting has also been observed by other authors [36] and of course is apparent in the new media, since in this context the actors of the on-line media market research opportunities related to identifying how advertisers are evaluating the effectiveness of Internet advertising performance of their website and what perceptions are associated with those components of their communication [37,38,39][7].

The pricing of advertising on the Internet includes traditional forms of measurement such as those related to subjective measurements applied to advertisers, with any adjustments relating to various factors (for example, the season). In addition to these traditional forms, this measurement may be the result of mathematical formulas related to the measurement of effectiveness. More precisely we can recognize three pricing models and measurements that are commonly used to buy and sell "banner advertising", and which include: 1) costs based on exposure to thousands of users (exposure-based cost-per-thousand); 2) costs for each click that demonstrate forms of interaction (interaction-based click-through rate); 3) pricing models based on results (outcome-based pricing model) where advertisers pay for measurable elements as requests or purchases [34].

The definition of pricing per thousands of exposures is

[7]In this area, for example, a study designed to identify factors which were capable of supporting websites success has identified that a good candidate was interactivity [30].

considered by many advertisers as a formula with a high degree of verifiability compared to others [40,41]. Using that pricing model seems to be based on three considerations. Firstly it may miss measures and uniform standards of control based on the results in terms of conversion rates. Secondly, the cost-per-thousand model (basically cost per click - Cpc) can be directly compared with the standard practice in more traditional media (particularly the print media). Finally, to charge on the basis of costs is consistent with the traditional responsibilities of the publisher to deliver to the advertiser an opportunity to be visible [34,41].

This is the area where advertising agencies are involved, which has already been examined in the literature on the basis of the experience of advertising agencies in important countries [36]. But this topic is only partially explored. The communication agencies in the on-line media market tend to favour a pricing based solely on objective measures or clicking choices displayed. In particular, the search engine optimizers are geared to develop communication of the performance metrics on the Internet. Already research carried out some years ago [42] showed that advertising agencies operating on the Internet in the 86% of cases declared using conversion rates to measure the effectiveness of the advertising and only 50% declared using criteria based on a cost-per-thousand exposure or, with different terminology, cost-per-impression [36].

Advertising on the Internet has its own evolution which starts almost immediately with the advent of the network and which is marked by a change of logic underlying the possible pricing models for the advertiser.

In the second half of the nineties the Internet business is essentially the offer of access to the network (Internet service provider) and advertising on the network is similar to a billboard road, which looks like material inserted in the sites of various actors, including at that time those of search engines [43]. In the next five years (2000−2005) the number of accesses to the Internet had grown enormously and businesses operating on the Internet ceased to obtain a fee for the service network access, and in many cases based their revenues on compensation for supplying advertising space. From this moment a process of consideration of advertising defined in terms of cost per impression (Cpim) becomes increasingly weaker. This is a form of remuneration agreement whereby every thousand "passers" by to the site determines the payment of a fee by the poster. To detect the number of steps which are present at this stage essentially two detection systems that also match more generally two types of other media advertising. The first collection system corresponds to the system "by census" put in place by the same publishers. The second system provides for the evaluation of the audience by third parties, making use of detection systems based on panels, such as those put in place by operators as AC Nielsen. These are systems that, in the opinion of the managers interviewed in the sector, give rise to significant errors that are dependent on the form and the very structure of the panel. Both systems, those "by census" as well as those based on surveys by the panel of third parties are still oriented to "count" the number of "eyes that see advertising". Beginning in 2005 the advent of new technologies and the flux of new capital lead to a new phase of development of businesses based on the Internet [44,45].

These new technologies are behind the advent of a series of products and platforms that make possible the reformulation of the new business model of online communication. Starting from this moment the communication process carried out in this context tends to differ from what is the traditional world of advertising. This is a step that business operators consider very important.

In the first place by traditional forms of evaluation of the consideration of advertising. Cost per impression of Cpim, it moves a more advanced type of cost per click (Cpc), and finally to cost per acquisition (Cpa). These fee formulas for advertising that have no equivalents in advertising built on traditional media such as print media and television. These formulas are possible only for communication on the Internet, in relation to the potential application of related technology. This development makes a decisive contribution to individuality and character specific advertising carried out on online media.

The cost of advertising is then connected not only to the relationship between media and audience, in other words it is not simply related to the extension of public exposure to the message because it si reached by means of communication. In the new models the cost of advertising is linked more directly to the number of players who are not only exposed, but at least choose to learn more about the object advertised (Cpc), or who buy (Cpa). This step is made possible by technology, but also from the evaluation on a statistical basis of the relationship between levels of the purchasing process conducted on-line (conversion rates). In the case of Cpa advertising changes the nature and the cost of communication. Advertising can then be evaluated in direct relation to the margin of the single sale. The extension of advertising for Cpa remains limited, while it is more extensive on Cpc, where most of the advertising proposal lies, such as the leading search engine Google.

The process of evaluating the benefit of advertising, which is inevitably linked to evaluating the cost related to it, we are freed from testing the number of "views", or in other words from its "estimated" audience. The ability to connect to the purchase advertising formula allows the publisher to ask for a share directly for the purchase and not just for the exposition and view. The advertising on

the Internet in this way tends to be welded directly to the achievement of the sale. The publisher is not only seller the means of communication, but in a sense a direct seller of products, asking for a commission for the sale (Cpa) and not only for the view of the information behind the banner (Cpc) or just passing by the site (Cpim).

This "short-cut" between communication activities and sales activities has consequences on the publishers' policies and perspectives. Visitors passing by is no longer sufficient, but we must improve the capability of communication to transform that passage into clicks (which assumes direct importance in the Cpc system) and then in sales (which assumes direct importance in the Cpa system). In other words, the communication process follows the purchase process in its virtual aspect, linking the cost of advertising for the advertiser to the different parameters forming part of the second and third steps of the evaluated process of online purchasing (view, information, purchase). A chain of the steps in the purchasing process is therefore reconstructible and a "pipeline" of online communication, where the advertiser can pay different elements of the process, to transform the de facto editor in a sales player which is recognised a Cpa commission in the system. This sequence of alternatives is the subject of the representation in Figure 3.

The advent of "pay per click" makes significant changes in on-line advertising, both in the communication characteristics and policies of the publisher, but also to the very nature of the entity providing work space for advertisers. To be honest this process is not immediate in the sense that different actors in the chain may be directed to different levels of the process of information-evaluation-choice-purchase by the consumer. This process allows the advertiser to connect a cost incurred, with payment for communication, not generic indicators of "visibility" (or "impression"), but directly to the result in terms of sales. Not only that, but this result can be measured in terms of statistical estimation, based on the historical series conversion from impression to click and from click to acquisition, but also directly through the counting of "complete chains" in the path impression-click-acquisition actually made, and to make this ex-ante estimate the impact of online communication on sales.

This context there is movement toward at seeking an optimization of online communication (by Seo already

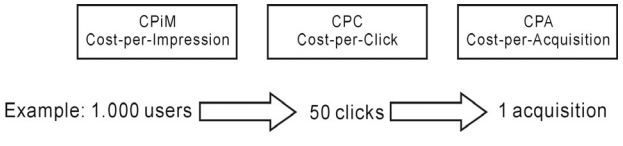

Figure 3. The process of switching between different cost configurations for the on-line advertising

mentioned in previous sections). Players of this type (as the described case Alpha) operate in a context that presents considerable specificity.

The traditional advertising agencies are linked to traditional media, which represent the "technology" dimension around which their production processes have shaped as well as their activities connecting with their current and potential customers. These media have an important role in generating awareness of products, and in general were not able to directly link their contribution to the benefits of sale. The advent of new media, with their new potential, may instead make it possible to connect the communication process directly to the sales of the product, bringing the cost of communication to take a different value in both terms of accounting and economic management. Indeed, the cost of advertising can be linked in this case directly to sales that derive from it, and that are specifically measurable in the case of the cost-per-acquisition solution (specific and direct costs). Advertising on the Internet passes so that investment recoverable over time, assumes the characteristics of direct costs related to the online sales process.

This point leads to questions about the nature of the communication process and the kind of advertising generated by search engines, as there is no doubt that these are processes that still fall within the field of marketing communications. Therefore the production of communication and advertising in the on-line media market requires economic and business evaluations and management of a different nature from those made in the traditional media market. Enabling concrete potential related to new communication technologies requires a presidium of knowledge, which may be realized using the advice of specialist, which are in the case of search systems the specialized actors already analysed. These consultants assume a contiguous position or play a role which can be even mixed with that of the traditional communications agency. In this context, integration of consultancy and agency communication follows an opposite path that traditional agencies follow in other instances. While the agencies of communication based on the traditional media can experience a tendency to shift from "producers" of advertising and communication to "consultants" for client companies for advertising and communications, the new agencies of the on-line media market can start from consultancy for the optimization of on-line visibility to later take the profile of communication agency that integrates additional competencies.

We have seen how the evolving technologies leading to a change in the nature of the communication process and a change of the actors which provide advertising for the on-line media. Change also affects the competitive processes that are generated in the advertising market and the dynamics affecting actors operating in the value

chain of advertising. Those who are able to offer Cpa communication conditions has a product in itself superior in terms of advertising sales compared to other traditional forms, putting the new media (Internet and search engines specifically) in positions of superiority and advantage, at least in terms of connection with their sales activities, compared to the means of traditional mass communication (first of all print media and television). In terms of actors operating in the value chain of advertising, there are two factors that influence and determine a significant change. A first factor relates to the need for a new type of technical skills and expertise, which traditionally were absent from the advertising agency [46], which offer this new type of communication according to the new logic above described. A second factor is related to the presence of actors willing to work on terms of remuneration (pay-cost) of a different nature, which opens the space to new brokers who are, based on appropriate evaluations, among the various levels, as "converting" to solutions expressed in terms of cost per contact in solutions expressed in terms of cost per acquisition.

The new forms of communications determine for the advertiser an advertising cost of a different nature than that understood in the traditional sense. The communication budget assigned to traditional media represents a risk because the investor can not assess with certainty the returns related to the cost incurred. This situation will occur even if the investment in online communication falls under the model Cpim. In other words, the investor can buy on-line advertising in the some way as buying advertising on other media, by simply acquiring visual space on the Internet to which the public accesses the media. Changes arriving with the advent of the Cpc model and especially of the Cpa model, also called "cost of acquisition" (Coa). In the latter case, the cost of the online communication takes a different nature as it can be conceived as a "direct cost", and even as a "specific cost" to the single acquisition. In this case, the communication budget is no longer limited by the decisions on expenditure by the advertiser, but by how much on-line traffic is available and existing since the sale will finance the cost of listing.

In this process, the role of the advertising agency is changing in several respects. In the first place it assumes a characteristic of the "communication consultant", with the same frequency as in the context of the agencies that operate on relatively more traditional media (newspapers, television, billboards, etc.). In the second place it is the customer who changes to a different logic from the past and requires the agency to make a contribution of different nature, in some respects a hybrid role between communication and sales[8].

It is estimated then the concept of click-to-rate (Ctr), or how many clicks it takes to produce a sale (for example, a Ctr 1% will mean that a sale occurs every one hundred clicks). This sale will depend on the various steps that are in the purchasing process, from the first click produced through the effectiveness of sales promotional sense, and to the generation of the final payment (for example through credit card).

4. Some Final Remarks

The interrelationship between online media and marketing communications is a topic of growing interest and importance. The complexity of this issue is due to various factors which include: 1) current trends in the traditional advertising agency; 2) the emergence of new actors involved in giving support and advice to those who wish to communicate on-line; 3) the integration between traditional advertising agencies and new actors and new technologies relevant to online communication. In this sense on the one hand the trends of the traditional advertising agency lead it from a role of producer of advertising to a role of provider of resources and consultancy for the client involved in the communication business [47]. The new players in relation to the new media, such as agencies for communication on the Internet, can increasingly provide activities of different types, alongside with solutions similar to those of traditional agencies and related site design and the formulation of elements of on-line visibility. These may be related to the development of a technological base to specific communications companies involved, rather than on issues of communication in terms of exposure in the new media, integrating with visibility systems of the site in relation to ranking offered by search engines. The new communication agencies taken into consideration in this article are proposed as communication optimizers through search engines (search engine optimizer - Seo). The specific technical culture in this type of player makes significant understanding of the complexity of the third factor above proposed, which presents a more general value, and that concerns the integration of new and traditional actors in the field of advertising services and communication [48].

As highlighted by Lace [36] the debate on the media, and especially on integration of new media with traditional media, has been largely confined to matters of design and interface with the consumer or generalisations on the need for synergies [49]. The difficulty of traditional advertising agencies to follow the new context of communication [50,51] not only interests technical sophistication related to the inference mechanisms of the functioning of search engines, but is also important on

[8]In the same manufacturing enterprises in countries with higher advertising income, from activities "outsourced" to agencies experts, becomes in some cases "core business" company. In this area, however the company does not have all the technical skills, and certainly not have the same ability to purchase media, for which the agency maintains a role as adviser and intermediary for the means.

the relatively more traditional front of design and online visualizing graphics [36].

The new online agency can operate, as we have seen, on a ground which is in some respects beyond the scope of communication and engages the issue of the sale. To understand the role of this agency it is important to enter the chain of its activities and see what skills and profiles are required.

For a long time the traditional advertising agency has specialized professionals such as those present in the creative department in which there are both specialist in computer images and graphics (visualizer) and specialists of texts (copywriter). There is also the company's interface with customers (accounts), essential for the acquisition and management of budget, and the interface with the means of communication (purchase vehicles). In the case of a new actor in the online communication structure, skills develop in different directions dictated by the characteristics of the media and business models of communication just described.

Some authors have shown in past years the development of skills in the area of new media as a process to be implemented urgently by advertising agencies, since these have had to respond to communication needs of customers even on this front [51]. A significant number of advertising agencies were not, from these studies, proactive in relation to the theme of skills required for this purpose and were not in a position to offer advice and design as part of their services for customers interested in communicating through the emerging media. On the other hand, again from this work it is shown that the Internet can be perceived as a key element of agency services [52], but the development of these activities may be seen as not integrated in their structure[9].

The organizational profiles required by enterprises in the online media market often provide figures that are at the same time sensitive to issues of communication and marketing and "network fans … with analytical capabilities related to the use of mathematics and modelling… but also creative…"[10]. These figures must develop, next to familiarity with the tool, even a semantics attitude, given the importance of the size of the signs and meanings of words. Indeed research on the Internet occurs primarily through "queries" made by network users through "keywords" that become a real product. Those who should interpret them to streamline processes must refine attitude to understanding news reports, an ability to immerse, to reproduce and sensing mechanisms of navigators to improve conversion rates by improving conversion rates in contacts and sales (Ctr or check-to-rate) which has already been referred to a key resource of an agency that has to earn for the customer and itself on the optimization process of conversion is the expansion of the database of keywords and its continuous updating.

The commercial or account figure assumes in these companies a growing importance. This is a figure that is to accompany the advertiser in the network, taking on a key role in communication between client and internal staff. This brings the online communication agency to seek integration into its organization of professionals who have matured sales capabilities with potential clients.

Assume then importance the complementarity with the resources of more traditional communication agency, which can continue to play for their clients a role as contact person in privileged communication processes overall, by developing a capacity for management of new forms of communication through growth processes (internal or external) in the on-line media market.

[9]In contrast with these studies, other authors have found that advertising agencies were sensitive to the problem and were undertaken to assess the issues and marketing activities related to the Internet [48].

[10]Considerations made by a manager and co-founder of a major Italian Internet-based company.

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A Modeling Framework for the Planning of Strategic Supply Chain Viewed from Complex Network

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ABSTRACT

Based on the theory of complex network, this paper focuses on the planning of logistics nodes for strategic supply chain. I propose a practical mathematical modeling framework that simultaneously captures many practical aspects but still understated in the existing literatures of network planning problems. Moreover, capacity expansion and reduction scenarios are also analyzed as well as modular capacity shifts for the fluctuation of demands. So this paper is of importance for the research of network planning in strategic supply chain systems.

Keywords: *strategic supply chain, logistics nodes, complex network*

1. Introduction

With the increasingly competitive situation, enterprises have to face the changes of their internal operation mode and external supply chain mode for higher efficiency and lower operational costs. Different from traditional supply chains, a strategic supply chain emphasizes on the optimization of all resources and the coordinate development of the allies based on their core competences. What's more, a strategic supply chain is also different from the integrated supply chain, which mainly emphasizes on the overall control of the upstream and downstream of the supply chain and unilaterally pursues the stability of the chain. Therefore, strategic supply chain is a neutral competitive mode which focuses on the integration of allies' core competences and is of such great features as coordination, agility and difference. Under strategic supply chain mode, the coordination among the allies is more intimate and more dynamic. So the whole supply chain is of much more complexity and perhaps the traditional theories and methods can not give the further support for some relative research.

Complex network is a theory attempted to describe the properties of an actual or virtual network and to establish a model (for instance, mathematical model) to mirror those properties. Based on this theory and from the view of logistics nodes planning of a strategic supply chain, this paper proposes a mathematical modeling framework that captures many practical aspects of network design problems which have not been received adequate attention in the relative literatures. Such aspects considered include: dynamic planning horizon, generic supply chain network structure, external supply of materials, inventory opportunities for goods, distribution of commodities, facility configuration, availability of capital for investments, and storage limitations. Therefore, the research of this paper may provide some references for the mechanism of a strategic supply chain.

2. The Significance for Strategic Supply Chain Design Applying Complex Network Theory

To better understand the significance for strategic supply chain design, it is necessary to briefly review the background and the fundamental contents about complex network theory. A network is a set of items, which are called nodes, with connections between them, called edges. Systems taking the form of networks (also called graphs in some of mathematical literatures) abound in the world. Typical examples of networks include the World Wide Web, information networks of citations between academic papers, technological networks, biological networks and social networks of acquaintance or other connections between individuals, organizations and business relations among companies, and supply chain networks for sure. The study of networks, in the form of mathematical graph theory, is one of the fundamental pillars of discrete mathematics. Networks have also been studied extensively in the social sciences and in the 1930s socialists realized the importance of the patterns of

connection between people to the understanding of the function of human society [1]. From then on, typical relevant researches address issues of centrality (which individuals are best connected to others or have most influence) and connectivity (whether and how individuals are connected to one another through the network). Recent years there have been a new change with the research focus shifting from the analysis of single small system and the property of individual nodes or edges within such systems to consideration of large-scaled (maybe millions or eve more of nodes and edges) statistics properties of systems. Recent work in this area is inspired particularly by a groundbreaking paper by Watts and Strogatz [2]. This new approach has been driven largely by the availability of computers and communication networks that allow us to gather and analyze data on a scale further larger than previously possible. This change of scale forces us a corresponding change in our analytic approach – strategic supply chain network is the case in point. For example, traditional research works about supply chain network of tens or hundreds nodes, it is relatively straightforward matter to draw a picture of the network with actual points and lines, and to give specific analysis (the human eye is also an analytic tool) about it through examining this picture. But this approach is not useful with a complex network of thousands or even more nodes – that is very common now for some modern multi-national companies' supply chain networks.

Furthermore, the theoretical body of complex network is established to do primary three aspects: 1) to find and highlight statistical properties, such as path lengths and degree distributions, which characterize the structure and behavior of a network, and to suggest appropriate ways to measure these properties; 2) to create models of networks that can help us to understand the meaning of these properties such as how they came to be as they are and how they interact with one another; 3) to predict what the behavior of networks system will be on the basis of measured structural properties and the local rules governing individual nodes. In fact, the scientific field has made an excellent start on the first two of these aims by drawing on ideas from a broad variety of disciplines. But such achievements are not well introduced in the research field of supply chain systems; especially the item (2) is understated in the planning of strategic supply chain network. Therefore, this paper attempts to apply complex networks theory to establish a modeling framework to better describe and interpret the systems of strategic supply chain.

3. Literatures Review and Properties Description of a Strategic Supply Chain

Research works on optimization of the supply chain through efficient planning decisions have been processed for many years such as Erlenkotter D. [3], Fong CO. and Srinivasan V. [4,5], Jacobsen SK [6], Sweeney DJ and Tatham RL [7] and in the strategic planning level, typical decisions concern the location of manufacturing and/or warehousing logistics nodes [8,9,10]. Moreover, recent years many research works have addressed the dynamic location problem such as: Daskin et al. [11] propose an extensive review of location problems, Beamon [12] distinguishes models with deterministic data from those with stochastic data, Owen and Daskin [13] clearly separate the static and dynamic models. Cordeau et al. [14] propose a static model considering a multi-commodity, multi-facility and single-country network. The decision variables concern the number of locations, the capacity and technology of manufacturing in plants and warehouses, selection of suppliers, selection of distribution channels, transportation modes and material flows. Hamer-Lavoie and Cordeau [15] simplify this model by removing the suppliers and the bills of materials. They suppose that the location has already been chosen for plants and the model focuses on warehouse location. The model is dynamic with stochastic demands, and takes inventories into account, including the safety stock. Dias et al. [16] work on the re-engineering of a two-echelon network (facilities and customers). The authors suppose that facilities can be opened, closed and reopened more than once during the planning horizon. They study these conditions within three scenarios: with maximum capacity restrictions; with both maximum and minimum capacity restrictions; and with a maximum capacity that decreases. With the same flexibility idea, Melo et al. [17] aim at relocating the network with expansion/reduction capacity scenarios. Despite of so many important researching works, some important real world issues have not received adequate attention. These include the external supply of products, inventory opportunities for products, storage limitations, availability of capital for investments, and relocation, expansion or reduction of nodes' capacities. Even though some of these issues have been researched individually in the literature, it is ignored that the structure of a network is strongly affected by the simultaneous consideration of these and other practical needs. One observes a lack of reasonably simple, yet comprehensive, models which can illustrate the effect of such factors on network configuration decisions.

In this paper, a supply chain is defined as a network of nodes (e.g. suppliers, manufacturing plants, distribution centers, warehouses, etc.) and lines (including physical lines, e.g. transportation lines, and virtual lines, e.g. information and communication channels) that perform a set of operations ranging from the acquisition of raw materials, the transformation of these materials into intermediate and finished products, to the distribution of the finished products to the customers network (Figure 1).

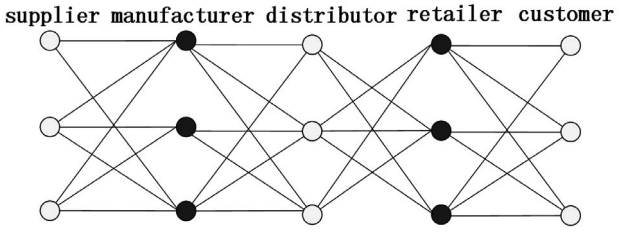

Figure 1. A network of supply chain

This paper attempts to bridge the gap between the complicated dynamic strategic supply chain in practice and the sound describing models in theory. So the main contribution is to provide a mathematical modeling framework for assisting decision-makers in the design of their supply chains. It is necessary to point out that the mathematical modeling framework in this paper firstly includes the relocation of existing logistics nodes, and can reflect the expansion and reduction of the nodes – it is very common in the practical supply chain operations. Further more, the notion of production in this paper is a wide conception which includes service and production. Then, the setup or shutdown of a node, or the expansion or reduction of a node, is usually a time-and-cost-consuming process. Finally, in strategic supply chain circumstances, it is emphasized that resources should be made full use and be integrated for better efficiency. So the capacity should be transmit to new nodes when some existing ones are shut down. Therefore, to implement smooth transition to a new network configuration needs better coordination of all operational aspects involved in this process, and better management of the required investment capital. Hence, to abate the financial burden put on such a comprehensive project, capital expenditures and network design decisions should be planned over some periods. Based on such contents, this paper tries to put forward a modeling framework which can generally reflect the factors taken into account in optimizing strategic supply chain.

4. Notation and Definition of Decision Variables

In order to simply describe the principle of the problem and precisely reflect the planning of logistics nodes in the supply chain, there is a very important disposal in this paper. That is, the planning horizon is partitioned into a set of consecutive and integer time periods which may not necessarily be equal. In total, there are n planning periods. Then, it is assumed that if capacity is to be shifted then this will occur at the beginning of period t ($t \in \{1,2,\cdots,n\}$), and will have a relatively short duration compared to the period length. Finally, it is assumed that prior to the planning all relevant data (costs, capacities, and other factors) were collected through appropriate forecasting methods or company-specific business analyses.

4.1 Sets

It is defined that:

N : set of logistics nodes.

φ : set of selectable logistics nodes, $\varphi \subset N$.

φ^s : set of selectable existing logistics nodes, $\varphi^s \subset \varphi$.

φ^n : set of potential sites for establishing new logistics nodes, $\varphi^n \subset \varphi$.

$\Re$: set of product types.

According to such definition, set N contains all types of logistics nodes and these are categorized in so-called selectable and non-selectable logistics nodes which can be denoted as "$N \setminus \varphi$". Selectable logistics nodes form the set φ, a subset of N, and include existing logistics nodes φ^s and potential sites for establishing new logistics nodes φ^n. Note that $\varphi^s \cap \varphi^n = \varphi$, $\varphi^s + \varphi^n = \varphi$. Another important assumption is: at the beginning of the planning horizon, all the logistics nodes in the set φ^s are operating. Afterwards, capacity can be shifted from these logistics nodes to new nodes located at the sites.

4.2 Costs

It is defined that:

$PC^t_{m,p}$: Variable cost of purchasing or producing one unit of product $p \in \Re$ by node $m \in N$ in period *t*.

$TC^t_{l,m,p}$: variable cost of shipping one unit of product $p \in \Re$ from node l to node m $(1, m \in N, l \neq m)$ in period *t*.

$IC^t_{m,p}$: variable inventory carrying cost per unit on hand of product p in node m at the end of period *t*.

$MC^t_{i,j}$: unit variable cost of moving capacity from the existing node $i \in \varphi^s$ to a new established node $j \in \varphi^n$ at the beginning of period *t*.

OC^t_m: fixed cost of operating node m in period *t*.

SC^t_i: fixed cost charged in period t for having shut down the existing node $i \in \varphi^s$ at the end of period $(t-1)$.

FC^t_j: fixed setup cost charged in period t when a new facility established at node $j \in \varphi^n$ starts its operation at the beginning of period $t+1$.

4.3 Important Parameters

During the research of this paper, there are such important parameters:

$\overline{K}_m^t$: maximum allowed capacity at node m in period t (similarly, $\underline{K}_m^t$ is the minimum required capacity at node m in period t).

$\mu_{m,p}$: unit capacity consumption factor of product p at node m in period t.

$I_{m,p}$:stock of product p of node m at the beginning of the planning horizon, observe that $I_{j,p} = 0$ for $j \in \varphi^n$.

B^t : available budget in period t where interest rate is λ , and assume that λ is a constant.

It is necessary to emphasize on that since each existing node $i \in \varphi^s$ may have its capacity transferred to one or more new nodes, it is assumed that its maximum capacity is non-increasing during the planning horizon, that is, $\overline{K}_i^t \geqslant \overline{K}_i^{t+1}$ .Similarly, potential new nodes must have non-decreasing capacities during the planning horizon, that is, $\overline{K}_j^1 = 0$ for $j \in \varphi^n$, and $\overline{K}_j^t \geqslant \overline{K}_j^{t+1}$.

4.4 Decision Variables

The decision variables of this paper are as follows:

$A_{m,p}^t$: amount of product p produced or purchased from an outside supplier by node $m \in N$ in period t.

$x_{l,m,p}^t$: amount of product p shipped from node l to node m ($l, m \in N, l \neq m$) in period t.

$y_{m,p}^t$: amount of product p held in stock in node $m \in N$ at the end of period t.

$z_{i,j}^t$: amount of capacity shifted from the existing node $i \in \varphi^s$ to a newly established node $j \in \varphi^n$ at the beginning of period t.

ξ^t : capital not invested in period t.

η_m^t : It's a "0-1" variable, if the selectable node $m \in N$ is operated during period t ,then η_m^t=1; otherwise, η_m^t=0.

According to such definition, it's obvious that $z_{i,j}^1 = 0$ because the capacity is not transferred at the beginning of planning horizon. What's more, at that time all existing nodes are operating and new nodes aren't established, so $\eta_j^1 = 0,\ \eta_i^1 = 1$.

5. Mathematical Modeling Framework and the Interpretation

5.1 Mathematical Modeling Framework

The formulation of this paper's model is as follows:

$$\min \omega = \sum_t \sum_{m\in N} \sum_{p\in \Re} PC_{m,p}^t \cdot A_{m,p}^t + \sum_t \sum_{l\in N} \sum_{m\in N\setminus\{l\}} \sum_{p\in \Re} TC_{l,m,p}^t \cdot x_{l,m,p}^t + \sum_t \sum_{m\in N} \sum_{p\in \Re} IC_{m,p}^t \cdot y_{m,p}^t$$
$$+ \sum_t \sum_{m\in \varphi} OC_m^t \cdot \eta_m^t + \sum_t \sum_{m\in N\setminus\varphi} OC_m^t + \sum_t \sum_{i\in\varphi^s} SC_i^t + \sum_t \sum_{j\in\varphi^n} FC_j^t \quad \textbf{(1)}$$

The formulation shows that the goal of planning horizon is to minimum the total costs. Where, the total costs are consist of purchasing/producing cost, shipping cost, inventory holding cost, operating cost, shutdown cost and establishing cost. The constraints are as follows (constraints of variables for non-negativity and integrality conditions are omitted):

S. t.

$$A_{m,p}^t + \sum_{m\in N\setminus\{l\}} x_{l,m,p}^t + y_{m,p}^{t-1} = D_{m,p}^t + \sum_{m\in N\setminus\{l\}} x_{m,l,p}^t + y_{m,p}^t, \quad l \in N \quad \textbf{(2)}$$

$$\overline{K}_i^1 - \sum_{\tau=1}^t \sum_{j\in\varphi^n} z_{i,j}^\tau \geq \overline{K}_i^t \cdot \eta_i^t, \quad i \in \varphi^s \quad \textbf{(3)}$$

$$\sum_{\tau=1}^t \sum_{i\in\varphi^s} z_{i,j}^\tau \leq \overline{K}_j^t \cdot \eta_j^t, \quad j \in \varphi^n \quad \textbf{(4)}$$

$$\sum_{\tau=1}^t \sum_{j\in\varphi^n} z_{i,j}^\tau \leq \overline{K}_i^1, \quad i \in \varphi^s \quad \textbf{(5)}$$

$$\sum_{p\in\Re}\mu_{i,p}\cdot\left(A_{i,p}^{t}+\sum_{l\in N\setminus\{i\}}x_{l,i,p}^{t}+y_{i,p}^{t-1}\right)\le\overline{K}_{i}^{1}-\sum_{\tau=1}^{t}\sum_{j\in\varphi^{n}}z_{i,j}^{\tau},\quad i\in\varphi^{s} \tag{6}$$

$$\sum_{p\in\Re}\mu_{j,p}\cdot\left(A_{j,p}^{t}+\sum_{l\in N\setminus\{i\}}x_{l,j,p}^{t}+y_{j,p}^{t-1}\right)\le\sum_{\tau=1}^{t}\sum_{i\in\varphi^{s}}z_{i,j}^{\tau},\quad j\in\varphi^{n} \tag{7}$$

$$\sum_{p\in\Re}\mu_{m,p}\cdot\left(A_{m,p}^{t}+\sum_{l\in N\setminus\{m\}}x_{l,m,p}^{t}+y_{m,p}^{t-1}\right)\le\overline{K}_{m}^{t},\quad m\in N\setminus\varphi \tag{8}$$

$$\sum_{p\in\Re}\mu_{m,p}\cdot\left(A_{m,p}^{t}+\sum_{l\in N\setminus\{m\}}x_{l,m,p}^{t}+y_{m,p}^{t-1}\right)\ge\underline{K}_{m}^{t}\cdot\eta_{m}^{t},\quad m\in\varphi \tag{9}$$

$$\eta_{i}^{t}\ge\eta_{i}^{t+1},\quad i\in\varphi^{s} \tag{10}$$

$$\eta_{j}^{t}\ge\eta_{j}^{t+1},\quad j\in\varphi^{n} \tag{11}$$

$$\sum_{j\in\varphi^{n}}FC_{j}^{1}\cdot\eta_{j}^{2}+\xi^{1}=B^{1} \tag{12}$$

$$\sum_{i\in\varphi^{s}}\sum_{j\in\varphi^{n}}MC_{i,j}^{t}\cdot z_{i,j}^{t}+\sum_{i\in\varphi^{s}}SC_{i}^{t}\cdot\left(\eta_{i}^{t-1}-\eta_{i}^{t}\right)+\sum_{j\in\varphi^{n}}FC_{j}^{t}\cdot\left(\eta_{j}^{t+1}-\eta_{j}^{t}\right)+\xi^{t}=B^{t}+\lambda\cdot\xi^{t-1} \tag{13}$$

$$\sum_{i\in\varphi^{s}}\sum_{j\in\varphi^{n}}MC_{i,j}^{n}\cdot z_{i,j}^{n}+\sum_{i\in\varphi^{s}}SC_{i}^{n}\cdot\left(\eta_{i}^{n-1}-\eta_{i}^{n}\right)+\xi^{n}=B^{n}+\lambda\cdot\xi^{n-1} \tag{14}$$

5.2 Interpretations of the Modeling Framework

Constraint (2) is the usual demand-supply flow conservation conditions which must hold for each product, logistics node, and period.

Constraints (3 – 5) ensure that only feasible capacity relocations can take place during the planning horizon. Where, constraint (3) guarantees that only operating existing logistics node $i\in\varphi^{s}$ can have their capacity moved to new facilities; constraint (4) imposes that by period t a new node has been constructed at site $j\in\varphi^{n}$ in order for a potential capacity relocation; constraint (5) states that if the capacity of an existing node has been completely transferred to others then the node has to be closed. The combination of (3) and (5) ensures that if an existing logistics node doesn't operate in a given period then its entire capacity was removed in one of the previous periods. Moreover, by constraint (5) no more capacity can be shifted out at the beginning of the planning horizon.

Constraints (6 – 8) impose that the capacity of each node can't be exceeded in each period. Observe that constraint (6) also prevents any supply chain activities from taking place in existing nodes whose capacity has been totally relocated.

Constraint (9) state that it is only worth to operate a selectable node if its output is above a given minimum level. Constraints (10) and (11) allow the configuration of each selectable node to change at most once. Hence, if an existing node is closed, it can't be re-opened. Similarly, when a new node is established it will remain in operation until the end of the planning horizon.

Conditions (12 – 14) are budget constraints. In each period, there is a limited amount of capital that can be spent on capacity transfers, shutting down existing nodes and establishing new logistics nodes. So the amount is given by the budget initially available in that period (represented by B^{t}) plus the remained capital not invested in previous periods (represented by $\lambda\cdot\xi^{t-1}$). In the first period, the allowed investments are as setting up new facilities that will start operating at the beginning of the second period (see constraint (12)). Moreover, in each one of the following period t, the available capital may cover capacity transfers, the costs incurred by closing existing logistics at the end of period $t-1$, and setups of new nodes that start operating at the beginning of period $t+1$ (see constraint (13)). In the last period n, the allowed investments concern capacity transfers as well as shutdowns of nodes that ceased operating at the end of period $n-1$ (see constraint (14)).

Thus, through reasonable assumptions and simplified methods, this paper puts forward a practical mathematical modeling framework that is very easy to be solved by normal software. In fact, this model is a mixed-integer planning problem, and after given relational data or parameters we can obtain the results. So it's not necessary to give a computational experience.

6. Numerical Simulation by Computer

A simple numerical example simulated by computer software is given in this part to prove the correctness and efficiency of my model. The objective function and relative restrains described in the previous sections were implemented using the modeling language ILOG OPL Studio 3.6, and a variety of test problems were solved with standard mathematical programming software, namely with the branch-and-bound algorithm of ILOG CPLEX 8.0, on a computer with the hardware of AMD Athlon(tm) 64X2 Dual PC with 1.8 GHz processor and 1GB RAM.

In order to simulate the dynamic supply chain network circumstances and indefinite original quantities of logistics nodes, I randomly generated a tri-echelon network with various alternatives for the flow of products such as inter-facility transportation, direct deliveries from the manufacturer to the customer level, and reverse arcs for the return of goods (Figure 2). For such a problem, Table 1 indicates the number of facilities selected and non-selected and displays the average, minimum, and maximum CPU times (in seconds) required to attain optimality of this problem for various variants of the original model. Some important contents should be noted: the second column of Table 1 gives the number of problems considered in this kind of network (for details about the problem characteristics we refer the reader to relative literatures). Five instances were randomly generated for this problem, thus yielding a total of 20 instances. The generated problems cover small and medium-scale networks. In an attempt to generate problems related to realistic cases, the amount of arcs available for the transportation of goods in the networks is restricted to 60%. Also, only a given number of product types can actually flow through each generated arc. In this way, we can constrain the volume of traffic in the networks. In all the problems, the relocation decisions involve the distribution centers and retailers. Furthermore, all data (costs, capacities, demands, etc.) were drawn at random from a uniform distribution over given intervals. These intervals were selected in such a way that a large variety of instances was created that differ by the number of periods, products and facilities, the availability of transportation arcs, the range of fixed and variable costs, and the range of capacities and capital for investments. For each subsequent period, the previous parameter value was increased or decreased by a certain percentage (for instance, 8%) which was randomly selected over a given interval. For example, customer demands for the first period were drawn following a uniform distribution in the interval [0, 25]. In the second period, the percentage increase compared to the first period was randomly generated by 8%. This procedure was repeated until the last period of the planning horizon was attained, thus creating an increasing demand sequence. As mentioned above, all the details can be found in Melo et al. [18].

7. Conclusions

Aiming at the planning problem of logistics nodes in strategic supply chain as well as through reasonable assumption and deep analysis, this paper makes research on it systematically. Based on the references of existing research woks and their insufficiencies, this paper establishes a mixed integer programming modeling framework for strategic supply chain design from the viewpoint of the planning of logistics nodes. The aspects considered include the relocation of existing nodes through

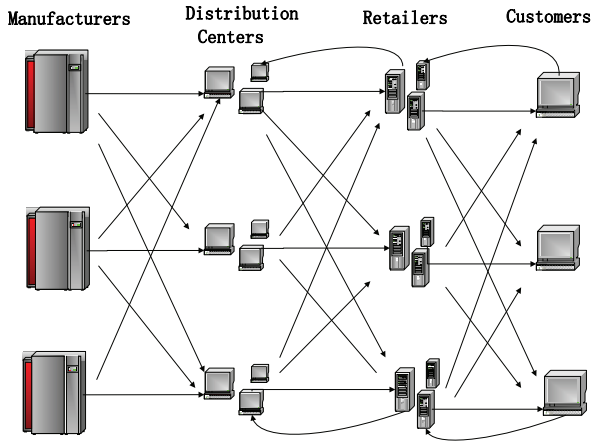

Figure 2. A tri-echelon network generated for computer simulation

Table 1. The results of computer simulation

Problems			4
Periods			3,4,5
Products			5
Non-selectable facilities	Manufactures		5
	Customers		50,75
Selectable facilities	Existing facilities	DCs	8
		Retailers	12
	New facilities	DCs	4
		Retailers	8
Variables	Average		26268
	Minimal		14568
	Maximal		34204
Constraints	Average		1968
	Minimal		1363
	Maximal		2315
CPU time(s)	Average		234
	Minimal		21
	Maximal		1246

capacity transfers to new locations, integration of inventory, transportation and supply decisions, the availability of a given budget for investments in node location and relocation, and the generic structure of the supply chain network. This paper has shown that capacity expansion and reduction scenarios as well as modular capacity shifts can easily be incorporated into this model. To verify the efficiency and correctness of the model, a computational simulation is generated by software. The simulation results show that a number of randomly generated test problems can be solved to optimality within no more than 2 hours at average. Therefore, my model is worthy of being applied for the dynamic situation and complex supply chain design.

In future research, an important extension for this model is expected to change the assumption of deterministic demand, costs, and other factors in the problem to stochastic variables. However, such a modification would have an impact on the complexity of the problem. So it is necessary to develop efficient solution methods to this very realistic and strategically significant practical problem.

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