

Logistics and Matter-Element Models Based on the Firm's Innovative Approach*

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ABSTRACT

In the development processes of a product's market life cycle, there are three phases of an enterprise's innovation: new product development, production processes, and product management. In this article, the analyses of benefit and costs, value, and profit to companies are discussed in different stages. New logistics features that appear in an enterprise's supply chain based on innovative modeling are discussed. Then a logistics model and its technical system based on the classified logistics center are established, which are appropriate for innovative modeling within an agile supply chain. Using the basic theory and techniques of 'extenics', the formal conception of innovative modeling-based manufacture in logistics is presented, and the matter-element models are established. Finally, a case study demonstrates the results.

Keywords: *classified logistics center, logistics model, innovative modeling, matter-element model, extenics*

I. INTRODUCTION

In the 21st century, the global economy will become more integrated and most enterprises will use some sort of innovative modeling development to continually meet customer demand. The globalization of business and continuous increases in competitive pressures have prompted many firms to develop logistics as a part of their corporate strategy for cost and service advantages. Today, many manufacturers and retailers seek to outsource their logistics activities to logistics service providers in order to introduce products and service innovations quickly to their markets. A manufacturing supply chain is an integrated set of business functions, encompassing all activities from raw material acquisition to final customer delivery.

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Today's changing industry dynamics have influenced the design, operation and objectives of supply chain systems by increasing emphasis on: (1) improved customer service levels; (2) reduced cycle time; (3) upgraded quality of products and services; (4) reduced costs; (5) integrated information technology and process flows; (6) planned and managed movement; and (7) flexibility of product customization to meet customer needs. The effective management of supply chain systems is achieved by identifying customer service requirements, determining inventory placement and levels, continued innovation of new products, and creating effective policies and procedures for the coordination of supply chain activities (Dove, 1996). The coordination of logistics functions as they are integrated into supply chain systems has increased the need for improved quality of the process. Improving the quality of all supply chain activities results in reduced costs, better resource utilization, and increased process efficiency.

Better enterprise innovative modeling can increase profits. For example, the Dell Corporation recently constructed some innovative modeling of its production and service areas with the intention of efficiently integrating those areas with its supply chain. Dell's supporting dynamic virtual organizations (or its dynamic alliance) along with its advanced flexible manufacturing technology high-tech and high-quality human resources enabled Dell to respond to a rapidly changing market, make forecasting market demand decisions, and gain long-term economic profits (Dove, 1996). All of these elements improved compatibility, helped to meet various customer demands, and presented organization modes with production in batches. Dell's innovative modeling of their supply chain resulted in other companies adopting similar changes since traditional logistics management is not well suited to the demands of innovative modeling.

This means that combined with the demands of innovative modeling, society, and customer demands, it is necessary to study those changeable logistic management modes. For example, Wal-Mart has utilized innovative modeling techniques for the organization and management of millions of goods to facilitate quick delivery and attract customers. Thus, today's logistics management is an integral part of managing the entire supply chain and a product's life cycle. This allows companies the ability to determine changes in the supply chain quickly, thus giving them a competitive advantage. Therefore, the long-standing innovation examples presented are a powerful competitive and developmental tool for the firm. From a company's standpoint, profits are the first priority which begs the question: How can we know that innovative modeling will result in higher profits? Answering this question is one of this article's tasks.

An extension approach often deals with multi-variable problems and can help analysis of a task in combination with quality and quantity. The extension approach has an important role in the decision-making research field as an operative and scientific technique. Extension sets usually are considered ordinary sets. By using the interrelated function and the extension transformation, we can analyze the multi-variate problems that compose many subsystems so that the incompatible elements become the compatible problem. With this framework, we can extend some model sets and key strategic sets to help managers make assistance decisions (Dove, 1995).

II. THE BASIC CONCEPTS

Generally, we define the basic variables of the enterprise's innovative modeling in the following sets: static matter-element set, control matter-element set, input matter-element set, output matter-element set, and disturbance matter-element set, and so on, where the static matter-element set may present the smallest matter-element set involved in a system and its surrounding characteristics. Consider that the different objects, the static matter-element set can be classified as the system static matter-element set and the surrounding matter-element set. This is written as-

$$R(t) = \{r_1(t), r_2(t), \dots, r_n(t)\} \text{ and } R^s(t) = \{r_1^s(t), r_2^s(t), \dots, r_n^s(t)\},$$

where $r_i(t) = (N_{r_i}(t), c_{r_i}(t), \nu_{r_i}(t))$ and $r_j^s(t) = (N_{r_j^s}(t), c_{r_j^s}(t), \nu_{r_j^s}(t))$, $i, j = 1, 2, \dots, n$. The controllable matter-element set is defined as - $W(t) = \{w_1(t), w_2(t), \dots, w_n(t)\}$, where $w_i(t) = (N_{w_i}(t), c_{w_i}(t), \nu_{w_i}(t))$, $i = 1, 2, \dots, n$. One can apply some matter-element transformation to these variables by using control measurement, to get the sufficient control of any innovative modeling. The input matter-element set indicates the surrounding influence on the circulation of the system, it is the active role produced by its surroundings, or it stands for the active absorption of the system, the latter is the part of the control matter-element set to be called the control input. The control of the input matter-element set can be denoted as follows respectively,

$$I(t) = \{i_1(t), i_2(t), \dots, i_n(t)\} \text{ and } I^u(t) = \{i_1^u(t), i_2^u(t), \dots, i_n^u(t)\},$$

where $i_j(t) = (N_{i_j}(t), c_{i_j}(t), \nu_{i_j}(t))$ and $i_j^u(t) = (N_{i_j^u}(t), c_{i_j^u}(t), \nu_{i_j^u}(t))$, $j = 1, 2, \dots, n$. The output matter-element set stands for the circulation or role produced by its surroundings, it is defined as $O(t) = \{o_1(t), o_2(t), \dots, o_m(t)\}$, where $o_j(t) = (N_{o_j}(t), c_{o_j}(t), \nu_{o_j}(t))$, $j = 1, 2, \dots, m$. One can not control difficult or forecast the disturbance from the inside or the surrounding areas respectively, the disturbance matter-element set is denoted and the system state and described as-

$$D(t) = \{d_1(t), d_2(t), \dots, d_l(t)\} \text{ and } D^s(t) = \{d_1^s(t), d_2^s(t), \dots, d_l^s(t)\},$$

where $d_i(t) = (N_{d_i}(t), c_{d_i}(t), \nu_{d_i}(t))$ and $d_i^s(t) = (N_{d_i^s}(t), c_{d_i^s}(t), \nu_{d_i^s}(t))$, $i = 1, 2, \dots, l$.

In addition to these variables, there are other variables in innovative modeling, such as objective, strategy, measurement. The objective is the expected result of the innovative modeling behavior, often defined by the output scale between the modeling operation periods $[t_o, t_r]$ and called the final state of the modeling plan. It can be denoted $Q = \{Q_1, Q_2, \dots, Q_s\}$. If $s = 1$, it is called a single-objective innovative modeling problem. If $s > 1$, it is the multi-objective innovative modeling problem, the objectives can be vectored by choosing some matter-element variables. The innovative modeling can be presented by the chosen plan in advance to meet some aims. From the extension view, the innovative modeling is the manager's way to optimize some matter-element transformation combinations with the different stages in advance periods, it follows as $p(W) = (T_{w_1}[t_o, t_r], T_{w_2}[t_o, t_r], \dots, T_{w_k}[t_o, t_r])$. Therefore, innovative modeling can be regarded as a kind of k -dimension matter-element transformation. All possible innovative modeling consists of the k -dimension matter-element transformation space. We called it the modeling set, i.e.,

$P = \{p_1(W), p_2(W), \dots, p_p(W)\}$. The matter-element transformation introduced the time-parameter can be used to describe the dynamic innovative modeling. Let T^s denote the realizable matter-element transformation set in a broad sense. The measurement condition is the manager to evaluate all kinds of restrictions that appeared in the innovative modeling operation, it measures the realizable degree of the predetermined objectives and other restrained conditions. The measurement condition is presented by the characteristic set, i.e., $M = \{M_1, M_2, \dots, M_q\}$, where $M_i = (c_i, V_i)$, $i = 1, 2, \dots, q$ denotes the characteristic element, and V_i is a real number.

III. EFFICIENCY AND EFFECTIVENESS FOR APPLYING INNOVATIVE MODELING

In the current business environment, most supply chain companies see a need for greater efficiency and effectiveness according to the aforementioned references (i.e., the Innovator's Advantage of using innovation and technology to improve business performance). The more companies are able to apply innovative modeling; the more confident they are about facing an uncertain business climate. These organizations also see the importance of new product and service development as well as new geographic market entry and they tend to be more committed to improving their processes and increasing their flexibility and speed of response.

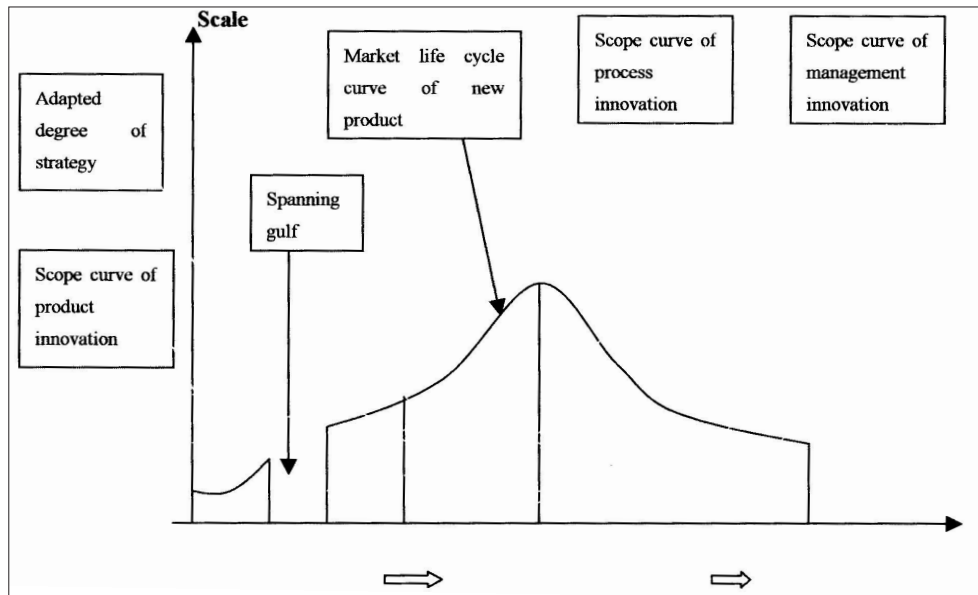
Companies that have applied innovative modeling are prepared to act swiftly in line with their strategic priorities. They give more importance to customer acquisition and retention, increasing sales, as well as new product and service development. They follow this through with relevant changes, not only in marketing and sales strategies, but also in other key areas of their business including research and development and logistics. For example, Avaya gained advantage through an innovative approach to training plus BP Trinidad and Tobago took a leading position on improving the local supply chain.

Innovators view innovation as an ongoing activity, a continuous process of change that is needed for long-term survival of a business. They also demonstrate: (1) *Inclusiveness* – well-directed collaboration, knowledge sharing and the ready availability of information; (2) *Flexibility*—readiness to work not only across departments within the business but also in partnerships and alliances; (3) *Dynamism*—more than two-thirds of companies that have applied innovative modeling have specific initiatives in place to capture creative concepts and promote innovation; and (4) *Strategic Leadership*—with leaders who create and communicate a strategic vision, supported by arrangements to encourage innovative ideas.

IV. STAGES OF AN ENTERPRISE'S INNOVATIVE MODELING

According to the development processes of the market life cycle of a product, an enterprise's innovative approach involves three stages: new product development; production processes; and management. Generally, the greatest innovation for new products arises in the initial stages of the market life cycle, process innovation arises from the market medium, and when the new products and processes are all determined and customer demands are clear, the market gradually goes into a mature period. At that point, innovative orientation turns to topics involving management, such as costs, quality, market orientation, customer service and so on. Certainly, the key task for any company is how to utilize innovation and operational modeling to maintain a competitive ability. These stages are illustrated in Figure 1.

Figure 1. Three Stages in Enterprise Innovation Modeling



1. *Spanning the market demands' gulf during a new product's development period*

Usually, the core task during the initial stage mainly focuses on the innovation of product function. Because market demands are uncertain and small scale, the enterprise management objectives are based on product innovation as a firm's only aim to soliciting market demands. Organization management therefore has more flexibility because the development and interactivity of market are closely related, and its importance is relatively low in terms of its effect on manufacture, production and management. Take the Ford Motor Company, for example, before the Model-T automobile appeared on the market, there was a higher frequency of automobile innovation than production. All competitive companies showed multiple new products continuously, and continued

improving product functions. Once, the Model -T became the standard product, the innovative emphases transferred into how to achieve massive production effectively. In fact, Ford only had the T-type automobile, but its production rates exceeded more than 2,000,000 vehicles. On the other hand, aircraft manufacturers have experienced a similar phenomenon, while DC3-type aircraft became the market standard, the rate of innovative for the Douglas Company quickly decreased, but the sales volume for this type of aircraft doubled than that of other aircraft. Ford had only the T-type product for 15 years, and it faced great challenges each year in increasing production to meet the customer demand, and the growing market.

We should understand that many innovations based upon technology are unsuccessful due to limited opportunity during the first stage of operation. In 1994, for instance, Apple Company kept ahead of its competition with the new PDA (Personal Digital Assistant). Many people anticipated that such a product would have greater market potential; however, sales of Apple's Newton were low, which caused Apple to drop out of the PDA market. Today, however, PDA products are widely sold. This case informs us that exceptional companies can overcome technological problems during the innovative product stages; the new products must meet customer demands and growth in the market. The new Apple PDA products failed since they could not meet the demands of market fluctuations. However, in another case, the success of JVC's (Japan Victor Company) development of new VHS (Video Home System) products shows that the company innovated continuously until the function of their new products met customer demands and facilitated market growth.

The product innovation stages are a kind of interactive process of technological innovation and market demands, among those, are the key determining factors whether companies effectively utilize the advantages of the new products spanning the demands of the market during the periods of new product developments and the promotion of market growth. In this period, in order to ensure the appearance of new products early, enterprises often make alliance strategies with competitors. For instance, Philips and Sony have collaborated to develop a CD (Compact Disk) player and Intel has authorized AMD (Advanced Micro Device) production of its CPU (Central Processing Unit) patent. The objective of strategic collaboration is to cooperatively improve market development. Once the market enters its mature period the demands of the alliance disappear and companies re-assume a mutually competitive status (Cai *et al.*, 1998).

2. Process Innovation is the Key Factor to an Enterprise Making Profits

When a product market enters its growth stages, from the perspective of enterprise operation and management, the main objective is to make substantial profits. During this period, the innovative emphasis lies on how to utilize process innovation to increase a company's competitiveness and enlarge market possession rates. While enterprises are in innovative stages, organizational management must be authorized to develop employees. However, recognition of the departmental performance is higher than the establishment of internal management rules. The innovative key lies in the internal processes, while

facilitation of investment demands increase. In fact, product improvement is still carried out during the innovative process periods and integration between development and manufacture is of great importance.. Function, speed, quality, and cost, compose the competitive core during this period.

In considering how output affects the overall innovative activity, process innovation is the greatest contribution to stages among the technological innovation's three stages, so it may be called the critical point of an enterprise's management and development. Some production enterprises, due to their organizational structure show relative rigidity, often making it difficult to undertake greater product innovation. However, if they find the market growth tendency beforehand, actively track strategic measurements and keep the lead in process innovative stages they can make substantial market profits. In doing so, they may become the market's leading strategists of low-risk and high-return. For instance, in the VHS market, Panasonic Co. in Japan was experiencing difficulty in leading product innovation, but then launched into new process innovation stages and eventually gained a large market share.

Companies that take strategic measurements must have the following organizational and technological resource management abilities:

- (1) Understand the overall tendencies of technological innovation and market demands;
- (2) Closely note the progress of market product innovation, and grasp the optimal leading market times;
- (3) Train the core abilities in advance, implementing involvement in process technologies and production resources;
- (4) Shift the organizational type of the project department, fully authorize technological employees, and sufficiently support manufacturing abilities;
- (5) Obtain new product technologies in effective forms, obtain the measurements involved in incorporating or hiring human resources, strategic alliances, technological transfers, and so on; and
- (6) Have some resource advantages in new products needed conditions.

Recently, many high-tech enterprises devoted their resources to technological development and adapted the competitive strategies to support patents produced by product innovation. In this way they did not pay enough attention to the process innovation side; some enterprises used production outsourcing to entirely avoid the risks associated with insufficient capacity and investment.

In the early 1990s, Computerless Computer Co. protested that the PC-industry should focus on development innovation and brands, and leave production manufacturing to other parties. Based on this viewpoint, they emphasized that the value-added tendencies of process innovation are not significant; therefore, high-tech enterprises should not use limited resources in production manufacturing.

Another typical case dealing with the problems of process innovation is Northridge Drugs Company and the huge loss it suffered. The company invested more than a hundred million dollars in new medical developments and because their development plans were very successful the new product was approved and introduced into the market rapidly. However, the company spent too much time on clinical tests while omitting production and process innovations. Management believed that product innovation had surpassed process innovation, and implemented successful new product innovations only after considering process innovation. However, soon after the new products were approved a serious flu epidemic surfaced in the United States. Extremely high demands in response to the new products appeared, but Northridge Drug's production capabilities could not meet those demands, and when the company transferred resources to production, the complex product structures were such that process innovation plans became difficult to carry out. Lastly, Northridge Drugs took almost two years to solve the problems associated with the innovation process. Due to this delay, Northridge Drugs lost nearly three hundred million dollars, and in the meantime products from competitors appeared consistently.

Since a new product's return in profits is determined by future market potential, the delayed process innovation production did not meet market demands. This was a bitter experience. Managers with foresight find process innovation important in order to introduce new products into the market. They will consider and accept process innovation as well as the overall parts of development, planning and deployment of the necessary resources.

3. Utilization of Management Innovation Molds Golden Enterprises

When products mature, market demand and growth decline. Products and process technologies mature in many relatively similar products with completely mutual functions. The utilization of innovative management modeling assures the continuance of a product's occupancy rates in its lifecycle, which becomes the key to the tertiary innovative stages development. Because prices and qualities reflect the identical core factors of market competitors in this period, enterprises will pay attention to quality management and process management, and multiple production assembly lines will meet demands based on different markets and different customers personal tastes and preferences.

Companies adapt management modeling during the maturation period as follows: one model uses product value-adding features to increase profits; another model adapts by decreasing costs to enlarge market occupancy rates. The first takes strategies from the classified profit-based market according to different customer demands, and designs a diversity of products or enlarge derived products. While enterprises use a diversified strategy, their management innovation objectives are to increase sales and service abilities, and search and harness unmet demands in order to design customer-oriented products and services to increase profits. The latter often enlarges production capacity, simplifies the production program, supplies all kinds of standard products, and creates profit with increases in output. Adapting to the competition of lower costs results in keeping fewer

products, and companies make little profit based on lower prices. During the mature market period, for example, Compaq Co. utilized lower price strategies according to their management innovation content, developed global logistics systems, and adapted build-to-order/customize-to-order (BTO/CTO) management modeling to lower production costs and increase speed. Lower price strategies maintained Compaq's lead position in the marketplace. However, the company made smaller profits, as a result of terminating their Chief Executive Officer (CEO) and their eventual purchase by Hewlett Packard (their competitor). Lead companies in the market's mature period should ideally give attention to two strategies; maintain greater production sizes, and develop towards a different orientation in order to make greater profits. For example, although Dell Co. entered the PC market late, it innovated management modeling with the sales of Internet-based customers and put forward many customized service products. Hence, not only did their market occupancy rates rise successively, but also their logistics and inventory costs were relatively lower and created greater profits. Certainly, companies want to operate and manage forever, hence they must maintain continuous innovative abilities. Even if some products in their mature period eventually become obsolete, new products, process innovations and management will remain to provide opportunities for future success (Cai *et.al*, 1998).

4. Logistics Based on the Innovative Enterprise Model

With global economic development, enterprises in the supply chain require continuous innovation approaches to meet market demands such as variety, personalization demands, products in small and medium-batches, and customer service requirements (Nagal and Dove, 1991). Innovative modeling has several forms, such as reconstructing the agile enterprise organization, operations management, and production techniques. An important form of the enterprise organization is the dynamic union, or virtual company. The basic demand of the enterprise promotes innovative modeling that constitutes the enterprise league. This involves in the application of new technology, new production development, and the introduction of better organization management. The enterprise alliance often comes from a market opportunity competence, according to the demands of the market and its customers. The "lead" company integrates a temporary alliance by using some innovative modeling to respond quickly to the market. Once the market demands have been satisfied, the alliance may be dismissed. When a new market demand appears, a new alliance may be created along with new innovative modeling. From that standpoint, the dynamic alliance is the enterprise dynamic created by using a network linked via a supply chain without regional limitations. The ultimate goals of the alliance usually involve the integration of all allied enterprise advantages to construct a new suitable organization management model, or the establishment of a new technological platform, or the development of new products. New product development must ensure a strong competitive ability based on four factors: T , Q , C , S . In the internal alliance, the same new product developments can be made in different enterprises and different places. The different productive development periods result in enterprises being in different states. The market's tendency and the repeated dynamic modes in innovative modeling will result in the higher costs of logistics in production and the uncertainty of

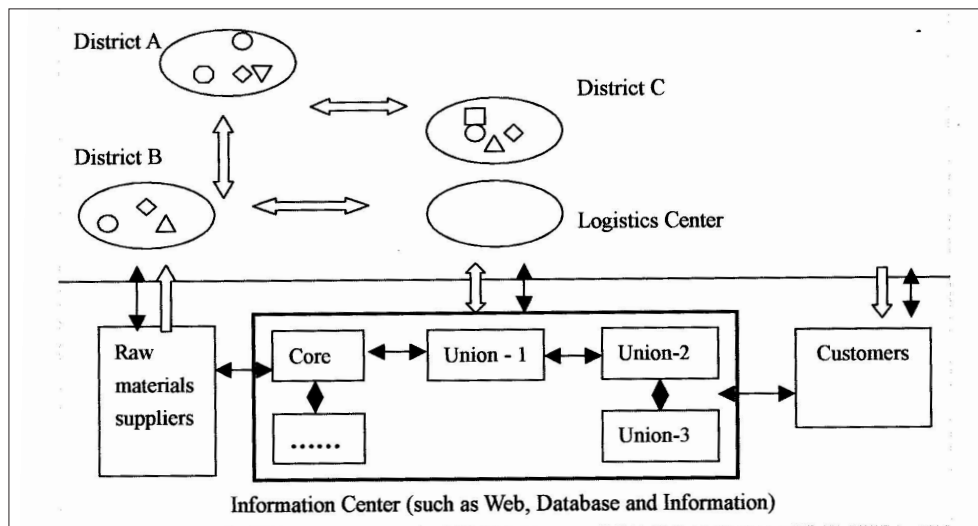
logistics activities, as well as all of the demands of logistics operations such as operating at high-speed with punctuality and agility commonly known as “just in time” (JIT) operations. Formerly, many enterprises wasted resources setting up their own logistics distribution centers, transportation teams and sales organizations. Obviously, such logistics modes require large quantities of resources, and the fixed costs of the logistics system are higher which hinders the creation of greater profits. Meanwhile, such a system has little flexibility (Muller 1996); therefore, the logistics mode fails to meet the demands of global enterprises that continuously seek out new innovative modeling. It is necessary to improve such logistics systems to meet demands of the new innovative model and an agile supply chain.

5. Logistics Management Models Based on Innovative Modeling

In consideration of the types of enterprises that fit the need for innovative modeling, this section describes, a kind of logistics management model that is based on classified logistics centers and suitable innovative modeling (Fig. 2).

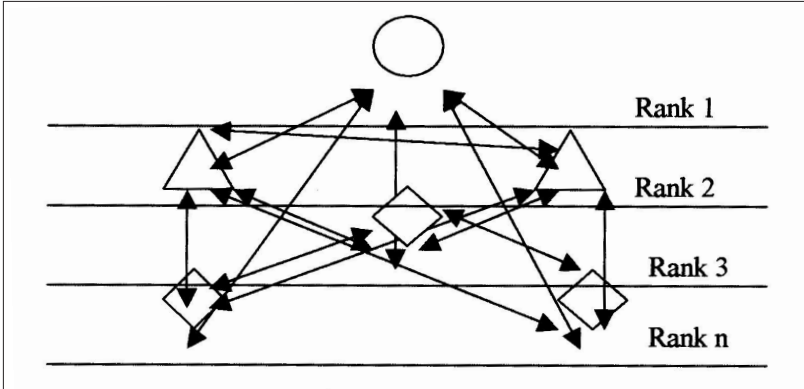
In Figure 2, there exists informational flow among between the principal or core, the union enterprise, the raw materials suppliers, customers, and all those distributed by the classified logistics centers in the supply chain along with a logistics flow and informational flow among the logistics centers.

Figure 2. Logistics Management Models Based on Innovative Modeling



○ denotes rank 1, △ denotes rank 2, ◇ denotes rank 3, ↔ denotes information flow oriented, and → denotes logistics direction, etc.

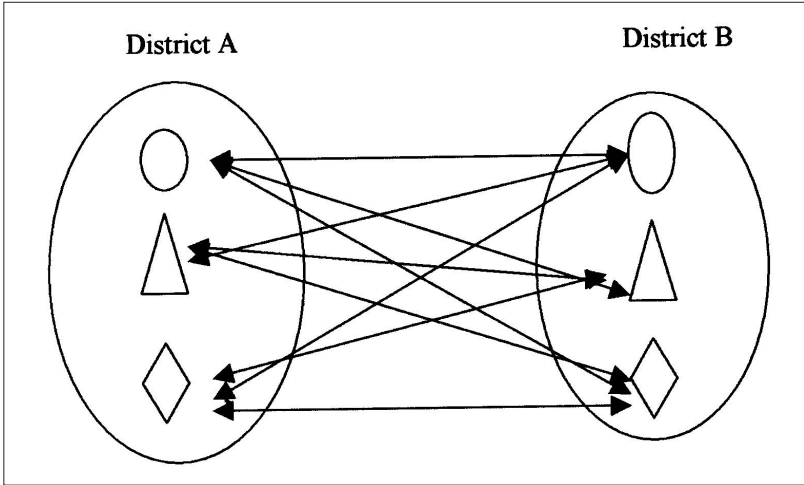
Figure 3. The logistics distribution center in one region:



where \longleftrightarrow denotes logistics interaction.

Figure 4 shows the material flow and informational flow among all regions connected to a logistics center, and the information center plays a central role in the logistics management models.

Figure 4. Material Flow and Information Flow Between All Regions Connected to a Logistics Center



V. ANALYSIS OF THE LOGISTICS MANAGEMENT MODELS

Consider that logistics processes are based on innovative modeling; the alliance enterprises keep only the minimum logistics facilities in normal operations. However, the logistics activities that have replaced the alliance enterprise components, (e.g., raw materials suppliers and customers.), have resulted in integrated management and have put the logistics system to work in a division involving transportation or distribution from the suppliers to market demands (raw materials, semi- or finished products) by using distribution centers. Hence, the transportation functions, both within companies and in company networks, are transferred by the manufacturing enterprise.

The system is operated through the logistics centers, and shows the advantages of production and transportation respectively. Logistics centers service many production enterprises by taking short-term inventory, stock, pack, delivery, distribution, acting as the agent of enterprises, combining numerous small batches, and delivering these quickly according to the customer's order. The centers reduce costs and resources on transportation equipment and labor, thus optimizing transportation facilities to such an extent that the manufacturing enterprise and its cooperatives gain higher economic benefits due to the added transportation value, low inventory and management costs, and reduced product costs by unit. On the other hand, using shared information (such as information on order forms) with production resources results in reduced complexity of basic facilities, added flexibility, and lowered construction costs to optimize resources. Third, environmental protection requires companies do their best to reduce transportation times within logistics system planning. Fourth, an innovative organization results in a logistics operation that is high-speed, agile, sharing information, being receptive to improved flexibility, that helps the enterprise meet innovative market demands and continuously develop new products.

The function of the logistics center involves distribution centers, information centers and control centers. Control of information is based on the logistics distribution center and the logistics information center having strategic dispatch intelligence, and links all logistics processes to the linked dynamic logistics networks (Brown and Allen, 1994). When constructing logistics centers companies must consider the scale of different districts or cities. For example, since the distribution of the majority of farming populations in China is over a wide region, in China, one must consider the following facts: executive authorities, policies, widely geographically dispersed regions and no centralized population. Then, giving more attention to those, better methods might be considered to spread construction of differently-scaled logistics centers in one district; or choosing highly ranked logistics centers to be located in the largest cities (such as provincial capitals), and second-rank logistics centers to be located in the next important cities, and third-rank logistics centers in the regional cities.

Applying ranks to constructing logistics centers will make full use of limited resources. The first-rank logistics center will meet higher standard demands on transportation conditions, transport facilities, inventory abilities, and hardware and

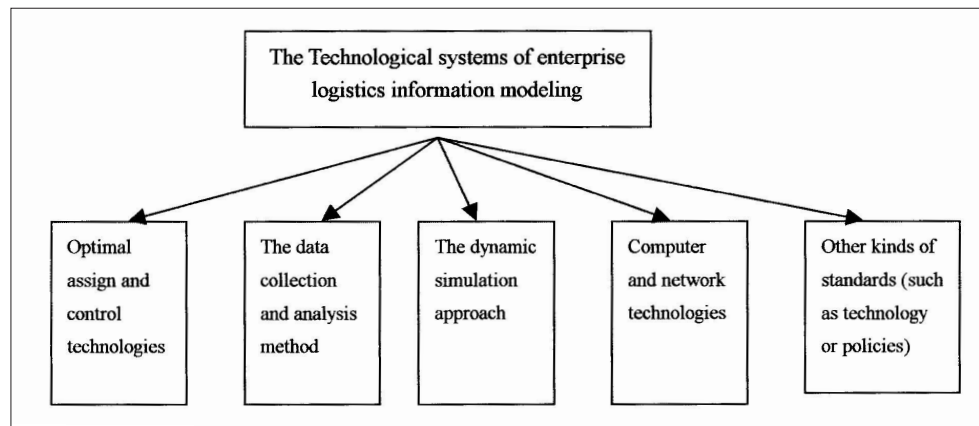
software systems,. In light of the different integrated levels, the first-rank logistics center extends the logistics activity itself and performs transfer integration roles that the second or third rank logistics centers cannot take. The second-rank logistics center has a similar function to the first one. Therefore, when lower ranked logistics centers cannot meet the logistics demands of the innovative model because of limited transportation conditions, the center depends on a higher rank to transfer in the district (perhaps by multi-transfer between ranks). In most situations, logistics centers play the role of logistics information centers and logistics control centers, sufficiently optimizing assignment according to physical background and demands.

VI. INFORMATION FLOW ANALYSIS

In supply chain management, information flow must be shared among logistics centers, alliance enterprises, raw materials suppliers, customers, the trans-enterprise logistics modes, and the technological systems of the logistics-based innovative modeling. The sharing of information facilitates communication between centers to meet customer demands, dynamically optimize assigned resources, and allow logistics customers to easily consult logistics information and data. For example, suppliers can access product information quickly, enabling them to control and adjust their production plans accordingly. Shared information among logistics centers facilitates resource sharing and optimizes assignment on a larger scale. The daily operation of transportation facilities can be controlled by the logistics centers as they introduce the necessary new information technology. This will help deal with any sudden changes and ensure that “the goods flow in suitable time, in the exactly amount, and of perfect quality”. With the aid of efficient information measurement, collection, management and delivery, results in information that is shared to a larger degree. This allows all members in the logistics system to cooperatively integrate and manage information, to meet projected profits, to meet the demand of the innovative modeling operation, agile manufacturing, and customer demands (Brown and Allen, 1994).

VII. THE TECHNOLOGICAL SYSTEM

The main technological system of the trans-enterprise logistics management model is shown in Figure 5.

Figure 5. The Technological System

1. Optimal Assignment and Control Technologies

Using the innovative model, logistics activities will include railway, highway, airline and shipping., with multimodal transportation facilities and dynamic changeable logistics demands. In contrast to innovative modeling, there are many optimal logistics assignment problems, for example optimal utilization problems for transportation facility abilities multi-objective logistics and optimal assignment problems based on times and costs in a deterministic logistics network. The dynamic optimal model assigns problems based on random variables and the dynamic optimal model assigns problems based on the renovation of information and technology.

To solve these problems, one must use more advanced field technologies such as computer networks, data base management, data collection, information systems and management, control engineering, system engineering, operations research, system forecasting, decision technology, simulation technology, parallel engineering, artificial intelligence, logistics theory and ITS technology, business management together with multi-field research such as transportation designing, city planning, supply chain management, and business management modeling. Pushing ahead with the study of these theories, approaches, technologies and management techniques of the optimal assignment model and control under continuous innovative modeling is the key to setting up better logistics management models.

2. Data Collection and Analysis

In order to set up better logistics management models, technology is the key for overall multi-rank data collection and analysis in the logistics systems. By using efficient methods one can manage random assignments to logistics systems dynamically in real-time. Conversely, real-time information and historical data can be searched by logistics customers and employees simultaneously. This includes important studies on data

collection and analysis involving data integration, data mining, communication and its sharing together with data characteristics drawing upon logistics information and information composition. From now on, one should consider some new system combinations, such as global mobile telecom system; electronic data interchange (EDI), and developing systems such as intelligent transportation systems (ITS), media transmission technology, computer and network technology, etc. Other aspects include the innovative ideas, as it often relies on sufficient data and its analysis. In other words, information may result in new ideas (Ji and Zhou, 2004).

3. Dynamic Simulation Techniques

The logistics system's optimal resolution of problems based on innovative modeling, according to continuous innovative demands, should discuss how to examine the changing rules and determine the optimal assignment plans to have greater efficiency by way of simulation techniques. These are important tools, or measurements, for implementing successful trans-enterprise logistics models.

4. Computer and Network Technology

Dynamic alliances facilitate organization among trans-enterprises, trans-districts, the global union, computer networks, Internet development, information technology, and makes it possible to have a dynamic alliance of united organizations with different districts. From this point, computer network technology is the basic technology. In fact, information sharing among logistics centers, alliance organizations, raw materials, the customers, and the integrated management of logistics and information flow all need the support of network technology. To some extent, the implementation of trans-enterprise logistics management models requires unblocked network systems. Also, any innovative modeling design and its operation requires the use of computer networks for preparation and basic conditions.

5. Other Standards

Standards (international or domestic) must be met during all types of logistics operations, including the execution of innovative modeling. Sometimes, these standards concern government policy or institutional regulations that need to be laid down, such as interchangeable data standards and government policy. All these standards will offer great convenience to information interchange among the alliance and the logistics centers. To some degree, the standard itself is involved in innovative modeling, even extended to innovative modeling evaluation and support.

VIII. NEW PRODUCT DEVELOPMENT USING INNOVATION MODELLING

In this section, we consider new product development by using innovative modeling. Suppose that the enterprise has the original product P_0 , it was described by the many-matter-element as follows:

$$R = \begin{bmatrix} P_0 & c_1 & v_1 \\ & c_2 & v_2 \\ & \vdots & \vdots \\ & c_n & v_n \end{bmatrix}$$

Now, the enterprise considers applying some innovative modeling to develop a new product P based on the original product P_0 . We list the characteristic element of the new product P based on the original product P_0 , written down it

$(c_1, v_1), (c_2, v_2), \dots, (c_t, v_t), (t < n)$. The matter-element formed by the characteristic element and is P as follows:

$$R_1 = \begin{bmatrix} P & c_1 & v_1 \\ & c_2 & v_2 \\ & \vdots & \vdots \\ & c_t & v_t \end{bmatrix} \stackrel{def}{=} (P, C_1, V_1)$$

Some techniques of the extension theory contain the dispersed-tree, decomposing integrating link, relating network, etc.. The dispersed-tree approach will be used here to find P_i such that satisfy (C_i, V_i) , and then we have the following expression:

$$R_1 = (P, C_1, V_1) - \{R_{1i} = (P_i, C_1, V_1), i = 1, 2, \dots, s\}$$

We called $\{P_i\}$ be the dispersion matter-element set, i.e., $P_0(P) = \{P_i : i = 1, 2, \dots, s\}$.

Now, we list the other characteristic elements of P that is related to P_0 , here we presented it as follows $(c_{k+1}, v_{k+1}), (c_{k+2}, v_{k+2}), \dots, (c_n, v_n)$. P and these characteristic elements consist in matter-element, it was written down as:

$$R_2 = \begin{bmatrix} P & c_{k+1} & v_{k+1} \\ & c_{k+2} & v_{k+2} \\ & \vdots & \vdots \\ & c_n & v_n \end{bmatrix} \stackrel{def}{=} (P, C_2, V_2)$$

Next, we deduce the dispersion matter set related to V_2 , similar to the above discussion, we hav

$$V_o(V_2) = \begin{bmatrix} V_o(v_{k+1}) \\ V_o(v_{k+2}) \\ \vdots \\ V_o(v_n) \end{bmatrix} \stackrel{def}{=} \{V_{2j_p}\}$$

Where $V_o(v_r) = \{v_{rj_p} \mid r = k+1, k+2, \dots, n; j_p = 1, 2, \dots, L_p; p = 1, 2, \dots, q\}$.

Under the above preparation, we will introduce the matter-element transformation. To R_2 , choosing $P_i \in P_o(P), (i = 1, 2, \dots, m)$, Let $T_i R_2 = (P_i, C_2, V_2) \stackrel{\text{def}}{=} R_{2i}, (i = 1, 2, \dots, m)$,

Let, $T_{ij_p} R_{2i} = (P_i, C_2, V_{2j_p}) \stackrel{\text{def}}{=} R_{2ij_p}, (i = 1, 2, \dots, m)$ for any R_{2i} , we take $V_{2j_p} \in V_o(V_2)$ to consider the following expression:

$$T_{ij_p} R_{2i} = (P_i, C_2, V_{2j_p}) \stackrel{\text{def}}{=} V_{2ij_p}, (j_p = 1, 2, \dots, L_p; p = 1, 2, \dots, n-t-1).$$

For any R_{2i} , let-

$$\begin{aligned} TR_{2i} &= R_{2i} \oplus R_{2ij_p} = (P_i, C_1, V_1) \oplus (P_i, C_2, V_{2j_p}) = \begin{bmatrix} P_i & C_1 & V_1 \\ & C_2 & V_{2j_p} \end{bmatrix} \\ &= \begin{bmatrix} P_i & c_1 & v_1 \\ & c_2 & v_2 \\ & \vdots & \vdots \\ & c_t & v_t \\ & c_{t+1} & v_{t+1, j_1} \\ & \vdots & \vdots \\ & c_n & v_{n, n-t-1} \end{bmatrix}, (i = 1, 2, \dots, m; j_p = 1, 2, \dots, L_p; p = 1, 2, \dots, n-t-1) \\ &= (P_i, C, V) \stackrel{\text{def}}{=} R^* \end{aligned}$$

A new production series can be shown using by $P_i, (i=1, 2, \dots, m)$ (Cai, *et al.*, 1998).

Remark: One can use the assistance of a computer to obtain the new result R^* in the above matter-element transformation process.

Now, we consider the new product's evaluation regulation. According to new product types, we establish the evaluative role and measurement conditions. The necessary conditions must be found, next the measurement conditions are obtained by using the technological requirements, and the economic abilities and the social demands. Then, we follow the steps below:

- (a) The necessary conditions and the measurement conditions that may be answered as yes or no. We first evaluate it by using the computer to select a group of products, assume that $P_1, P_2, \dots, P_c, (c < m)$;
- (b) To product $P_1, P_2, \dots, P_c, (c < m)$, suppose that measurement conditions set across the first selected as follows $M = \{M_1, M_2, \dots, M_r\}$, where $M_j = (d_j, V_j), (j=1, 2, \dots, r)$, V_j is a scale number, then the relative matter-element follows that

$$R_i = \begin{bmatrix} P_i & d_1 & V_1 \\ & d_2 & V_2 \\ & \vdots & \vdots \\ & d_c & V_c \end{bmatrix}, (i = 1, 2, \dots, c).$$

(c) To determine the weight scales, using the measurement conditions above and the different important degree, let choosing the weight scales are in $[0, 1]$, written $\alpha_1, \alpha_2, \dots, \alpha_r$, that meet $\sum_{i=1}^r \alpha_i = 1$.

(d) Find a compatible function and calculate the qualified degree and the norm-qualified degree. For V_i , the compatible function denotes as follows:

$$K_i(x) = \begin{cases} \frac{\rho(x, D_{oi})}{|D_{oi}|}, & \text{if } V_i \text{ is denoted by the district } D_{oi} \\ \frac{\rho(x, D_{oi})}{\rho(x, D_i) - \rho(x, D_{oi})}, & \text{if } V_i \text{ is denoted by the district cover } D_{oi}, \text{ and } D_i \end{cases}$$

Where $i = 1, 2, \dots, r; D_{oi} \subset D_i$. The compatible function value for P_j to V_i can abbreviate like $K_i(P_j)$, then the qualified degree for $P_j (j = 1, 2, \dots, q)$ to M_i follows that

$$K_i = (K_i(P_1), K_i(P_2), \dots, K_i(P_q)), i = 1, 2, \dots, r$$

And the norm-qualified degree introduces here

$$k_i = (k_{i1}, k_{i2}, \dots, k_{iq})$$

Where

$$k_{ij} = \begin{cases} \frac{K_i(P_j)}{\max_{x \in X_{oi}} K_i(x)}, & K_i(P_j) > 0 \\ \frac{K_i(P_j)}{\max_{x \notin X_{oi}} K_i(x)}, & K_i(P_j) < 0 \end{cases} \quad (i = 1, 2, \dots, r; j = 1, 2, \dots, q)$$

(e) Calculating optimal degree. To P_j , the norm qualified degree for M_i can be expressed as-

$$K(P_j) = (k_{1j}, k_{2j}, \dots, k_{rj})^T, j = 1, 2, \dots, q$$

Then, the optimal degree for P_j has the following form:

$$Opt(P_j) = \sum_{i=1}^r \alpha_i k_{ij}, (j = 1, 2, \dots, q)$$

Comparing with the optimization based on P , we choose one or several P_i that having higher optimal degree as the innovative new product plan to develop.

Remark: If the original product P is composed of parts, and the innovative modeling only contributes to some of the parts, then we repeat the above steps for parts and eventually choose the new parts.

IX. CASE STUDY 1

The Sunflower Cosmetics Co. manufactures skin products for women and has obtained company brand recognition in one city. To enlarge its market share and make greater profits, the company decided to develop some new production on the innovative model under its present brands and facilities. Specifically, they changed product packing and added products for men. By using the above models, we consider the new product design. Assume that $P_0 = \text{cosmetics}$, we give the dimensions matter-element expressions based on the original product P_0 , i.e.,

$$\text{original product } P_0, \text{ i.e.,}$$

$$R = \begin{bmatrix} \text{Cosmetics} & \text{Brand} & \text{Jas min e} \\ & \text{Function} & \text{Keepface} \\ & \text{PackageMaterials} & \text{Ceramics} \\ & \text{Packageform} & \text{Paperbox} \\ & \text{Weight} & \text{45g / unit} \end{bmatrix} \stackrel{\text{def}}{=} \begin{bmatrix} P_0 & c_1 & v_1 \\ & c_2 & v_2 \\ & c_3 & v_3 \\ & c_4 & v_4 \\ & c_5 & v_5 \end{bmatrix}$$

Suppose that the new product is P , and has characteristic elements as follows (c_1, v_1) , (c_2, v_2) . P and (c_1, v_1) , (c_2, v_2) together make up the following matter-element

$$R_1 = \begin{bmatrix} P & c_1 & v_1 \\ & c_2 & v_2 \end{bmatrix} \stackrel{\text{def}}{=} (P, C_1, V_1). \text{ Now, the dispersed-tree technique applying to find the object } P_i \text{ that meets } (C_1, V_1), \text{ i.e.}$$

$$R_1 = (P, C_1, V_1) - \{(P_0, C_1, V_1), (\text{skinoil}, C_1, V_1), (\text{skinpaste}, C_1, V_1), (\text{washingjuice}, C_1, V_1), (\text{lotion}, C_1, V_1)\}$$

Then, the dispersed-tree matter-element set based on P can be obtained

$$P_0(P) = \{\text{cosmetics}, \text{skinoil}, \text{skinpaste}, \text{washingjuice}, \text{lotion}\}$$

We list other three characteristics element related to P_0 , which those and P get the matter-element respectively.

$$R_2 = \begin{bmatrix} P & c_3 & v_3 \\ & c_4 & v_4 \\ & c_5 & v_5 \end{bmatrix} \stackrel{def}{=} (P, C_2, V_2)$$

And let $V_0(v_3) = \{\text{Ceramics, Glass, Hardplaste, cermet}\}$

$V_0(v_4) = \{\text{Squarebag, Squarebox, Roundbag, Roundbox, Squarebottle, Roundbottle}\}$

and $V_0(v_5) = \{10g, 45g, 100g, 200g\}$, by using the conclusions in section 8, we have a series of new productions such as

$$R_1^* = \begin{bmatrix} P_0 & c_1 & v_1 \\ & c_2 & v_2 \\ & c_3 & v_3 \\ & c_4 & \text{Squarebox} \\ & c_5 & 100g \end{bmatrix}, R_2^* = \begin{bmatrix} \text{Skinpaste} & c_1 & v_1 \\ & c_2 & v_2 \\ & c_3 & \text{Glass} \\ & c_4 & v_4 \\ & c_5 & 10g \end{bmatrix},$$

$$R_3^* = \begin{bmatrix} \text{Washingjuice} & c_1 & v_1 \\ & c_2 & v_2 \\ & c_3 & v_3 \\ & c_4 & \text{Roundbottle} \\ & c_5 & 75g \end{bmatrix}, \dots$$

Therefore, some new models that relate to packing forms are obtained. For instance, 100g cosmetics can be packed using square ceramic-boxes; 10g skin-paste can be packed using square glass-bags; 75g laundry detergent can be packed using round ceramic bottles, and so on. Next, the obtained results need to be evaluated to the optimal degree in order to determine the optimal production.

With cosmetics, the necessary advantage is to take good care of people's skin, especially the face. Hence, the innovative modeling roles for new products must consider these basic requirements; all plans that cannot meet the requirements must first be eliminated through selection. From the firm's current technological conditions, we assume that it has cosmetic-producing technologies and will only require the addition of some facilities for new product development demands. Hence the following evaluation will only analyze the economic demands and the demands of customers. From the aforementioned, the firm do a market analysis to determine measurement conditions based on the firm's margin (such as costs, return on investments and profit), and consumer demands such as

lowered-usage, no side-reaction, and reasonable prices. On the other hand, since customers prefer the smaller package products, the special requirement should consider measurement conditions. Once the firm establishes measurement conditions by using section 8 as described to evaluative modeling, it calculates a plan's optimal degree and compares those optimal degrees respectively. Lastly, choosing one or more plans the firm continues its innovation of new products.

Remarks: (1) Applying the above mentioned models, at the same time, using computer technology, one can carry out a plan under the optimal evaluation. (2) In case 1, we find element sets $\{P_i\}$ that meet (C_i, V_i) be considered. In fact, using the extension set and its techniques the matter P_i maybe not be meet (C_i, V_i) . In this instance the inclusion of transformations to meet market demands, should be considered.

X. CASE STUDY 2

The Integration Culture computer firm is primarily involved in the manufacture and sale of printers, computers and processors. Assuming that the business's primary income is at \$ a (million) in 2002, and the firm will create a new plan to increase its incomes by $C\%$ degrees per year in the future, we can now undertake the key innovative modeling exercise to bring out the objective.

Suppose that the objective matter-element is $Q=(\text{computer firm A, primary business incomes, } v(t))$, where $v(t)=a(1+c\%)^{t-2002}$, $t = \{2002, 2003, 2004\}$. $R=(\text{computer firm A, primary business incomes at present, } a)$. Let $P =$ the computer firm, we will discuss its structures.

wsP={assembly production workshop variable: prime modeling workshop, printer replacement workshop, parts workshop, painting workshop, repairing workshop, transportation team and other functional group},

rsP={variable relative to firm's relationship} = {relationship among the same business competitors} \cup {relationship among the suppliers in the united management } \cup {relationship among customers} \cup {relationship among administrative departments} \cup {relationship among government departments} \cup {relationship among stockholders} \cup {relationship among employees} \cup {relationship among bank or insurance} \cup {relationship among the new institutes} \cup {relationship among academic schools and research institutes } \cup ...

imP={variable relative to firm's latency}= {firm culture} \cup {firm image in domestic and abroad } \cup {the noted degree in domestic and abroad } \cup {enjoy government preferential policy } \cup {patent, owned technology and other intangible property} \cup ...

reP={variable relative to firm's resources}={human resources(manager, technician, seller, worker), financial resources(fixed fund, current funds), facilities and goods (facilities used in production and service, key raw materials and subsidiary materials, production and stock)},

ptP={project under structuring and prepared, new production under studying, researching

ability, potential market, enterprise development strategy and other potential development factors },

alP ={available production, available property, available market, available technology etc. },

fiP ={flow in cash produced in managing activity} \cup {flow in cash produced in investment} \cup {flow in cash produced in produced raising funds} \cup {cash add-value duo to exchange rate change} \cup ...

$fo(c)P$ ={flow out cash produced in managing activity} \cup {flow out cash produced in investment} \cup {flow out in produced raising funds} \cup {cash depreciated duo to exchange rate change} \cup ...

Next, we will discuss the related analysis and characteristics of production income c , list as follows. c_1 denotes sales volume, c_2 is production price, c_3 is expenses, c_4 is expenditure expect managing, c_5 stands for stock level, c_6 show technological level, c_7 present funds managing level, c_8 is employees' knowledge quality. All those variables together present the new product development capability of a firm, and might be determined by using the approaches involved in the experts system or the historical data evaluation, and might weigh the firm's strengths and weaknesses, advantages and disadvantages, especially for c_1, c_2, c_3, c_4, c_6 , which we analyze in detail as follows. We use a contained system approach to find key characteristics and analysis.

For c_1 , we consider as follows: production species involve well-sell, slow-sell, new product c_{11} , and may make use of adding well-sell, reducing slow-sell and continuous innovation to get better profits; production quality must pass the quality system attested and managed by TQC; objective markets must consider domestic customers if they have a better relationship, overseas customers c_{12} ; market share, which contains promotion ability, brand image, etc.

For c_2 , we consider that as follows: production cost involves the directive materials (there is reasonable price for raw materials); wages standards are moderate; managing cost c_{21} includes establishment of a standard cost accounting system for the management; improvement of the managing process; lower power consumption; lower rate of rejects; market supply and demand covering domestic and overseas market state; domestic market influences, such as government investment informational services; State encouraged of foreign investment; the effects of Western development; overseas market affected by strong competition in the computer market; demand decreasing in Asia and the global economy; and so on.

For c_3 , the following factors need to be considered: selling cost be moderate; management expenses; financial expenses including exchange rate loss, balance of trade etc.; and tariff, income tax, circulation tax, some preferential tariff and return tax.

For c_4 , some logistics expenses for the manufacturing firm need consideration, such as hospital and the dining hall.

For c_6 , the following factors should be considered: available facilities level , production technology content etc. With above the mentioned, we will find the top-level characteristics such as c_{11} , c_{12} , c_{13} , c_{21} , c_{31} , c_{61}, c_{62} , the characteristics elements results follows:
(c_{11} , less), (c_{12} , single-structure), (c_{13} , weakness), (c_{21} , higher), (c_{31} , higher slightly), (c_{61} , the level similar to advanced county in 1995), (c_{62} , not higher).

Then, we try to find the matter-element transformation and use the extension technique and evaluation approach to do some technological economic evaluation. We choose the following transformation: $T_1Q_1 = (P, c_{11} \text{ more})$, $T_1 = (T_{11}, T_{12})$, where T_{11} denotes that joint-venture construct dominant-plate manufacturing line, T_{12} denotes that add new production development funds; $T_2Q_2 = (P, c_{12} \text{ structure diversified})$, T_2 where denotes that enlarging international market; $T_3Q_3 = (P, c_{13} \text{ stronger})$, $T_3 = (T_{31}, T_{32}, T_{33})$ where T_{31} denotes that chosen qualifications firm as agent, T_{32} denotes that put into practice competitive selling, T_{33} denotes that directly supply to high reputation or important customers; $T_4Q_4 = (P, c_{21} \text{ lowest})$, $T_4 = (T_{41}, T_{42})$, where T_{41} denotes establishment of a standard cost accounting system for the managing procedure, denotes improvement of managing process, lower power consumption, lower rate of rejects etc.; $T_5Q_5 = (P, c_{31} \text{ moderate})$, T_5 denotes that decrease business reception expenses; $T_6Q_6 = (P, c_{61} \text{ advanced country development level 1995s})$, $T_6 = (T_{61}, T_{62}, T_{63})$, where T_{61} denotes expanding the main factory, T_{62} denotes rebuilding the main manufacture line, T_{63} denotes enlarging the logistics facilities; $T_7Q_7 = (P, c_{62} \text{ highest})$, where T_7 has similar means to T_1 .

According to the above statement for matter-element relationship, we can obtain the following results.

Result 1: $T_2 \wedge T_3 \Rightarrow T_1^*$, that is, carry out further promotion, well-equipping the sales network, enlarging domestic and overseas market.

Result 2: $T_4 \wedge T_5 \Rightarrow T_2^*$, that is strengthening organizational management, lowering costs,

decreasing inventory.

Result 3: $T_1 \wedge T_0 \Rightarrow T_3^*$, that is quickening technological reinvestment, intensifying new product development based on the innovative modeling, further enhancing production value-added and rank.

XI. CONCLUSIONS

Using the basic theory and techniques of extenics, the formal conception of innovative modeling, and establishing matter-element models, we discussed and analyzed the effect, value, and profit to companies represented in an enterprise's three stages of innovation (new product development, production, and management) according to the development processes of a product's market life cycle. New logistics features based on innovative modeling as they appear in supply chain enterprises were discussed, and a logistics model with a technical system based on a classified logistics center, was presented. Finally, two cases studies were used to demonstrate our results.

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