Consideration and Classification of the Integrated Manufacturing in Petrochemical Complex

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Abstract: Because the circumstances in the oil and petrochemical industry recently have been severe, oil and petrochemical companies came up with the idea of business cooperation in the same region in order to acquire global competitiveness. Under the purpose, 20 companies in oil industry and chemical industry gathered round at first. Under the Research Association of Technology Law, Research Association of Refinery Integration for Group-Operation (RING) was established in 2000. RING has acted group-operation programs in the industrial complexes in Japan. In this paper, I classified experimental studies in RING3 projects into nine types. And I considered and analyzed the approach to and ways of the high-level integration for group operation in petrochemical complex.
Key words: Industrial complex; Oil and petrochemical industry; Group operation; Business cooperation; Economies of integration; Management of sustainability

1 Introduction

Oil and petrochemical companies are in the severe situation where they should deal with various problems. These subjects are global competitiveness, sudden rise of price of raw material, response to environmental issues, minimization of resource energy consumption, security of safety technology, employment and economical contribution to the region, requirement to satisfy severe product quality standard, further upgrade and cost reduction in system of production, and construction of system of production for sustainable development etc.. In Japan, oil and petrochemical companies have taken up matters of energy saving measure, actions on environmental problems, security of global competitiveness, and restructuring of system of production etc.

In such a severe situation, oil and petrochemical companies came up with the idea of business cooperation in the same region in order to acquire global competitiveness. 20 companies in oil industry and chemical industry gathered round at first. Under the Research Association of Technology Law, Research Association of Refinery Integration for Group-Operation (RING) was established in 2000. In order to gain global competitiveness, RING has acted group-operation programs in the industrial complexes in Japan. In this paper, I classified experimental studies in RING3 projects into nine types. And I considered and analyzed the approach to and ways of the high-level integration for group operation in petrochemical complex. And I described the meaning of the plans, and the economies arising from the group operation business.

2 Experimental Studies in Kashima Complex

It is not easy to cooperate in businesses between two or more enterprises. To achieve business cooperation, there are problems of adjusting interests between enterprises. As assumption of a project like RING, a place for adjusting the interests should exist. Only after there is a place of discussion that exceeds wall of capital, the business cooperation like RING could be done. The prototype of the idea of RING project is the early movement in the Kashima complex. In the Kashima complex, the discuss-ground about problems of entire complex existed at first of the complex establishment in the latter half of the 1960's. Mitsubishi Chemical Corp., that is the participating company of Kashima complex, has thought about not only the region but also development of the chemical industry in the future. When there is such a background, the cooperative organization comes into existence.

There is the Corporate Liaison Council in Kashima Seaside Industrial Zone in the Kashima complex. It is composed of "General meeting" (all companies), "Operational committee" (nine district representative companies), "Environmental standing committee" (12 district representative companies), and "Harbors standing committee" (11 district representative companies). The occasion where senior executives of the enterprises can chat regularly (every two months) has been set. They have discussed common problems and aimed at the solution. To exceed wall of capital, a place where top management can discuss regularly is necessary. Many problems in the field have been discussed by top managers. They have searched for solutions mutually. Such a system has been constructed since establishment.

In the Kashima complex, participating companies always share recognition and consider each other's interests and developments.

Additionally, personal exchanges were actively done on site. Under "Factory Meeting Committee" in organization of the site of the Kashima complex, there are "Six Companies Committee", "Administration and Environmental Measures Report Committee," "Labor Report Committee," "Production Report Committee," "Technological Report Committee" ("Manager Committee" is under that), "Security Measures Report Committee." Together with "Factory Meeting Committee," there is "Security Measures Liaison Council" ("Manager Committee" is under that). According to the function of their jobs, personal interchanges with same departments of other companies have been promoted in the Kashima complex. The development and interests of the Kashima complex has been shared in the field. Under such a system, they have undertaken actions on some problems, every day operations, and adjustment of regular repair etc. since establishing the complex. They have known well the circumstances of other companies, and always have recognized the advantage of joint management. In addition to examination about rationalization of each company, for the purpose of strengthening competitiveness of the complex, they came to think some strategies. As a result, mainly in oil refinement and petrochemicals, they began to examine business integration utilizing mutual flexibility piping.

Kashima Oil Co. and Mitsubishi Chemical Corp., as RING 1, undertook "Development of Integrated Operation Technology Allowing Enhanced Utilization of Refinery and Petrochemical By-product" for the upgrade of mutual effective use of by-product material. And they succeeded to heighten the added value of by-products. In addition, the experimental study in which they efficiently collected the olefin fraction of petrochemical raw material from off-gas generated as a by-product by Kashima Oil, had been accomplished for three years from 2004. The result of this study is going to be used as high-value-added raw material in the petrochemical sector. "Development of Integrated Refining Technology Allowing High Recovery of Cracked Off-gas" was carried out in RING 2. The technology collecting olefin fraction from off-gas, which had not been evaluated only as a fuel, was expected to be applied widely to other complexes. The high-level utilization of unused product will lead to strengthening cost competitiveness, and contribute to effective use of the resource. These technologies with cooperation of oil refinement and petrochemicals will improve competitive advantage in complexes. It is expected to contribute to energy conservation and environmental measures.

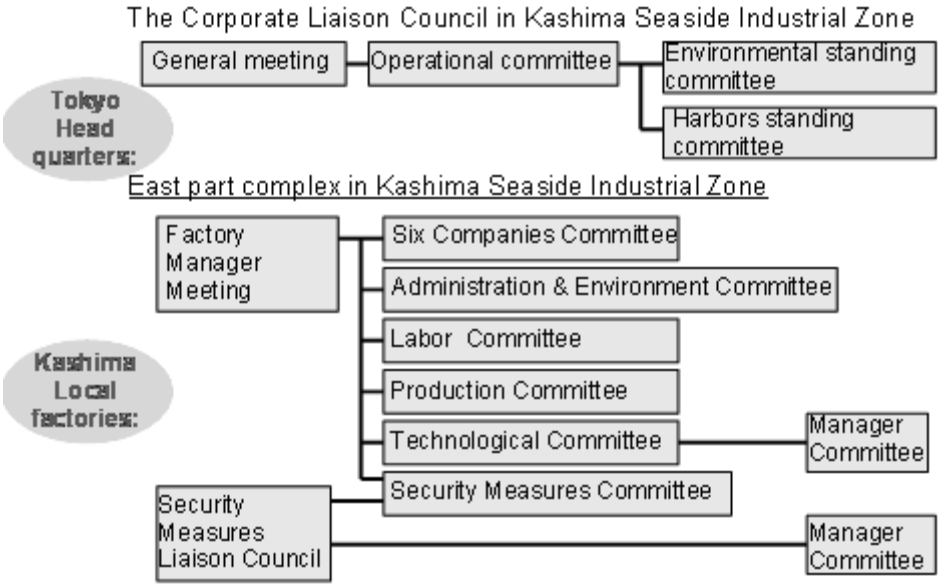

Figure 1 The Corporate Council in Kashima Seaside Industrial Zone

3 Economies of Integration

Strengthening cost competitiveness is requested in oil and petrochemical enterprises in Japan. The consolidation and expansion of manufacturing scale, efficiency improvement in manufacturing process, and reduction in cost of manufacturing are more necessary to obtain global competitiveness. To solve the problems, RING was established in 2000. In RING projects, they have tried to find new methods of integrated management, exceeding types of business and a frame of capital, developing some latest

technologies, aiming at efficiency improvement and optimization. It is important that one complex is thought of as virtual one factory. If it is so, the integrated management could be practiced. As a result, new effects, economies and innovations by new technological development would be achieved. These practices are difficult for one company to do alone.

In RING, the research and development business, related to advanced united management, has been done between different types of business such as oil and petrochemical factory, etc. The first R&D project (RING 1) had got good results of the proof of R&D in the each district. It had resulted that strong unity was caused among complex enterprises through these activities. Following this, the second R&D project (RING 2) was executed in 2003. Development of advanced, highly integrated technologies for reducing environmental burdens was performed there. In addition, the action to optimize entire petrochemical complex and carry out advanced function unification was executed in the third R&D project (RING 3) in 2006. At present, such a business has been accomplished in most complexes in Japan, that is, in Kashima, Chiba, Kawasaki, Chita, Sakai Senboku, Mizushima, and Shunan.

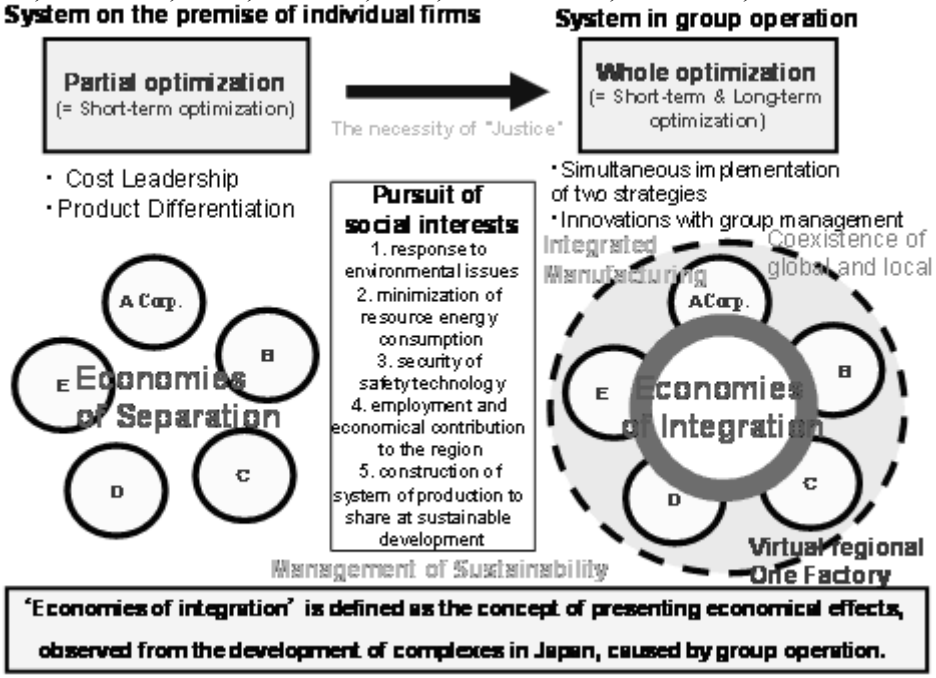

Figure 2 Comparison of Two Systems

One company perhaps tends to attempt single survival and optimization. Even if it notices the importance of cooperation, the priority level might be low. There are only two choices whether to execute it or not in one enterprise. Therefore, the government needs to put out a subsidy at first as a trigger, and it is necessary to establish the third-party institution in order to give the motivation to business cooperation. It is important to build the organization to adjust common interest. The support of the government for RING projects is a pump-priming policy. And the enterprises have recognized new possibilities in business cooperation. They would begin to mix well with them, and come to analyze a system of production with each other. They would examine construction of system of production and technological development accommodating wasted gas, heat, and energy etc. And profits between enterprises, which one company cannot conceive, would begin to be recognized, and their interest would spread various contents such as treatment of waste, contribution to the region, joint power generation etc.

The RING project is an attempt of joint operation and business cooperation in oil and petrochemical business. The project assumes current production facilities, capital tie, and business activities. On that assumption, it is necessary for two or more enterprises to cooperate and work on reduction of environmental burdens facing the world. Different from the strategy that one company pursues productivity and efficiency, same kind of effects may be achieved by cooperation between enterprises and different types of business. Whole optimization will be achieved by the system in group operation. And they can implement simultaneously two strategies, Cost Leadership and Product Differentiation.

In addition to economies of scale and economies of scope, some social interests will be pursued. When collaboration with many enterprises is achieved, 'justice' will be necessary for cooperation. Therefore, the aspects to social interest will arise: joint energy use, efficiency improvement, regional contribution, establishment of safety technology, positive commitment to environmental measures, and cooperative treatment of waste etc. And enterprises will pay more attention to practices of social activities: greening of the complex, ownership of joint power generating equipment, security cooperative relationship etc. In this paper, economies of integration is defined as some economic effects which group operation produces; whole optimization and efficiency, simultaneous implementation of two strategies, pursuit of social interests, innovations with group management, management of sustainability.

4 Classification of R&D Projects in the Integrated Operation of RING3

RING3 had been done in the theme 'Development of advanced functional integration technologies for petroleum refining (Third stage R&D projects)' during the four years from 2006 to 2009.This projects can be located with a finished type of the entire projects.

This R&D projects had been accomplished among different industries and companies. They intended to promote the integration of all the operational functions of oil refineries and petrochemical plants in each industrial complex. And they had aimed to increase in productivity and reduction in environmental burden. These projects had been acted in the three regions of Kashima, Chiba, and Mizushima.

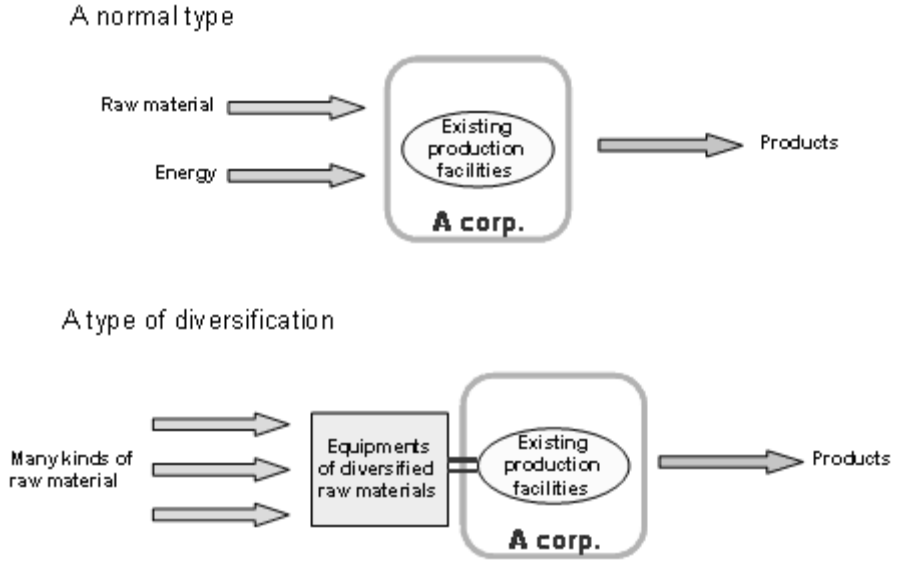

Figure 3 Normal Type and Type of Diversification

RING3 in major technical efforts put it this:

'1. Development of efficient integrated production technology for petroleum and petrochemical materials that will enable the high-efficiency integrated production of raw materials from condensate for both petroleum refining and petrochemical use.'

'2. Development of technology for the advanced use of cracked C4 components in which the unused C4 fraction generated by petroleum refining and petrochemical processing will be utilized as a transportation fuel and petrochemical feedstock.'

'3. Development of advanced technology for the integrated purification of by-product hydrogen that will enable the large-scale collection and sophisticated utilization of the hydrogen generated as a by-product throughout the refining and petrochemical complex.'

'4. Development of technology for the optimum supply of a diversified range of raw materials in each refining and petrochemical complex that will enable the best mix of diversified raw materials to be used for petroleum refining and petrochemical processing by producing stable materials for the ethylene cracker and reformer. [4]'

[4] "Reseach Association of Refinery Integration for Group-Operation(RING)" pamphlet, RING, 2011, p.6.

I classified experimental studies in RING3 into nine types. I think nine types, describing here, are basic cooperative model in thinking about the group operation. RING3 is a finished form in all the projects. And I can consider it as a center of the classification.

The ninth type can be one of special importance. This is not a form that the equipments are only added to the individual firm. There is a feature that relations of many enterprises are considered as if one factory for whole optimization, in order to aim at the profits of the entire industrial complex.

In Mizushima Region, there is a plan that RING3 projects will be developed more than now. In addition to the past oil refinement and the petrochemistry, such different industries as electric power, iron and steel, automobile, and others prepare to participate in the industrial complex. In this occasion, total optimization for all industries can be planned with mutual accommodation of medium materials, energy, and utilities etc.

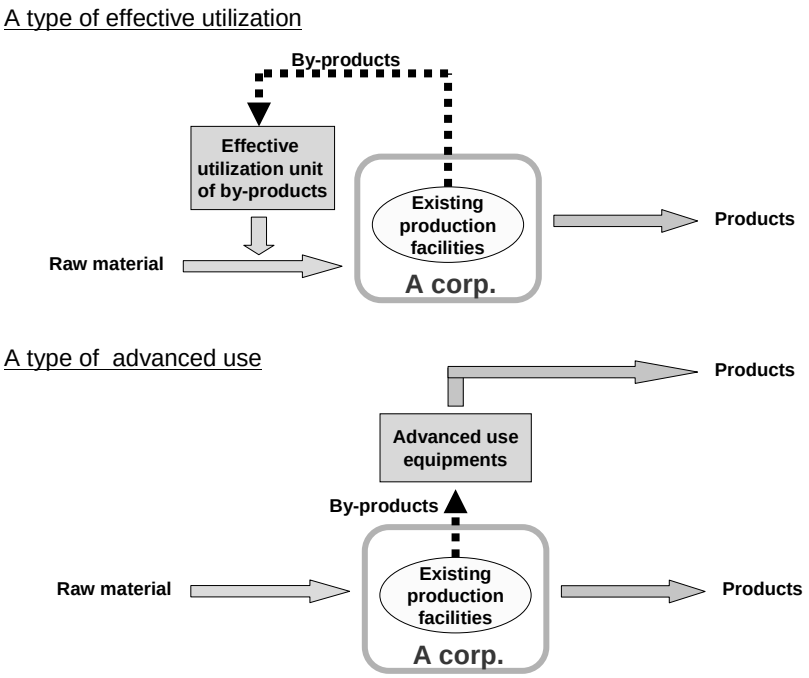

Figure 4 Type of Effective Utilization and Type of Advanced Use

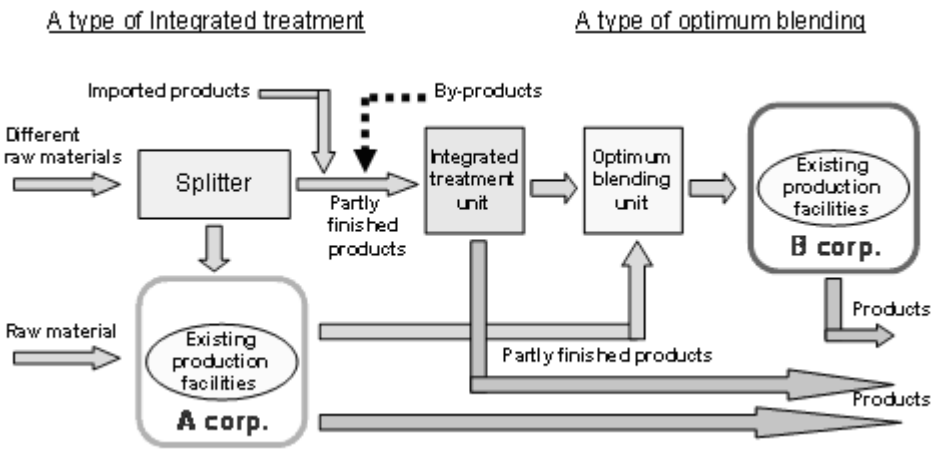

Figure 5 Type of Integrated Treatment and Type of Optimum Blending

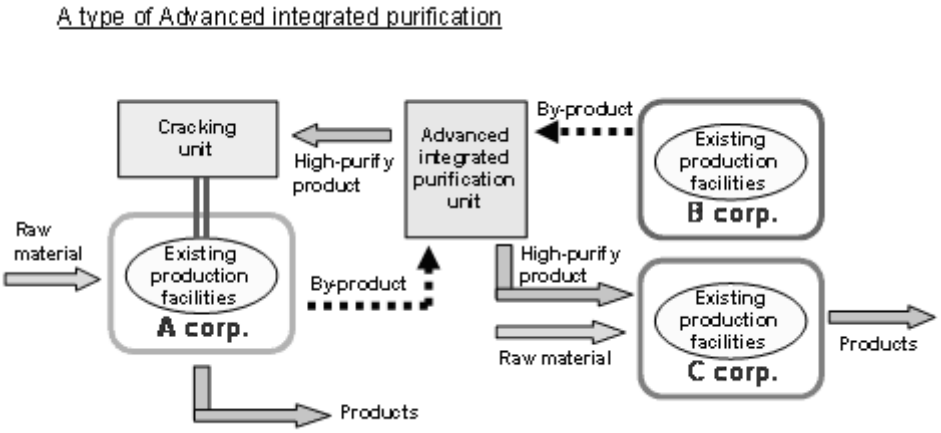

Figure 6 Type of Advanced Integrated Purification

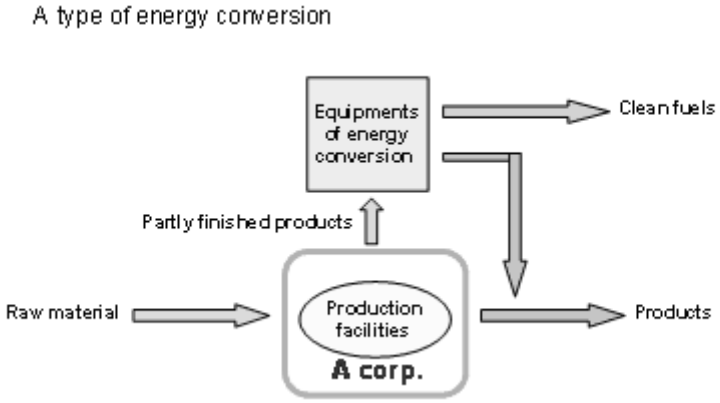

Figure 7 Type of Energy Conversion

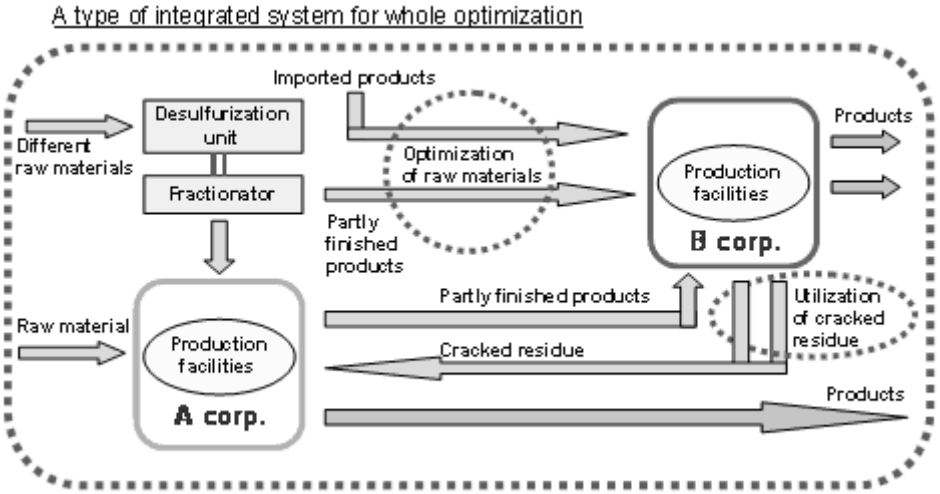

Figure 8 Type of Integrated System for Whole Optimization

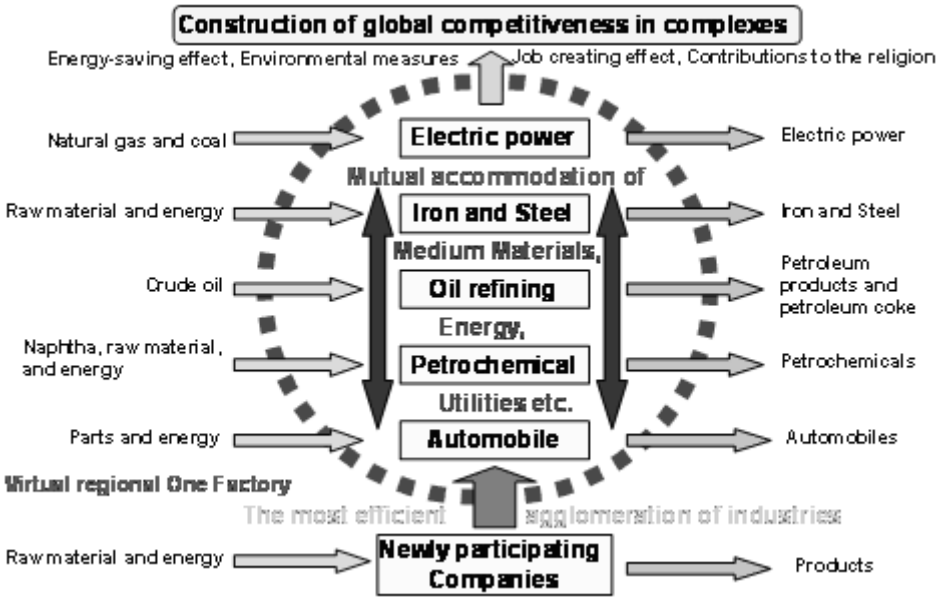

Figure 9 Construction of Global Competitiveness in Compleses

Additionally, the interest group intends to formalize the method of negotiations between enterprises. They examine to discuss conflicts of interest between those involved regularly, and plan to make organizations for conducting negotiations well in order to advance business cooperation smoothly.

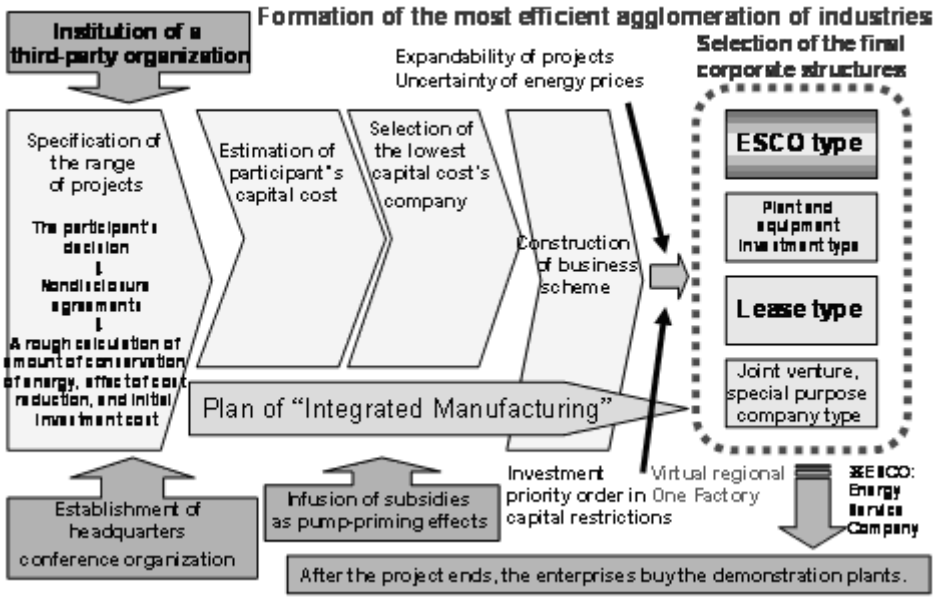

Figure 10 Formation of the Most Efficient Agglomeration of Industries

5 Conclusion

Oil and petrochemical companies in Japan come up with the idea of integrated manufacturing to gain global competitiveness. In addition, this way has various effects and the meanings. Especially, there is an important meaning that this would ease control by market mechanism.

The headquarters one-sidedly draw up neither the business plan nor the production plan. Neither the price nor production might be controlled by an international market. The cooperative relationship by group operation is a method of pursuing for such a new economy. It is the management separating

system though businesses are integrated. Various resources would be used by negotiations through the network of the producer, the consumer, the local government, and the resident, etc. It contains the policy of the overall distribution of various resources, the growth rate, investments, the energy consumption, transportations, and the plans of sustainable development and environmental protection. Definite variables of economic activities are systematically decided by the decision making organizations adapting to the level of district, local, national, and international. Detailed plans are decided at each level based on discretion. In the process of all the discussions, the idea of whole optimization will occupy the center of business plans and policies. As a result, the whole optimization is prior to the partial optimization. And social necessities may decide the plans that what and how much you produce. On competition by individual firm and requests of international market, enterprises will be deprived of the authority to make decisions that what and how much you produce. In pursuing the economies of integration, the decisions can be regularly exercised. In such a meaning, the regional, joint manufacturing body has the right to make decisions of the investment. It is not a top-down type from the headquarters in each company, but a bottom-up type from the agglomeration of factories in regional zones. In the same way, the price will be set not by decision in headquarters, but the unit cost of production based on inputs from consumers, customer, and regional profit groups etc. However, such a production method doesn't adjust to all industries. This should adjust to the goods, close to the employment and development of regions, such as food, health, medical treatment, medicine manufacture, education, transportation, energy, product necessary for living etc. On the contrary, consumer goods、luxury goods etc. should be controlled by market mechanism. The joint production of many interests firms seems to require the complicated and troublesome administration and organization. But the scheme of joint business operation would be used, if the form of administration and organization is constructed once. In doing so, actual complication of interests adjustment could be standardized.

Which system would be superior in the cost and time spent on administration and organization? There might be more wasteful spending in system on the premise of individual firms than system in group operation, when individual firms, which are influenced by market, would be aimed at partial optimization. There is no evidence that the system in group operation would spend in the cost and time more than the system on the premise of individual firms.

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