

Communication Network Systems for Competitiveness: the Japanese World Class Manufacturing Case

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[Abstract] The functioning of the communication systems has been thought as one of the most important management and operating processes for the firm's competitiveness. This paper is trying to identify the communication systems' structure which leads to high competitiveness, from the positive analysis of the Japanese World Class Manufacturing companies. The "linkage" structure throughout the firm from the strategic or innovative communication phase to the operational communication phase has appeared. We inquire into the determinants of the structure. The process of forming the structure is proposed hypothetically based on the analysis. we also provide the implications for modeling the structure by the system simulation like System Dynamics, the problems to be challenged and potential managerial meanings we could obtain as the result of it.

1. Communication systems as a basic determinant for competitiveness

What BPR tells

The firm, as a composition of people, is a complex of numerous activities of an individual, their groups and their totality. Management of the firm deals with a complex web of such activities, each of which stems from the information processing including information exchanges and development of thinking by the activity units. As a result of it, management is destined to suffer from the limitation of their information processing capabilities, which might be called "bounded rationality" (March and Simon 1958).

The concept of the bounded rationality is reasonable in general, but there exists a lot of firms which could escape from the constraint imposed by the concept to the extent that they could be called "excellent" or "more competent" relative to other firms. The concept may have a connotation that there prevails the malady of which cause is reduced to the fact that the firm consists of human beings and their groups with the constrained information processing ability, and from which the firm suffers more or less. The important managerial assignment to the firm is how to correct the actual deviation from the optimal point under the immunity from the malady.

Communication, given IQ or DNA quality endowment, is one of the most important determinants of the effectiveness of the information processing of which results are decision-makings and actions. Communication includes not only conveying data or facts which indicate what the situation is, but also implying the contextual message how the situation they tell is important, for example, to the firm. For instance, just putting a report in the tray to be processed sometimes fails to invoke the concerns of the particular persons who could handle the situation to turn out not in time for satisfactory response.

Communication includes the contextual elements which are concerned with receivers' interpreting messages, creating a plot or scenario and triggering actions, as well as the transmission of data and facts. They are the elements for "understanding". Important managerial concepts like coordination, sharing of information and values, fusion and creation of ideas, just-in-time actions, plan-do-check-action cycle, etc. are all dependent on the quality of communication among people in the organization.

Business Process Reengineering, born in USA, puts its emphasis on "business process" to renovate the weakened firm (Hammer and Champy 1993). BPR, however, could be viewed from the point of restructuring communication power. Their many suggested prescriptions might be interpreted as follows.

(1) If you find the symptom of unfilled communication needs, first of all question whether the need should be met by activating communication among people. Sometimes you can eliminate the communication among them as unnecessary. One efficient way is to break up the present division of works and let one person or least people do all pieces of the total work. Unnecessary creation of needs of communication often a big source of troubles.

(2) If you face the problem due to the poor communication compared with the requirement level of it, then raise the communication efficiency by using IT or by providing with the focuses of communication such as clear goals and visions, which facilitate convergence of communication.

(3) If you need creative ideas, then make maximum use of human resources' synergistic effects by minimizing barriers of communication such as narrow professionalism, cultural and social factors that hinder free and open communication.

Those prescriptions will improve "correctness", "speed", "timeliness", "coverage", "coherency" and "creativity" of the firm's communication system, leading to the leaped competitiveness of the firm.

They emphasize BPR is a kind of radical or renovate efforts. Indeed changing communication styles or manners, especially in the case of going into the stage of (3) which concerns with deeper and important behavioral aspects, but will be more resourceful in outcome, is difficult. It tries to touch and change the basic property of the organization.

Activated Communication Leads to High Competitiveness: The Japanese World Class Manufacturing Firms' Case

As a first basic hypothesis we propose "the more activated the firm's communication, the higher the competitiveness". The degree of activation of communication could be measured by various ways. Here we use the measure of degree of communication evaluated by the relevant people in specific but representative communication phases covering most of the firm's business activities in terms of the Likert scale from 1 to 5 (1: lowest, 5: highest communication). These scales are rather subjective, that is, if a particular person says "5", it means it's very satisfactory and the maximum communication level to him or her is perceived to be attained there.

We have picked the 13 communication phases up for the measurement. They are as follows.⁽¹⁾

(1) Communication on the factory floor: the degree of communication among workers, managers and other relevant people to achieve production on the factory floor. The higher, the better, since there is more probable for them to talk and consult with relevant persons to solve any problems.

(2) Supportive communication for the floor activities: the degree of information availability to working on the floor which is provided by supporting managers and staffs. The proximate location of production engineers to the floor and the availability of well updated manuals are examples of such provisions.

(3)Communication in the form of training and education: the degree of educational communication to workers. Knowledge and prerequisites workers should be equipped with will be supplied by such communication styles.

(4)Feedback communication to the floor: the degree of the performance information fed back to the floor by which the workers could find their problems and excellency based on which there would emerge awareness of their activities being attended and learning opportunities on the floor.

(5)Invisible communication of "trust": the degree of trust in the organization which is held by individuals. This invisible communication could be an important catalysis for well functioning of works.

(6)Cross functional communication for daily operations: the degree of communicative relations between different functions. Its activation could enhance the problem solving ability and bring about more effective cooperative actions beyond the boundaries of functions.

(7)Cross functional communication for development: the degree of communication across functions for developing products or processes. This phase is more purposeful and ad hoc when compared with (6).

(8)Communication in the form of short-term plan: the degree of effective functioning of short-term plans. The plan is one of communication phases and styles. This is more formal communication.

(9)Communication in the form of long-range plan: the degree of effective and respectful functioning of long-range plans. When the long-range plan is made to be ignored, we can not say it's activated.

(10)Communication between corporate and business unit: the degree of top management gets familiar with business units and takes care of their problems from the integrated viewpoint. The higher, the more the corporate functions as an coordinator.

(11)Communication with customers: the degree of cooperative communication with customers. The more activated, the more effective the development of products, etc.

(12)Communication with suppliers in logistical aspects: the degree of communicative relations in achieving production and delivery efficiently in the current operations with suppliers. The higher, the more efficient the operations.

(13)Communication with suppliers in research & development: the degree of communication when developing products and processes with suppliers. The more activated, the more speedy and effective the development.

Fig.1 exhibits the three sampled industries' activated degrees of the 13 communication phases. The similar patterns emerge, indicating common feeling of difficulty of the activation of communication in particular phases. Fig.2 shows the levels of the two groups, the higher than average and the lower than average groups. Firms of the two groups are picked up from each industry by comparing their average scores over the 13 phases with the corresponding average of each industry to make adjustment to the differences of the averages of the industries. We can find a clear parallel gap between the two groups, even though they are WCM firms.

When looking at management of any firm, even if it is categorized "WCM" or "excellent" like black and white, from the viewpoint of communication, you could discern their differences so that you could know "any firm is unique". It means the factor of "communication" as a management research ingredient contains rich information to know

Fig.1 The activation level of communication of the three industries

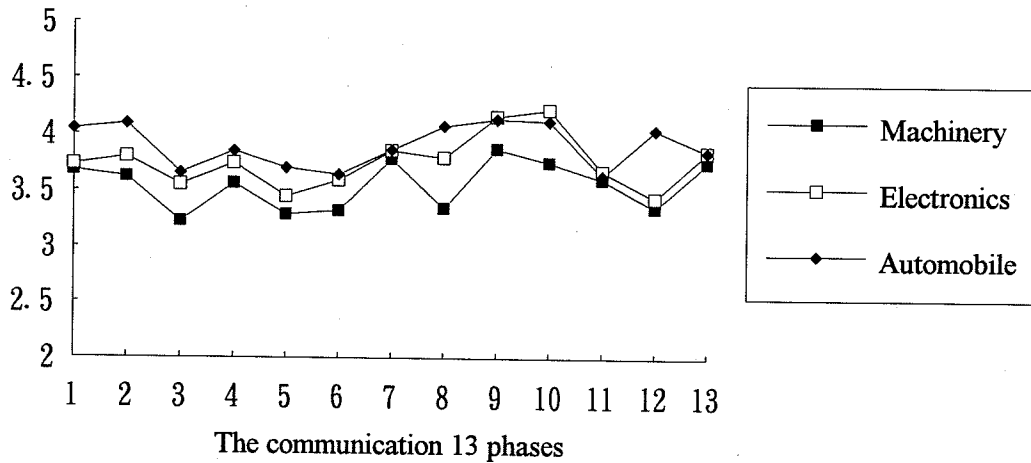
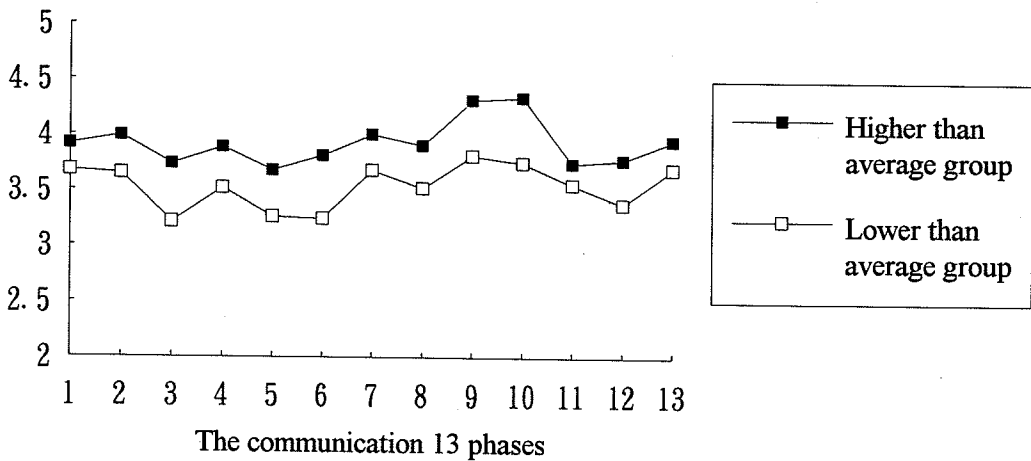


Fig.2 The activation level of the two groups



- 1:Communication on the factory floor
- 2:Supportive communication for the floor activities
- 3:Communication in the form of training and education
- 4:Feedback communication to the floor
- 5:Invisible communication of "trust"
- 6:Cross functional communication for daily operations
- 7:Cross functional communication for development
- 8:Communication in the form of short-term plan
- 9:Communication in the form of long-range plan
- 10:Communication between corporate and business unit
- 11:Communication with customers
- 12:Communication with suppliers in logistical aspects
- 13:Communication with suppliers in research & development

and evaluate management.

The parallel gap between the two groups in Fig.2 indicates that there is the activated communication climate that extends all over the organization's communication phases. That is, the communication climate is the concept of general communication propensity which is not limited to particular phases of communication. We can hardly say that we have a good communication in R&D or the production floor, but it's bad when it comes to the planning system, etc.. In the case the comparison with other firms having significantly higher communication climates will show that even that phases' activation levels may not be higher than those of the firms. The parallel gap suggests there could be the interactive force among the 13 phases, that could contribute to the development of the communication climate of the organization as a whole as well as the activation level of individual phase. If the communication climate has certain effects on the firm's competitiveness, then it could be one of important research targets to obtain some insight into competitiveness, for example, its structure, construction and normative implications.

Fig.3 shows some often adopted competitive measures marked from 1 to 5 (1: weakest, 5:strongest), evaluated subjectively by the plant manager of his main businesses, of the two groups. There are not-small gaps in all competitive measures, that are positively related with the gap of the activation level of communication, or the communication climate. The hypothesis mentioned above, though the degree of significance may differ depending on the measure, could be confirmed. Table 1 shows the values of the competitive measures of the two groups. One notable implication from Table 1 is that the communication climate is more important and critical in the speed of new product development, manufacturing cost, product performance and quality, which are most important in the present global competition. Furthermore the goal to raise the competence of new product development or of manufacturing cost is more difficult or challenging than the goal of improving the capacity of on-time delivery, in terms of the management task to make the communication climate more activated.

2. The structure of the communication system of the Japanese WCM

The emerging communication structure of the Japanese WCM

The parallel gap which appeared in the Fig.2 suggests that there may be certain relationships among the 13 communication phases, which have influences on the degree of the activation of the communication climate. If a certain set of the relationships contributes most to the activation level, the set could be viewed as the desirable target for designing the communication structure for competitiveness.

Fig.4 exhibits the structural composition of the relationships of the 13 communication phases. The structure is the result of the cluster analysis of the 13 communication phases in terms of the activation level marked from 1 to 5 of each phase.⁽²⁾ The relationships enclosed by the bold real lines indicates the most correlated, in other words, most proximate phases among the phases. For example, when the communication between the business unit and the corporate is activated, the long-range planing is also activated.

The other enclosures by the bold lines are found in the area of working on the floor level and also in the area of supply from external suppliers. The communication on the factory floor, the communication of trust and the feedback communication to the floor compose one aspect of the total climate with their proximate relationships. When you try

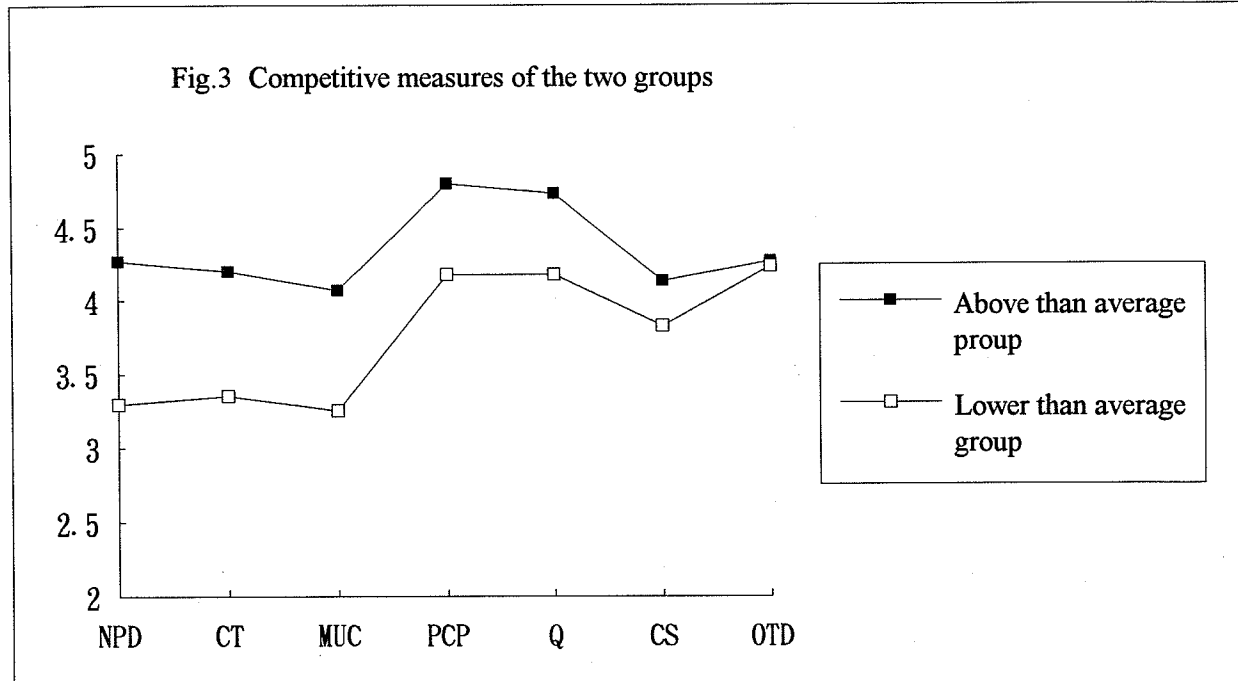
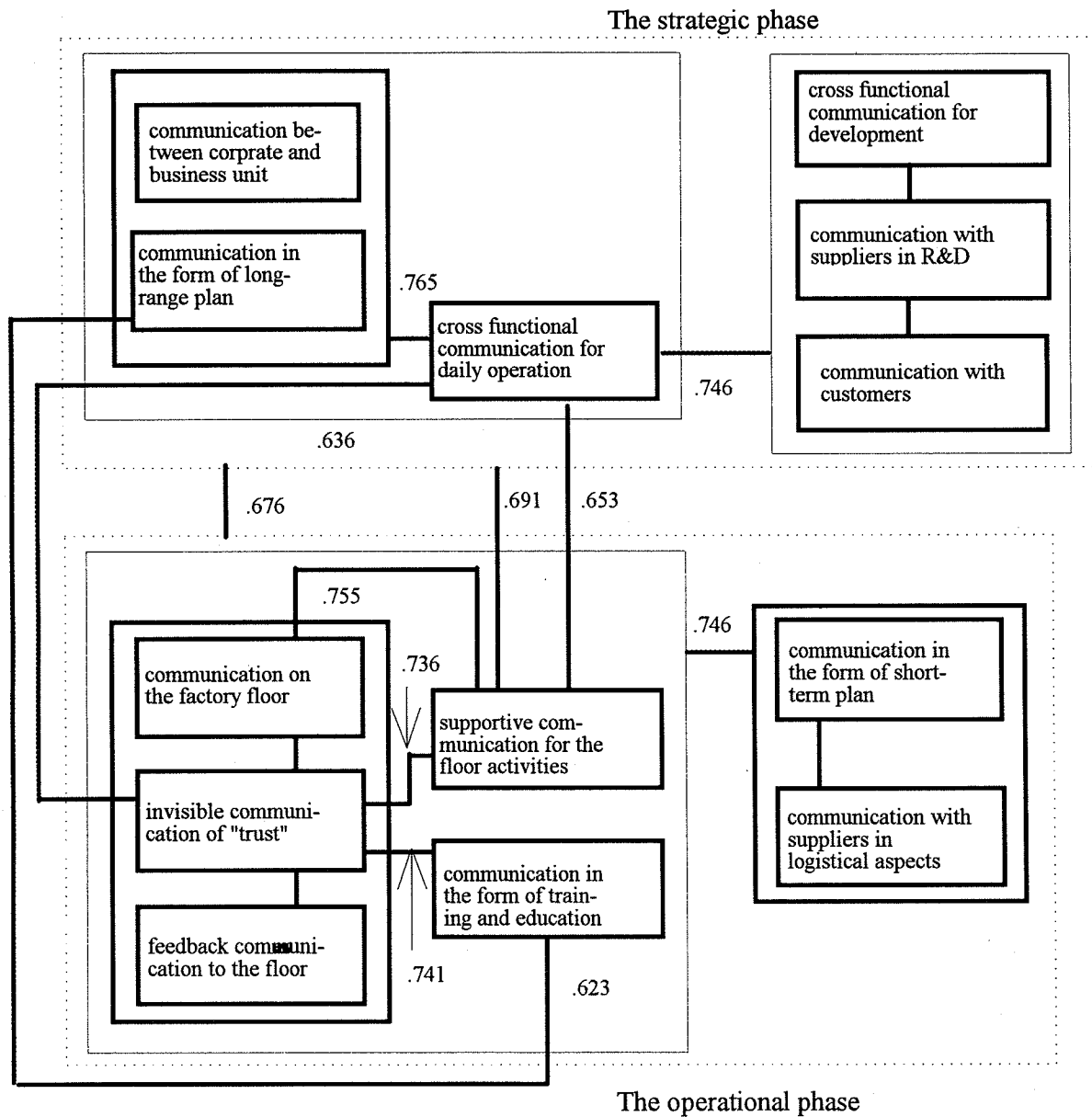


Table 1 Comparison of the competitive measures of the two groups

	Above than average proup	Lower than average group
Manufacturing unit cost (MUC)	4.07	3.25
Quality (Q)	4.73	4.18
On-Time delivery (OTD)	4.27	4.24
New product development speed (NPD)	4.27	3.29
Product capability & performance(PCP)	4.80	4.18
Customer Service (CS)	4.13	3.82
Cycle time from procurement to delivery (CT)	4.20	3.35

Fig. 4 Construction of the communication phases



enhanced by the most extended linkage with all communication phases being activated due to their interdependency on the final outcome of the firm.

(3) The linkage structure indicates the gearing of the strategic system and the operation system: the entire linkage consists of the two sub-linkages. The strategic linkage concerns with the corporate long-range planning and the development of new products and processes. The operation linkage supports the effective operations. The linkage of the two systems each of which also has the linkage structure of relevant communication phases, means the total linkage of communication phases, from strategy to operation, that could be described as the activated communication climate of the firm.

(4) The linkage structure should contribute to the firm's final competitiveness as the linkage extends: the extension of the linkage could be realized if the dominant perspective of management and operation, which might be held by management and/or line people, could be expanded beyond tasks and functions along the sequence of interdependencies of them leading to the final outcome. The extension of the linkage has been continued since it has been effective to improve the firm's competitiveness. The important point is the linkage should be achieved along the logical sequence which is effective to the firm's competitiveness. The linkage structure as shown in Fig.4 tells such a logical sequence.

3. Implications for building-up of the linkage structure

The structure as exhibited in Fig.4 looks persuasive to explain the Japanese WCM firms' management behaviors, with the help of discussion results about the structure with them. Their responses are affirmative in the sense that the structure seems to successfully epitomize what they have achieved aiming at strengthening competitiveness regardless of their explicit consciousness of the structure.

When summarizing their experiences and conducts building up the linkage structure which is essential to achieve a series of activities with the firm's goals in mind, we can extract some implications to construct the model of building up the linkage.

(1) Communication is activated by the successful cycle: even if management persuades employees to communicate well with relevant people in order to improve their performance, such as cost reduction, if the result of it is poor, they are not motivated to do so next time. But if the result turns out better, they easily understand it's effective and try it again or more. The motivation to communicate is a basic booster of quality and quantity of communication. The motivation is strengthened by the positive feedback of the result.

(2) The successful cycle should be planned: the successful cycle does not appear spontaneously. First of all we need "a success" or "a confidence or scent of it" as the starter. It is only realized by the well designed planning cycle, that is, the Plan-Do-Check-Action cycle. Then we have to associate the success with the motivation for next actions. No firm of the Japanese WCM takes, for example, the small group problem solving activity and QC circle activity on the floor as a voluntary or spontaneous grass root activity among workers. They are all designed well and implemented patiently by the devoted management so that they could lead to real outcome by invoking productive communication in various forms, within workers, between them and management, cross functions and departments.

to activate the communication relevant to working on the floor, the three communication phases should be considered together. The last enclosure gives us an interesting implication. That is, when improving the communicative relation with external suppliers, you have to make the short-term planning that can be implemented and effective internally.

The next enclosure level by the real thin line indicates a set of weaker proximate relationships between the phases than the enclosure by the bold line, but still composes a set of relatively strong relationships between the phases. We can find the three sets at the level. The decline of the strength of relationship is due to the fact that some firms fail to keep the same level of positively interactive relationship among the phases as the level in the set enclosed by the bold line.

The three enclosures at the secondly proximate level are indicative of the three basic functions, namely, the long-range planning, the development of new products and processes, and the production operation. We can say in the Japanese WCM companies, the total communication system is composed of the four communication subsystems each of which consists of mutually proximate or positively interactive communication phases relevant to each function.

When we go to the next level, that is, further weaker proximate level, all subsystems are put into the two basic subsystems, the strategic system and the operating system. The strategic system includes the former two functions, the long-range planning and the development. The operating system consists of the latter two functions, the production operation and the physical supply. The two systems are the enclosures by the dotted line.

The last enclosure, the total communication system, would contain the two enclosures. The structure of proximate relationships of the communication phases, that is, the positively interactive relationships between the phases, could explain the existence of the parallel gap over all communication phases. In other words, the existence of the structure gives birth to the parallel gap which turns out to be the different degree of the communication climate.

What the structure implies

The structure shown in Fig.4 brings about interesting implications. They are summarized as follows.

(1) Competitiveness is a combined effect of total phases of communication of the firm: theoretically every function, if it's necessary, has to be achieved "best" to attain the firm's global optimum. The best combination of each functioning could be realized only by the best arrangement or coordination of them. It does not necessarily the sum of the simple local optimal activities. Communication could be one of the most influential elements for the best coordination that could bring about the "best" functioning of each function. The activation in all communication phases will make it easy for the firm to achieve the total coordination well.

(2) The activation of all communication phases emerges with the structure formed by the positively interactive relationships among the phases, which could be characterized by the concept of "linkage" or "gearing": when certain phases are recognized having certain interdependency among them, of which coordination invoking the activation of each phase determines the goal achievement, the linkage of them emerges in the form of mutually responding relation. The firm's outcome at the final stage, therefore, will be

(3) The high communication climate is the result of the linkage of the communication phases accompanied by the broader management perspective: the activation of communication as a whole is enhanced as the linkage of activated communication is created where the local activation of each phase forms interactive or cooperative relationships with the other phases to achieve higher effectiveness to the firm under the broader management perspective. The local activation is facilitated by the local effort to improve the local performance, but the positive interactions between the phases raise each activation level more compared with the case of only local effort. The activation in a particular phase is facilitated by the demands from the other relevant phases, which are felt important to achieve their missions and performances given the understanding of the goals of the firm by its interdependent relationships with them. The management and people relevant to the phases should have the broad perspective or awareness to understand the effectiveness of their works on the total goals of the firm as well. It comes from their sharing of the firm's goals. The broad perspective could motivate them to cooperate with the needs from the others.

(4) The complementary contribution of the strategic phase and the operational phase to the firm's competence is the source of long-run activated communication climate: the communication climate, which is supported by the success cycle, can be maintained by the sustainable success of the firm. The sustainability of the firm's success depends on the synergistic effectiveness of the strategic phase and the operational phase. The most important function of the strategic phase concerns with the creation of innovations and leaps in the framework of firm's activities. The development of new products and processes is one of the most important ones. On the other hand the most important function of the operational phase includes typically the improvement of existing products and processes. The total linkage depicted in Fig.4, from the strategic phase to the operational phase, suggests the complementary contribution of the two phases to the firm's or business competence could work like in Fig.5.

Fig.5 indicates that the contributions of the two phases sustain the firm's competence like cost competitiveness in a complementary or reciprocal way. The leaps in the stepwise line mean the contributions from the strategic phase and the monotonous but diminishing increasing line segments show the contributions from the operational phase. When the improvement of the operational phase is going to reach to its less efficient stage, the contribution of the strategic phase like a new model introduction or innovation including such as a change of the design concept and technology emerges with the help of the information or suggestions communicated from the operational phase and at the same time shunts the improvement rail to bring in a new opportunity for the improvement of the operational phase.

No merge, on the other hand, will not be able to achieve the same levels of enhancement of competitiveness as those in Fig.5 at each phase, since it means that the two phases do not correspondingly or constructively interact with each other, that is, less linkage.

The linkage of the contributions of the two phases indicates that the innovation relevant communication network should not be completely independent of the operational communication network in the sense of the contribution to the firm's competitiveness, which fortifies the firm's total motivation if they can share own and their achievement. Usual saying that the operational function is conservative and the innovative function is

progressive suggests that the conflictive and independent relationship prevails. Of course there must be differences between the two functions in terms of their activities and factors involved in them. But it does not mean that they are conflictive or confronted.

The linkage seems to emphasize the "continuous innovation" too much. The firm could not enjoy the breakthrough leap. But the observation of large electronics companies hints the linkage could be a catalysis for the breakthrough type innovation. They mostly own the kind of research and development institute in the field of production. The institute has a close contact with the factory personnel including high skilled workers through the daily problem solving on the floor and the development and improvement of existing and new process machines. It also has cooperative research projects with the genuine R&D institute. It functions as an intermediary to implement technologically more advanced innovations effectively. The linkage includes such a communication function. Then the linkage contributes to a great extent to the breakthrough type innovation.

(5) The interactive linkage structure may work to accelerate the decline of the communication climate when either phase fails to achieve the mission implicit in the reciprocal relationship: the firm may experience either phase's low performance, or sometimes both, due to the maturity of the market, the unexpected environmental impact like the drastic up-valuation of Yen, etc.. It may invite the vicious cycle through the interactive relationship. No response from either phase gives the negative impact to each other, which may be weak under the less interactive relationship structure. A kind of the domino effect happens. Therefore the linkage structure through the interactive relationship functions as a multiplier in the negative or positive direction. The point is to maintain the positive multiplier effect as possible.

(6) The positive multiplier effect will reduce the degree of strategic threats like new entries or more competitive products and also build up a formidable strength over the product life cycle: the firm could reduce the degree of strategic threats by the steady and effective improvement of competitiveness without an emerging threat by the linkage between the strategic phase and the operational phase because the entry barrier would become tougher to potential competitors. Further over the product life cycle they create necessary competitiveness in the measure like cost, quality, cost performance, etc. and can attain the first class position in the market. We can find a lot of the cases where the innovator could not sustain its favorable position over the long-run, which is too oriented to the strategic phase disregarding the multiplier effect by the linkage.

(7) The interactive total linkage communication structure could be a basis for the organizational learning: the total linkage would give the basis for the firm to realize the learning. The management cycle is a mechanism by which the learning could occur in the firm. It holds among the Japanese WCM firms. The random walk process is not expected to invite the learning but the knowledge that it brings about no memory or nothing. The total linkage means that the firm can have the good conduit into which the distortion, for example, of conducts, creeps due to less communication, through which the organizational learning occurs. It determines the right interpretation of the right people, which is a starter of the learning. The total interactive linkage creates the convergent alignment of activities toward the firm's goals through the effective communication. The quality of the conduit is enhanced by the constructive linkage of the necessary communication phases.

All these findings or hypothetical arguments are based on the linkage communication

structure extracted and the discussions with people of the WCM firms. In sum the real competence is derived from the fusion or linkage of the innovative phase and the operational phase. The two phases should not be conflictive each other or in the trade-off relation, but complementary. The degree of the complementary relationship between the two basic elements of the communication structure determines the degree of the total linkage of the communication phases, that leads to the firm's competitiveness.

Only the activation of the operational phase, of which results are the QC circle activity, the lean system, the JIT system, etc., as the literature have pointed out as the source of competitive strengths, could have not achieved the real competence. The success cycle in the operational phase would have reached soon to the saturation without the complementary contribution from the strategic phase. Also only the strategic phase could not have achieved well without the help from the operational phase. Because the former would have felt responsible for the total load and then had to develop the more innovative products or ideas than otherwise, without less information from the operational activities on the floor and the market. It must have been so overloaded that the strategic phase could have hardly achieved the duty. The success cycle would diminish in the firm. The communication climate would decline.

4. Modeling of the communication structure of the firm for competitiveness

The aim of this chapter is to provide a perceptual model of the communication structure of the firm based on the analysis of the real Japanese WCM. This kind of model is expected to give much insights into designing and managing of the communication structure, which is one of the most important factors to raise competitiveness.

The three basic sectors of the model of communication systems for competitiveness

The total communication model consists of the three sectors, the performance sector, the organizational perceptual sector, and the organizational motivation sector. Fig.6 shows the three sectors with their component processes.

The performance sector explains the communication linkage process of the communication phases leading to the firm's performance. Fig.7 proposes a model of the process by the relationships of the phases. This process is hypothetically extracted from the analysis of the correlation coefficients among the phases in the higher than average group of the Japanese WCM firms. In the model the performances are the innovative (strategic) performance like new product introduction and the operational performance. Improvement could be included in the both performances. The competitiveness of the firm is determined by the two performances. The resulted competitiveness goes to the organizational perceptual sector.

Every organizational member, not limited to top management, could have his or her own perception of the performance. Based on the perception he or she could have his or her own goals and expectations which he or she feels should be met by the others such as top management, R&D researchers, marketing people, production people, etc.. The perception of each member includes each person's satisfaction with his or her performance, relevant people's cooperative responses and their contributions as the result of communication activities. The organizational perception plays the two roles of initiative and reactor in the next model of the organizational motivation formation.

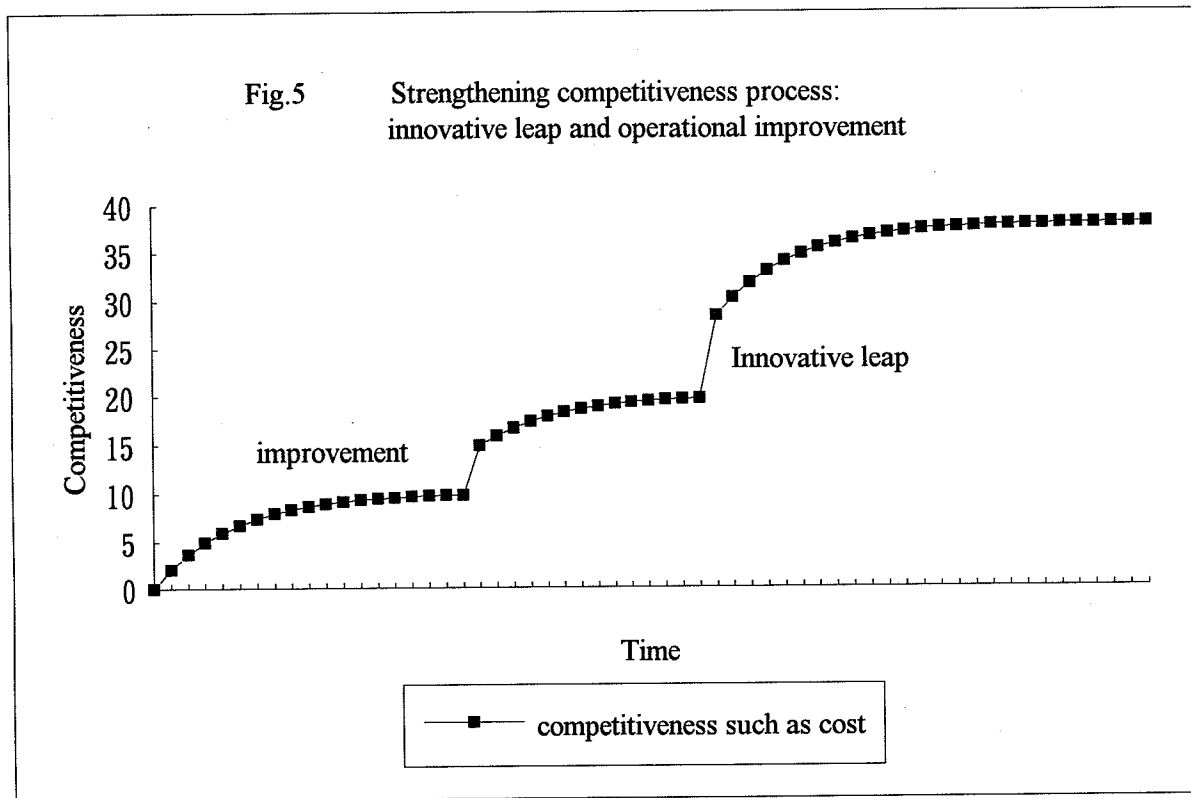
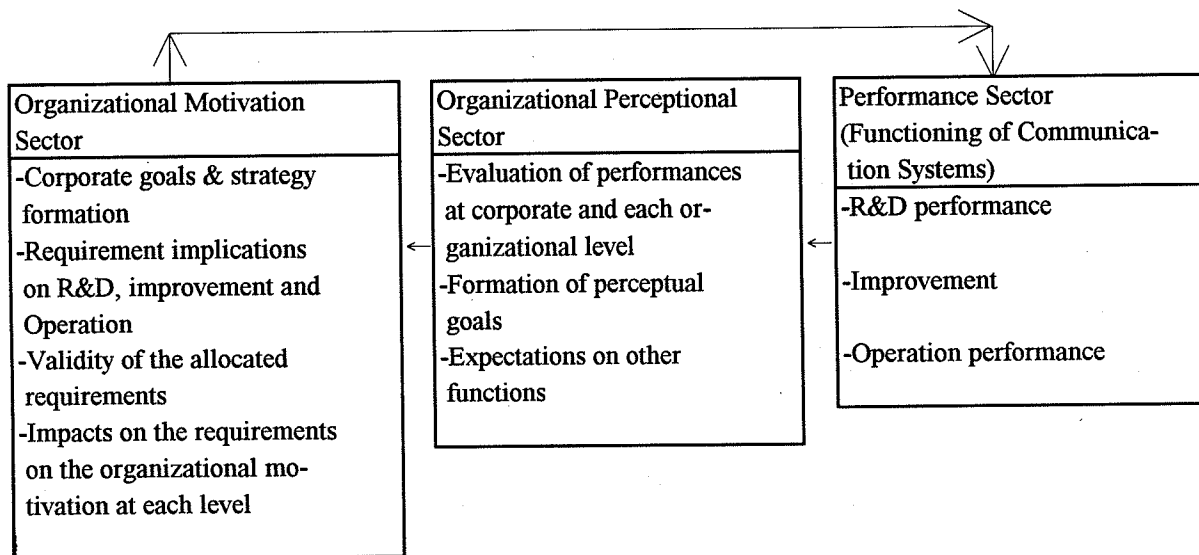


Fig.6 The three basic blocks of the communication model



The organizational motivation sector concerns with how next organizational goals and plans are made and how people in the organization react to them in terms of their motivation for next activities. If they feel too loaded and powerless for the agenda or given no promising opportunity to develop and challenge, the goals and plans set would be hardly respected. Furthermore their motivation would be discouraged. The feel of fairness of load and opportunity, which comes from the comparison of the implications in the next goals and plans with the perceptions on the past performance, is one of the most important conditions to determine the motivation level.

We have extracted mostly the relationships in terms of the communication phases in the performance sector from the Japanese WCM firms' data. The underlying motivation structure has to be hypothesized from the structure appeared in the data and the discussions with the firms based on the extracted structure. Their responses to our model have been confirmative. Their evaluation is that the model looks to be a summary of what they have done even without explicit consciousness of the total structural logic we have presented to them.

The reason why the total model has not been recognized explicitly is that the linkage structure of the communication phases has been formed based on the local positive interactions between the relevant or functionally related communication phases perceived, especially by the relevant management with the perspective for posting their works and performances in the relationships with the other functions or departments as well as the total firm's goals and performances. There are many top managers who know the firm's all works should be integrated well to achieve the goals, regardless of weight differences put on the works. But the point is how they achieve the integration. No one, probably, could design what each work should be specifically coordinated and done in advance. The linkage built up by expanding the local positive interactions suggests such a realistic approach to the integration. "Acting locally and thinking globally" concept is suggestive in this point(Senge and Sterman 1994).

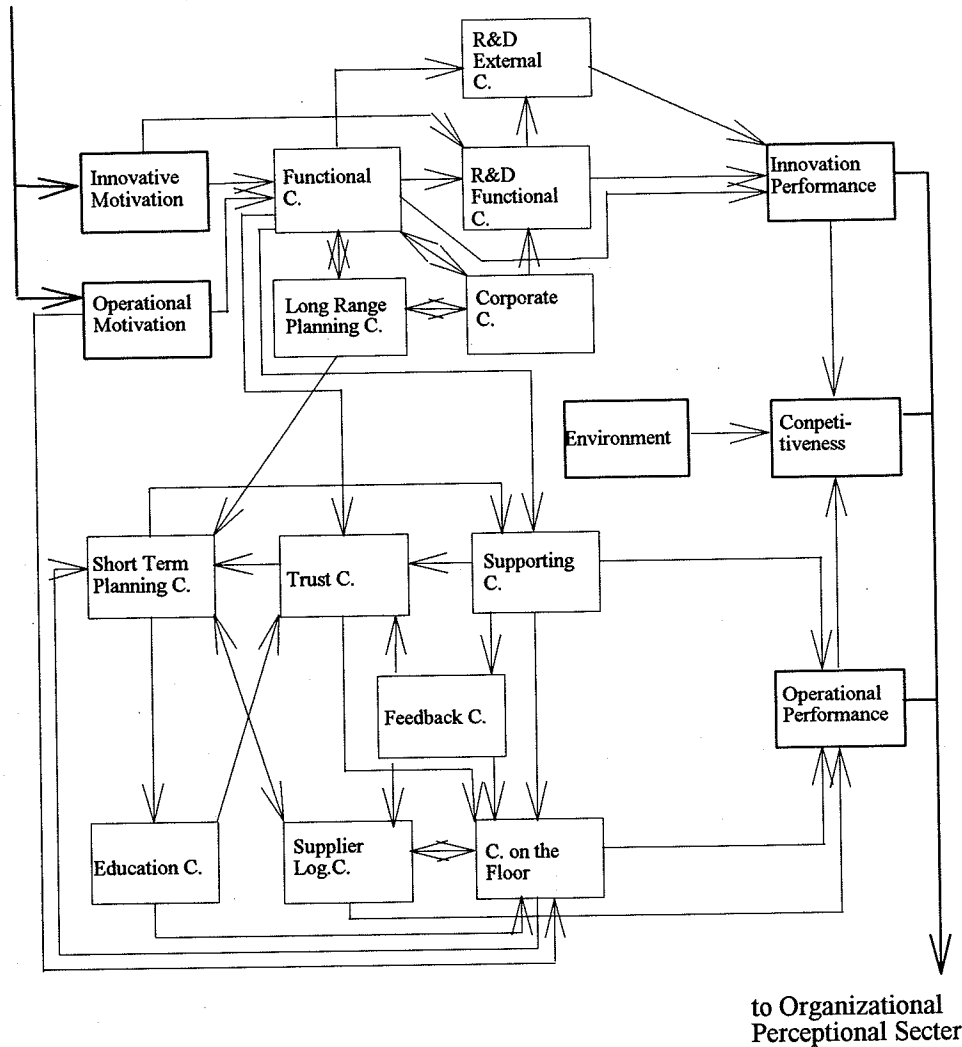
Implications for SD modeling and meanings from the modeling analysis

The relationships among the communication phases in Fig.7 of the performance sector is still a hypothetical one, which is derived from the data analysis and the discussions with the firms' people. There work the two processes in the structure. The strategic, or innovative processes depends on the 5 communication phases, the communication with corporate, the long-range planning, the cross-functional communication in the daily operations, the cross-functional communication in R&D, and the external communication in R&D to achieve the strategic performances like new product introduction and other innovations or large changes. The second process consists of the rest communication phases of the 13 communication phases. The process determines the operational performances like production volume, cost, quality, delivery, etc..

The difficulty of modeling this process is that we have to cope with the interactive relationships. The interactive relationships indicate the need to think of the process dynamically to understand properties of the process, though we should be ready to tackle with the problem of "chicken and egg" cycle relationship. Furthermore when we discuss with people of the WCM firms, the problem is that we may not be able to define the relationship by the predetermined t and $t-1$ recursive notation which is familiar in modeling the dynamic system. In other words, for a particular period one phase works

Fig.7 Performance sector model

from Organizational Motivational Sector



to Organizational Perceptual Sector

- C. on the Floor: Communication on the factory floor
- Supporting C.: Supportive communication for the floor activities
- Education C.: Communication in the form of training and education
- Feedback C.: Feedback communication to the floor
- Trust C.: Invisible communication of "trust"
- Functional C.: Cross functional communication for daily operations
- R&D Functional C.: Cross functional communication for development
- Short Term Planning C.: Communication in the form of short-term plan
- Long Range Planning C.: Communication in the form of long-range plan
- Corporate C.: Communication between corporate and business unit
- R&D External C.: Communication with customers + Communication with suppliers in R&D
- Supplier Log. C.: Communication with suppliers in logistical aspects

initially on the others, but it may be possible for the others initially to work on it next time. The reverse of the direction looks not systematic. The direction at one time unit, or DT, does not necessarily hold over time. Depending on the situation either direction will emerge. Therefore we can not predetermine the direction unless we could understand the process of one phase's working on the others and put the mechanism of the process in the model. It is not necessarily a problem of the determination of the length of DT.

The SD modeling has to go beyond the limitation of describing human beings or their groups as the communicator whose channels of communications and directions are fixed in the predetermined way like a mechanistic organization. The modeling of the processes of communication is the toughest task left.

Researchers or analysts often try to model the system by using the analysis unit such as activity units like consumers, households, management, etc. or functional elements like production, finance, marketing and their relevant variables like production volume, cash flow or price. But the relationships among them and those of them with the performances of the systems are assumed to be the same throughout the analysis period. The sensitivity analysis and what if question type analysis are supplementary techniques for the rigidity of the model.

The assumption of the constant level of communication among the relevant units, however, is the most significant limitation of such modeling. The short of the modeling of the communication processes could not consider the real dynamism of the firm, especially the excellent firm's structure. There could be a wisdom saying that we should try the modeling only in clear or restricted areas. But on the other hand we can expect the modeling to give a means to make a research on the communication process of the firm. Also based on the hypothetical structure which could be put in the model, we can test the validity of the hypothesis on the communication mechanism which has been pointed as one of the most important sources of competitiveness in the literature. The linkage structure, extracted from the analysis of the Japanese WCM firms, could be a hypothesis on the desirable structure of communication systems, to be tested by the modeling. But it's still far from it. There are much unknown remained to be ascertained for the purpose and also less supporting methodology only with voiced arguments boosted by publishing companies.

Managerial Insights expected from the modeling

The modeling by the system simulation technique, for example SD, of the communication linkage structure leading to competitiveness is indeed difficult. But let us think of the managerial benefits or insights from the modeling analysis.

The first benefit is that the modeling itself can give an opportunity to pay its attention to the communication performance which could be ignored often. What factors are ruling the communication mechanism within the company? What dominant loops work to determine the firm's performances? The structure like extracted from the analysis of the WCM firms may give a kind of the structural bench marking reference to evaluate its own structure. The bench marking is sometimes carried out with the factors being compared independently without any structural framework. Such mere comparisons over each factor will say nothing on the meanings of the structure. The modeling trial

perhaps will trigger them to check closely the communication system due to the poor data availability on such aspects.

As the second benefit, the model, if completed, could give the firm certain information for the resource allocation or managerial activities based on the characteristics of the communication system's structure. For example, the analysis of the model may make it possible for the firm to make the decision on where or what aspects it should emphasize to put its managerial emphasis. The innovative activities or R&D ? Or the operational improvement? The discussions with the randomly sampled firms besides the WCM firms based on the results of the analysis of their communication activation levels reveal their real managerial problems. Even the qualitative model as implied in Fig.6 could show what their managerial problems are to them based on the insights of their communication levels, assuming the levels reflect people's motivational levels. By introducing the communication system factors into account we could obtain much managerial insights into the underlying behavioral characteristics of the firm. The coping with them could invoke more effective management for competitiveness.

5. Conclusions

The communication systems or networks determine the firm's real competitiveness. The activities appeared sometimes become the target of remedial management actions. The management or person in charge of the mall-function is removed or fired easily. If the next person is talented, he or she may improve somewhat. But the real problem which could be removed remains the same. We may lose the opportunity to strengthen the firm.

The most distinguished property of the communication systems in the Japanese WCM company could be called the "linkage " structure of the various communication phases from head to foot. In other words, it means the linkage of the innovative phase and the operational phase. They are mutually dependent to complement each other to create the firm's competitiveness. The most important communication phases to make the structure are the cross-functional phases in the daily and R&D activities. They invoke the "success cycle" by their committed plan and behaviors. Also they have the broad perspective on their functions beyond their functional boundaries supported by their understanding the firm's goals. Their conducts proceed in the way that the interdependent aspects interact with each other constructively to achieve their performances to be appreciated by the higher organizational level. This process, if successful, strengthens at each organizational member or unit level the motivation to cooperate and develop itself by communication. The strategic planning, the firm's goals to be formed and the allocation of resources reflecting them would determine the sustainability of the cycle over time through the mechanism of the interaction of the perceptions on the gaps of the self-appraisal at each organizational level and the organizational evaluation of the actual performances. We can often find some

The modeling of the communication systems and processes gives us an opportunity to obtain many insights into the basic dynamic mechanism determining the firm's effective behaviors. It could provide many management implications, which are essentially important and have been neglected due to the disregard of the communication mechanisms, to management to create sustainable competitiveness.

Note

(1) The question items composing the 13 communication phases are as listed below. These measures or phases have been tested by the Cronbach's α and the factor analysis for reliability and validity. The former cut-off value is .60 and the latter cut-off value is .50. All measures and question items have passed the test.

The sampled firms come from the three industries, machinery, electronics and automobile. The individual sample firm has been selected as the WCM(World Class Manufacturing) firm based on mostly the market share on a particular business or line of products and its business size in terms of sales volume as well as the other considerations such as general reputation. The machinery industry includes 12 companies, the electronics industry 12 companies, and the automobile industry 8 companies including parts manufacturers. In addition to them we also collected the same data from 14 randomly sampled firms from the three industries. The research is being done with the grants from Monbushou (Ministry of Education), Nippon Shouken Shougaku Foundation and Gakushuin University Computer Center Special Research Program.

All question items have been asked to averagely several people to avoid possible biased responses. Each company has selected one plant or factory the company thinks representing it for our data collection target. 26 people have been selected from the various functional and positional categories. They include Plant Manager (1), Plant Superintendent (1), Plant Research Coordinator (1), Plant Accountant (1), Human Resource Manager (1), Inventory/Purchasing Manager (1), Information Systems Manager (1), Process Engineer (1), Production Control Manager (1), Quality Manager (1), SupervisorsA (2) & B (2), Direct WorkerA (4), B (4) and C (4). The figure in the parenthesis stands for the number of people sampled. The value of the measures is the average over the respondents. The value is measured by the 5-points Likert's scale.

(1) Communication on the Factory Floor

- Departments in the plant communicate frequently with each other.
- Supervisors encourage people who work for them to exchange opinions and ideas.
- Supervisors encourage the persons who work for them to work as a team.
- Supervisors frequently hold group meetings where the people who work for them can really discuss things together.
- Managers in this plant believe in using a lot of face-to-face contact.
- Our plant forms teams to solve problems.
- We select employees who are able to work well in small groups.

(2) Supportive communication for the floor activities

- Written operating procedures are easily accessible to workers on the shop floor.
- Written manufacturing procedures are updated when processes are improved on the shop floor.
- It is difficult to change written manufacturing procedures, even when they can be improved.
- Our written manufacturing procedures are clear and easy to use.
- Actual operating procedures are very different from our written shop floor procedures.
- Managers are readily available on the shop floor when they are needed.
- Manufacturing engineers are often on the shop floor to assist with production problems.

(3) Communication in the form of training and education

- Plant employees receive training and development in work-place skills on a regular bases.
- Our workers are trained to reduce set-up time.
- We use a pay-for-skill knowledge system to reward workers.

(4) Feedback communication to the floor

- Charts showing defect rates are posted on the shop floor.

- At our plant, manufacturing is kept in step with our business strategy.
- Manufacturing management is not aware of the business strategy.

(11) Communication with customers

- Customer requirements are thoroughly analyzed in the new product design process.
- We frequently are in close contact with our customers.
- Our customers give us feedback on quality and delivery performance.
- Our customers are actively involved in the product design process.
- We strive to be highly responsive to our customers' needs.
- We regularly survey our customers requirements.
- Our customers involve us in their quality improvement efforts.
- Our customers can rely on us for quality products and processes.

(12) Communication with suppliers in logistical aspects

- Our suppliers deliver to us on a just-in-time bases.
- We receive daily shipments from most suppliers.
- We have long-plan arrangements with our suppliers.
- Our suppliers deliver to us on short notice.
- We can depend upon on-time delivery from our suppliers.

(13) Communication with suppliers in research & development

- We strive to establish long-term relationships with suppliers.
- Our suppliers are actively involved in a new product development process.
- We maintain close communication with suppliers about quality considerations and design changes.
- We work closely with suppliers in developing new process technology.

(2) The agglomerative technique adopted here is the Ward's Error Sum of Squares Method. The nearest cluster's cut-off distance is .67, the second nearest cluster's 1.0, and the third nearest cluster's 1.36. The figures near the lines connecting the boxes mean the value of the largest correlation coefficient attached to the relationship with the communication phases outside the cluster.

References

- Hammer, M. and Champy, J. *Reengineering the Corporation* : Harper Business, 1993.
March, J.G. and Simon, H.A.. *Organizations* : John Wiley, 1958.
Senge, P.M. and Sterman, J.D. Systems Thinking and Organizational Learning: Acting Locally and Thinking Globally in the Organization of the Future. J.D.W.Morecroft and J.D.Sterman(eds.). *Modeling for learning Organizations* : Productivity Press, 1994.

- Charts showing schedule compliance are posted on the shop floor.
 - Charts plotting the frequency of machine brake downs are posted on the shop floor.
 - I am never told whether I am doing a good job.
 - Information on quality performance is readily available to employees.
 - Information on productivity is readily available to employees.
 - Management tells us why our suggestions are implemented or not used.
 - Many useful suggestions are implemented at this plant.
- (5) Invisible communication of "trust"
- I talk up this organization to my friends as a great organization to work for.
 - I would accept almost any type of job assignment in order to keep working for this organization.
 - I find that my values and the organization's values are very similar.
 - I am proud to tell others that I am part of this organization.
 - This organization really inspires the best in me in the way of job performance.
 - I am extremely glad that I chose this organization to work for over others I was considering at the time I joined.
 - For me, this is the best of all organization for which to work.
- (6) Cross functional communication for daily operations
- At our company, manufacturing is centrally involved in marketing and engineering decision.
 - The functions of our firm are well integrated.
 - The functions in our company work well together.
 - Marketing and finance know a great deal about manufacturing.
 - Job design at this plant is closely coordinated with manufacturing.
 - Staffing, training and development of employees is closely coordinated with manufacturing.
- (7) Cross functional communication for development
- Direct labor employees are involved to a great extent (on teams or consulted)before introducing new products or making product changes.
 - There is little involvement of manufacturing and quality people in the early design of products, before they reach the plant.
 - We work in teams, with members from a variety of areas (marketing, manufacturing,etc.) to introduce new products.
 - We design for producibility.
- (8) Communication in the form of short-term plan
- We use both MRP and JIT for our production control.
 - The master schedule is level-loaded on our plant from day to day.
 - We usually meet the production schedule each day.
 - Our daily schedule is reasonable to complete on time.
 - We usually complete our daily schedule as planned.
- (9) Communication in the form of long-range plan
- We have a manufacturing strategy which is actively pursued.
 - We have a regular system of monitoring plant performance against formal criteria.
 - We have a well-developed manufacturing strategy in our plant.
 - Our plant is well-focused.
 - Our plant has a formal strategic planning process which results in a written mission, long-range goes and strategies for implementation.
 - The plant has a strategic plan which is put in writing.
 - The plant management routinely reviews and updates a long-range strategic plan.
 - The plant has an informal strategy which is not very well refined.
 - In our plant, goals, objectives and strategies are communicated to me.
 - I know how we are planning to be competitive at this plant.
 - I understand the long-run competitive strategy of this plant.
- (10) Communication between corporate and business unit
- Managerial innovations are transferred among plants within our corporation.
 - Our business strategy is translated into manufacturing terms.
 - Potential manufacturing investments are screened for consistency with our business strategy.