

Critical Success Factors of Supplier Quality Management

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Abstract

Supplier quality management (SQM) is considered as a proactive approach in the buyers' perspective to seek for continuous supply quality improvement and collaborative ongoing alliance between buyers and suppliers. Therefore, it is important for the buyers to understand their circumstances for managing their suppliers, and thereby to search for an improved way to rectify managerial deficiencies, if any. This paper aims to identify the critical factors of SQM, and then propose a hierarchical framework which can facilitate the assessment of their SQM performance in the buyers' perspective and also serve as a working tool for managing supply quality performance.

Key words :

1. Introduction

Supply related quality costs for an organization always represent a significant portion of the selling price, perhaps in the range of 10 to 20 percentages. Through proper control of supply quality, the reduction in quality costs can be directly translated into profits and the assurance that products and services are improved in the marketplace. As a consequence, Supplier Quality Management (SQM) is considered as an important way to seek for continuous quality improvement. It is imperative for the buying organization to self-assess whether it has a good system to manage its supplier quality performance. In this paper, a list of critical SQM success factors are identified from a comprehensive literature review and then the factors are integrated in a proposed hierarchical framework as a tool for managing SQM such as conducting self-assessment of the organization's SQM performance.

2. Core Values and Concepts of SQM

Before examining the critical factors of SQM, it is necessary to consolidate the modern concepts of SQM. The described core values and concepts of SQM in this section are embedded beliefs and behaviors found in managing supply quality in modern quality management. There are six interrelated core values and concepts for SQM, namely, mutual trust, single supplier policy, resources sharing, cooperative work, preventive approach and performance measurement, which are elaborated below.

2.1 Mutual trust

In the contemporary buyer-supplier relationships, mutual trust emerges as a crucial component of alliances, which helps to foster long-term cooperation between buyer and supplier, since each party depends on the other to satisfy mutual goals [69,79]. Generally, it is a belief and confidence that the strategic collaborating partner is reliable enough and is able to fulfill its obligation in their cooperation. In fact, the term of trust has widely been studied and defined by numerous researchers. According to Bradach & Eccles (1989), they conceived of trust as "a type of expectation that alleviates the fear that one's exchange partner will act opportunistically" [26]. Once the trust is established, both the buyer and supplier should recognize that joint efforts would lead to a synergetic outcome than acted independently. However, this close bond requires a long time to develop through ongoing interaction. Mutual trust itself is difficult to observe and measure. But once close and trusting relationships between buyer and supplier are developed, it will clearly facilitate the exchange of information between two parties. On the contrary, information exchange will be deleterious and the effectiveness of joint problem solving will be diminished due to the lack of trust.

2.2 Single supplier policy

Modern management recommends buyer to alleviate its supplier base through reducing the number of its suppliers to facilitate the establishment of close long-term relationships with suppliers. This practice leads fewer but closer collaborating suppliers to play a critical role in contributing to new product development, quality improvement and costs reduction [66]. In fact, the single sourcing strategy, which uses only one source of supply for a particular material or component, is an ultimate purpose for the reduction of supplier base. In the famous Deming's "Fourteen Points" for managing never-ending improvement, Deming contended to "move toward a single supplier for any one item, on a long-term relationship

of loyalty and trust" [39]. The policy is claimed to lead to improved quality and better price. In addition, it leads to closer relationships with suppliers, as well as more tangible benefits such as fewer incoming defective parts, greater delivery reliability and lower costs.

2.3 Resources sharing

In the contemporary partnering practices, there are various methods for the buyer and supplier to show their willingness and responsibilities for contributing in the buyer-supplier partnership. However, resources sharing are the most typical and direct method to demonstrate participation in this strategic alliance. Both parties are required to share common purpose, therefore advantages can be gained through mutually exchanging either hard or soft resources between the buyer and supplier. Hard resources encompass financial assistance, operating equipment and material; while soft resources such as managerial and technical skills, information, contacts and credibility will be taken into account [10]. Consequently, this attribute is essential as a concrete performance in managing supply quality.

2.4 Cooperative work

Cooperation has prompted many organizations to move away from the adversarial buyer-supplier stance [24]. It advocates the coordinated actions directed at mutual objectives that are consistently across buyer and supplier. Achieving the collaborative and highly performance work practices require jointly efforts and involvement between the buyer and supplier in such advantageous partnership in order to maximize the outcome. In fact, this cooperative work between the buyer and supplier requires mutual trust, commitment, coordination and communication as the foundation of such integrating activities. Meanwhile, joint agreement is required to determine the pattern of collaboration. Cooperative work, for instance, includes joint strategic planning, joint problem solving and early supplier involvement in R&D process. It will create new add-on values rather than a straight exchange of their existing values [13].

2.5 Preventive approach

Preventive approach is the enthusiastic thinking to strive for perfection in managing supply quality and it helps to cease the potential occurrence of the problems. It also serves to achieve continuous improvement to maintain an ongoing transaction, through planned and systematic approaches such as taking more aggressive actions to accelerate supplier performance and capability improvements beyond current practice. Whereas prevention is

promoted over detection, many progressive buying organizations are suggested to closely monitor their key suppliers' performances on a periodical basis, considering at various performance areas of quality, technological capabilities, delivery record, service levels and price at both the contract and the aggregate levels [22].

2.6 Performance measurement

Performance measurement is a quantitative approach, to evaluate both the existing or potential suppliers' performances by giving relative scores in respect to those objective and measurable performance attributes. It is an effective way for the progressive buyer to apply it in supplier selection and performance monitoring process respectively. In addition, the performance measurement indicators are not confined to those traditional supplier performance areas, including quality, delivery and cost, but extended to numerous possible functional areas, such as the average investment in purchased parts inventory and supplier responsiveness to change [29,75]. It emphasizes those indicators varying from different purchasing policy, business environment and purchased products.

3. Critical Factors of SQM

Critical factors of SQM are defined as the fundamental elements for implementing good SQM practices. Each of these critical factors addresses a distinctive value to achieve the successful management of supply quality. In addition, the factors have three significant roles for the buyer in managing its supply quality. First, to serve as a working tool for recognizing organizational performance in managing supply quality; second, to understand the insufficiencies in managing supply quality and the aspects should be concentrated; third, to help improve organizational performance practices, capabilities and results. The critical factors of SQM in the buyer's perspective can be categorized into three dimensions, namely, strategic alliance, supplier development and supplier monitoring. Each of these factors can be defined well in terms of numerous sub-factors to foster self-assessment for managing supply quality thoroughly. To identify the factors, we have reviewed 79 relevant contemporary SQM papers and the results are summarized as illustrated in Table 1. This list of papers can provide evidences for supporting the defined critical factors for SQM. In addition, the full citations are provided in the References section at the end of this article.

In order to facilitate a thorough understanding of SQM, the detailed descriptions of SQM should be addressed to explain the necessities of SQM. Therefore, the critical factors of

SQM are extended into three levels with 19 critical factors expanded. Consequently, a proposed hierarchical framework of SQM with three strategic decision levels is structured as shown in Figure 1, which is a comprehensive and integrated framework for managing suppliers' quality in the buyers' perspective.

Table 1. Summary of SQM critical factors

SQM Critical Factors	Literature reviewed [References]	
<i>1. Strategic Alliance</i>		
1.1 Buyer-supplier Partnership	1.1.1 Early Supplier Involvement	4,6,8,10,16,17,18,19,22,
	1.1.2 Senior Management Support	27,29,34,36,40,43,46,47,
	1.1.3 Shared Training and Education	50,52,55,56,57,58,59,70,
	1.1.4 Inter-organization Team	71,72,74,79,81,82
1.2 Technology and Information Sharing	1.2.1 Technology Sharing	13,42,46,48,49,56,57,62,
	1.2.2 Accessing of Critical Information	69,72,79
	1.2.3 Compatible Information Systems	
<i>2. Supplier Development</i>		
2.1 Sourcing Strategies	2.1.1 Make or Buy Strategy	4,6,19,20,22,27,32,33,39,
	2.1.2 The Supply Base Structure	47,50,54,55,64,65,66,69
	2.1.3 Sources of Supply	
2.2 Supplier Evaluation and Selection	2.2.1 Supplier Selection Process	9,15,19,20,22,27,30,32,
	2.2.2 Supplier Rating System	34,35,36,38,44,45,49,51, 60,64,69,70,73,74,75,76, 77
2.3 Supplier Motivation	2.3.1 Supplier Recognition by Reward	
	2.3.2 Supplier Training and Education	18,20,34,35,36,37,50
	2.3.3 Technical and Financial Assistance to Suppliers	
<i>3. Supplier Monitoring</i>		
3.1 Supplier Performance Measurement	3.1.1 Supplier Performance Appraisal	1,2,5,7,11,12,14,21,23,
	3.1.2 Reward and Penalty to Suppliers	28,29,31,36,37,50,53,61, 67,68,74,78,83
3.2 Continuous Supplier Performance Improvement	3.2.1 Periodic Review of Supplier's Process	2,4,12,19,20,21,22,25,31, 34,35,37,39,46,50,55,58,
	3.2.2 Supplier Certification	63,67,69,78,80

4. Strategic Alliance

Strategic alliance addresses the buyer to maintain a long-term and cooperative relationship with its suppliers to gain greater success in achieving desired outcomes and move away from an adversarial buyer-supplier stance. It is recognized that a cooperative relationship is not a sufficient condition for a successful alliance and the transition to an alliance is worthwhile in order to enhance performance and achieve its goals [79]. This on-going alliance, involves commitment, trust and interdependence to mutual share of resources along with a sharing of the risks and rewards of the relationship [49,48,56,41]. Long-term relationship between the buyer and suppliers should coordinate and willingly change their business practices to improve joint performance that eliminate duplicate research efforts and reduce uncertainty in a competitive environment [79,56]. This category mainly includes the *strategic integration between the buyer and supplier' personnel, and the integrated communication platform to exchange technology and information.*

4.1 Buyer-supplier partnership

Buyer-supplier partnership stresses the buyer's supplier management system to integrate its suppliers to improve joint performance with a long-term relationship. This partnership encircles mutual influence, with a thoughtful balance between cooperation and respective independence, which includes mutual respect, equal participation in decision-making, mutual accountability, and transparency [10]. This buyer-supplier partnership category examines how the buyer integrates its preferred suppliers in the early phases of its organization system and operation; provides senior management support to individual directly involved in alliance activity; involves all the key suppliers to share education and provide training of technology, proprietary knowledge and experience; and forms a cross-functional team with team members extended to the suppliers to allow better buyer-supplier partnership.

4.1.1 Early supplier involvement

Early supplier involvement brings the buyer to integrate its preferred supplier's capabilities in the early phases of its system and operations, with the aim to improve manufacturing and product and process advancements. It emphasizes the involvement of preferred suppliers in the early phases of the product design and development, with the areas including material specification, tolerances, standardization, order sizes, process changes in supplier's manufacturing, packaging, inventory, transportation, and assembly changes in its plants [17]. In addition, it requires inviting highly qualified suppliers into early discussions with the

design engineers, thereby different aspects such as management, quality, technology and delivery, along with cost competence are expected to improve. This critical factor, that involves suppliers early and gives them influence over design, is associated with greater contributions of suppliers to cost reduction, quality improvement and design for manufacturability [43]. This relationship needs to be carefully examined in terms of potential supplier candidates, since the extensive design responsibility taken by the supplier. Therefore, open and direct communication is a critical success factor in early involvement of suppliers and thus it is absolutely necessary for establishing the high level of trust between buyer and supplier.

4.1.2 Senior management support

Senior management support examines the buyer's supplier management system to provide adequate senior management support for strategic alliance, with the purpose to maintain collaborative buyer-supplier partnership. This support involves both strategic and operational levels to provide encouragement and resources such as personnel, time, technology and physical facilities to individual directly involved in alliance activities [79]. If senior management were highly involved in or supportive of the alliance, both the buyer and supplier performance would be expected to improve. Many studies indicate that senior management support is important to partnering success [18]. Therefore it is inadequate if senior management support is *only involved at the beginning of the partnership development process*. The senior management should reinforce communication through regular basis meetings to discuss related to the issue of partnership.

4.1.3 Shared training and education

Shared training and education encourages the buyer's supplier management system to involve all its key suppliers to share technology, proprietary knowledge and experience, thereby to enhance communication and improve joint performance. This critical factor emphasizes the use of education and training sessions to further align the objectives of suppliers and buyer to strengthen mutual commitment and trust between both parties. Shared education and training is one of the critical approaches used to drive the strategic alliance successes. The training efforts can be classified into periodic and ad hoc training. Periodic education and training generally involves all key suppliers and addresses various performance improvement areas including management, quality control processes, problem solving techniques, team building, activity-based costing, government or agency regulations, and continuous process improvement; while ad hoc education and training addresses specific

issues to facilitate the new product development effort and help to establish long-term relationships [57].

4.1.4 Inter-organization team

Inter-organization team advocates the buyer to establish a formal team with team members from different internal functional departments and suppliers, with the aim to enhance communication, share knowledge, improve decision-making, and thereby upgrade the joint performance in different aspects. It facilitates adequate involvement of suppliers to all the relevant functional areas in the buying organization. The supplier that works with the inter-organization team members will understand more about the requirements and difficulties to the buying firm [52]. This critical factor emphasizes the team building and inter-company communication via periodic meeting and discussion group between the buyer and supplier's personnel, and therefore the communication, coordination and long-term commitment between both parties can be enhanced.

4.2 Technology and information sharing

Technology and information sharing pushes the buyer ahead to maintain technology and information flow, with the aim to ensure appropriate and consistent technology and information exchanging to its suppliers [3]. It serves as a two-way communication vehicle to make strategic and tactical data, skills and resources available to the supply partners of the supply chain, in order to foster decision-making and operation [24]. Sharing technology and information with suppliers is necessary to make the supply chain channel more efficient and competitive, while open sharing of information such as inventory levels, forecasts, sales promotion strategies and marketing strategies can reduce the uncertainty between supply partners and result in enhanced performance. This critical factor examines how the buyer share intellectual, human and physical assets with its supply partners; establish confidentiality and nondisclosure agreements with its key suppliers, and determine the accessible information exchange platform that allows efficient and accurate information exchange activities between both the buying and supplying organizations.

4.2.1 Technology sharing

Technology sharing emphasizes the buyer's supply chain management system to share technological assets with its suppliers, with the aim to maintain closer, more open and trusting long-term supplier relationships. In order to promote a high level of technological capabilities between buyer and supplier, exchanging specialized knowledge and technological

know-how is an irresistible trend [57]. Specialized knowledge is the latest and proprietary cognition; while technological know-how encompasses the special abilities, skills and techniques. Technology sharing provides mutual benefits to both the buyer and supplier that maintains an on-going and collaborative relationship and also facilitates buyer-supplier integration. The buyer may benefit from sharing technologies through higher quality, more innovative, and lower cost purchased products. On the other hand, the supplier takes advantages from sharing technologies by gaining long-term business, preferred status and market penetration through the buying company's products.

4.2.2 Accessing critical information

Accessing critical information advocates the buyer's supplier management system to provide the confidentiality and nondisclosure agreements, with the aim to allow open sharing of critical information and maintain secure information transaction. The sensitive information includes technological know-how, customer requirements, and new product and process technology information [46]. The critical information will be utilized for planning and control activities, and transmitted in summarized form from senior management to support strategic planning. Security is a critical issue in accessing critical information. The critical information from internal and external sources is required to enable senior management to appraise organizational strengths, weaknesses, opportunities and threats. Information at this strategic level will be irregular, infrequent, forward looking and wide ranging. It is used to make non-programmed, non-routine strategic decisions related to adaptations towards longer-term, more broadly conceived ends. As a result, the information system should adopt an encryption policy to ensure the integrity of transactions concerning documents.

4.2.3 Compatible information systems

Compatible information systems suggest the buyer's supplier management system to establish the accessible information exchange platform that allows efficient and accurate information exchange activities with its suppliers. Data asset is positioned of a vital long-term importance to the company and information system generally plays a key role in the buying organization to tie in suppliers more closely. This compatible information system emphasizes the ability of the buying organization to move transactions and data co-operatively across heterogeneous system environments with its suppliers [57]. The World Wide Web is a good way to provide the infrastructure for collecting, distributing, and sharing information. It integrates the buyer for managing activities on all levels of the company and provides new electronic links for reaching out with its suppliers.

5. Supplier Development

Supplier Development addresses the buyer's effort with supplier to improve its performance, capabilities and achieve both the buyer's short- and long-term supply needs [37]. Attention is given to how the buyer creates new sources of supply where no adequate ones exist and maintains a network of competent suppliers that encourages high supply performance. This category also includes the buyer's strategies of sourcing new suppliers, appraisal of potential suppliers' overall performance and how to motivate its suppliers to improve their performance of supply.

5.1 Sourcing strategies

Sourcing Strategies address the process of creating a value added mix of supply relationship to provide a competitive advantage. This category is concerned with top-level and longer-term sourcing decisions relating to both the strategic items and supply risk items. It is an initial step to develop new source of supply and outline the strategic consideration of the structure of sourcing suppliers. This category examines how the buyer determines the shape and capability of its manufacturing operation, thereby providing the framework for shorter term tactic and operational decisions; optimizes the supplier base practices related to the range, location and characteristics of the supplier base that may result in closely-working supplier relationship and provide expeditious supply and services; and ensures that sourcing of supplier information will be effective and the sources of supplier are adequate.

5.1.1 Make or buy strategy

Make or buy strategy promotes the buyer's strategic decision-making, whether to make the supplies within the organization or buy them from outside. This critical factor serves as a significant starting point of supplier management that once the buy decision is made, the follow up buy-strategy and supplier management are accompanied. In determining the capability of the buyer's manufacturing operation, it is clear that irrespective of whether it relates to the strategic, tactical or operational levels, many quantitative and qualitative factors have to be considered when arriving at make or buy decisions [54]. In addition, this critical factor also emphasizes how the buyer provides actionable and clear operational guidance, such decisions are normally made on the basis of calculations like marginal costing and break-even analysis.

5.1.2 The supply base structure

The supply base structure emphasizes the buyer's processes to determine the supply base structure, with the aim of identifying the direction of sourcing suppliers. There are two key issues regarding the supply base structure, one is the number of suppliers and the other is the geographic location of suppliers. Supply base strategies are determined by many considerations including the size of the undertaking, nature of the undertaking subsidiary, the location of the markets and types of production. Managing suppliers is a complex and demanding management task. The buyer should reduce the number of suppliers with whom they do business in order to establish close long-term relationships with their remaining suppliers [54,66]. As a result of this best practice, closer co-operated suppliers can then play a key role by significantly and regularly contributing to new product design, reducing costs, and constantly improving quality. The geographic location of suppliers is a significant element in implementing JIT systems and reducing transportation costs [54]. However, getting supplies from international or local would vary from different supplies, competitive environment and the requirements of each particular enterprise. As the reasons regarding international sourcing include the intense international competition, pressure to reduce costs, need for manufacturing flexibility, shorter product development cycles, stringent quality standards and ever changing technology, significant numbers of manufacturing organizations are obtaining their supplies from international base.

5.1.3 Sources of supply

Sources of supply propose the buyer's supplier management system for securing potential suppliers' information to accomplish the preliminary screening of potential suppliers. The aim is to ensure that the buyer's sourcing strategies are deployed for adequate sources of supply and useful information of potential suppliers. Since there are various sources of potential suppliers' information, those sources of information relating to potential suppliers such as supplier purchasing information file, supplier catalogs, trade registers and directories, trade journals, the yellow pages, filing of mailing pieces, sales personnel, trade exhibitions, company personnel, other purchasing departments and international sources should be identified and collected. Furthermore, this critical factor provides the exterior information about the suppliers' capabilities and performance, those basic information are treated as preliminary supplier selection criteria like manufacturing experiences and facilities. Certainly, general supplier information and personnel responsibilities should also be described.

5.2 Supplier evaluation and selection

Supplier evaluation and selection addresses how the buyer performs the assessment and appraisal of the potential suppliers' performances. The appraisal arises when a prospective supplier is placed on the buyer's approved list or in the course of negotiation, or when it wishes to assure that supplier can meet requirements reliably. Supplier evaluation and selection plays a significant role in the supplier development process. Selecting the supplier with whom the buyer can build the right relationship is the foundation upon which all value is created [74]. In addition, identifying the suppliers who can share the buyer's vision, have commitment to the relationship, and deliver what they promise is a critical work. This category provides the buyer with objective information in which judgments relating to source selection can be based. It also enables the buying organization to provide the supplier with an indication of its performance rating and where improvements is required.

5.2.1 Supplier selection process

Supplier selection process indicates the ways of the buyer to acquire the information about the potential supplier performance that can be used as the indicator for supplier selection. Selection of right source is critical, since more buyers are entering into long-term partnerships with a reducing number of suppliers [44]. Therefore, a comprehensive method for selection of suppliers is essential to the buying organization. It is suggested to develop an entire assessment approach to acquire a realistic and reliable appraisal results of supplier performance. with the possible techniques of supplier selection include on-site evaluation of supplier capability and quality system; evaluation of product samples; investigation of the past history with similar products; analysis of the test results of similar products; and evaluation of published experience of other users.

5.2.2 Supplier rating system

Supplier rating system fosters the buyer to develop a formal evaluation system for supplier selection. thereby to determine a proper source of supply through making objective and accurate appraisal of supplier performance. This supplier rating system includes the development of supplier selection criteria, the rating system for criteria, and the assessment and rating of each selection criterion. The buyer traditionally uses criteria such as price, production capacity and financial position as the determinants of assessing potential suppliers, while cost, quality and delivery performance have been consistently identified as being important determinants of it [70,38,27,77]. Besides, intangible factors such as management compatibility and strategic decision of the supplier have also been shown to be significant,

particularly in the context of strategic buyer-supplier partnerships [32]. As a result, the buyer is asked to develop an analytical assessment framework, which combines qualitative and quantitative factors with interrelationships of different criteria and their levels of importance.

A supplier selection decision inherently is a multi-criteria problem solving, which varies according to the purchasing situation [9,44]. The determination of the relative importance of each criterion is critical to the overall supplier selection process. Therefore, this critical factor asks how the buyer priorities the importance of the selection criteria, thereby to obtain a realistic judgement of appraisal. Traditional formalized methodologies of the supplier selection process in the research literatures include the cost-ratio method, the categorical method and weighted-point evaluations. The cost-ratio method evaluates supplier performance using the tools of standard cost analysis that all criteria are expressed with the cost as a percentage of the total value of the purchase; the categorical method involves categorizing each supplier's performance or expected performance, in specific areas defined by a list of relevant performance variables; the weighted-point method places a weight on each criterion and provides a total score for each supplier by summing up the supplier's performance on the criteria multiplied by these weights [73,30]. This critical factor emphasizes the buyer to structure the evaluation process and methodologies in a clear and systematic way.

5.3 Supplier motivation

Supplier motivation encourages the buyer to design the effective supplier motivation and reward systems that will bring about high supplier performance level. Supplier motivation is defined as the willingness to exert high levels of effort to achieve a better supplier performance and reach a more cooperative and long-term buyer-supplier relationships, conditioned by the effort's ability to satisfy the buyer's need. This category involves practices that are likely to lead to more motivated suppliers; including supplier recognition by reward, providing training and education to suppliers, and providing technical and financial assistance to suppliers.

5.3.1 Supplier recognition by reward

Supplier recognition by reward encourages the buyer to acknowledge its supplier performance by rewarding, which may be financial or non-financial, while their performance or capabilities achieved to a prerequisite level of standard, with the aim to achieve the performance consistency [35]. This supplier recognition is a potential hands-off mechanism for motivation of the suppliers to achieve a certified status. A prerequisite level of performance standard should be established before assessing the supplier performance. This is

an expected performance standard for the suppliers to achieve and should be understood by the suppliers entirely. In addition, it also serves as a motivating tool for suppliers. They can be committed to higher volumes or future business only if they improve their performance. They may strive for reward status by improving their overall supply performance to achieve a certified or preferred status [36]. Rewards, such as more fringe benefits, increasing volume of purchase, and higher opportunity for the prior supply, can stimulate competition and provide incentive and recognition for outstanding achievement.

5.3.2 Supplier training and education

Supplier training and education addresses the buyer to provide cultivation to its supplier's personnel, with the purpose to foster its performance and capabilities improvement [50,20]. This critical factor is characterized by communication and interaction between the buyer and its suppliers; and it involves significantly higher levels of commitment. A regular training should be organized by the quality experts, managers or employees with special capabilities, knowledge or techniques from the buying organization. The forms of training provided by the buying organization can be a group discussion, workshop or seminar that it depends on the number of participants, characteristics and behaviors of the suppliers' personnel. The nature of the subjects or skills taught to the supplier's personnel are in the improvement areas, including topics such as statistical process control, total quality management, design of experiments, sampling methods, inspection techniques, and ISO 9000 [35]. Other general subject areas include safety procedures, material requirements planning, and information regarding the use of the supplier's product by the buying organization.

5.3.3 Technical and financial assistance to suppliers

Technical and financial assistance to suppliers encourages the buyer to motivate its suppliers through providing technical assistance and direct investment of capital, resources and time, with the aim to foster their capabilities and performance improvement. It would result in increased commitment by the supplier to the buying organization and contribution to a more cooperative relationship. Buyers should be encouraged to demonstrate a more proactive attitude by providing to suppliers technical assistance and immediate technical support that helps to avoid problem deterioration. The buyer should regard the suppliers' problems as its problems. The technical assistance involves providing technical consultation, technical information and knowledge to its suppliers. With the aim to motivate the supplier performance, providing technical assistance is a direct method to solve its suppliers' problem and thereby to improve their performance, based on mutual trust, commitment and good

communication. In addition, this critical factor also manifests a commitment by the buyer in the form of capital, time and resources investments in its supplier's operations. The buyer should demonstrate a greater willingness to co-operate with, and invest capital, time and resources in the supplier's operations to increase its performance. The involved areas of the supplier's operations may include tooling, molds, and dedicated capital equipment [35]. Therefore, the investment appraisal should be conducted to perform best investment. This may involve the consideration of identifying the areas of supplier's operations and the amount of resources to be invested.

6. Supplier monitoring

Supplier monitoring addresses the buyer's process with the aim to maximize its supplier performance contributions and capability improvement continuously. This category of factors is a mechanism for controlling the performance of existing suppliers and supporting continuous performance improvement to achieve efficient buyer-supplier relationships [21,67]. Attention is given to how the buyer performance be measured in order to orientate the actual performance of its supplier and to compare actual results with planned performance; and how to sustain continuous improvement for supplier's performance. This category includes the supplier performance measurement, which acts as a basis for progressive improvement and the approaches for continuous supplier performance improvement to maintain a long-term collaborative alliance.

6.1 Supplier performance measurement

Supplier performance measurement addresses the buyer's process to measure its supplier's performance, with the purpose to act as a basis for progressive performance improvement. Performance measurement is used to measure and improve the efficiency and the quality of the supplier performance, and identify the opportunities for progressive improvements in process performance [78,12]. It also helps to find out the problems with current practices and present performance level thereby to estimate the improvement potential, used for continuous monitoring of supplier's operations. Supplier performance doesn't improve simply by measuring results of it, but it can be used as an indicator of the future improvement. This category mainly includes the selection of performance indicators as the evaluation criteria for supplier performance and the techniques to monitor supplier performance; also the reward and penalty approaches to suppliers.

6.1.1 Supplier performance appraisal

Supplier performance appraisal emphasizes the buyer to perform the selection of reasonable and realistically measurable performance criteria and conduct the formal appraisal of the supplier performance against previously defined standard of performance criteria, with the aim to evaluate the supplier performance accurately and systematically. The supplier's progress is periodically assessed to obtain the current result of supplier performance, which is useful for future supplier performance improvement.

Regarding to the selection of performance criteria, a good strategically aligned supplier performance assessment system should cover many aspects of supply quality dimensions, such as quality, technological capabilities, flexibility, delivery record and service levels [29]. The selection of supplier performance criteria varies in different organizations, thus it is significant to identify appropriate performance indicators solely for the buying organization. It attempts to rectify the shortcomings by using a broader array of objective performance indicators to measure the supplier performance with effectiveness and progress toward achieving continuous improvement. In the supplier performance evaluation system, the importance among different performance criteria is different; therefore relative weightings to each performance indicator should be well defined for evaluating supplier performance reasonably [21]. The method to evaluate supplier performance should be simple and totally understood by both parties; and measurements chosen should truly indicate how the supplier performance helps to meet the buyer's objectives. In addition, communicating performance appraisal results to supplier is vital to the buyer and also the supplier, which can utilize the feedback information in investigating the causes for their performance decline, thereby to assists them in undertaking remedial actions to improve their performance.

6.1.2 Reward and penalty to suppliers

Reward and penalty to suppliers suggests the buyer to address the corresponding actions taken to its supplier, with respect to the results of the supplier performance appraisal. This approach encourages suppliers who improved internally to achieve an agreed satisfactory level of performance. It relies on rewards and incentives to drive supplier capability improvements, since it is recognized that there is a direct link exists between rewards and supplier improvement. Supplier performance rewards include offering the suppliers new business on related parts, an opportunity for future purchase contracts, better price and technical assistance or any benefits offered [50]. On the contrary, disciplinary actions, such as eliminating their chances for future contract, introducing more competition with new suppliers, taking away their preferential services, etc., should be taken to alert the suppliers

whose performance cannot be maintained at a satisfactory level.

6.2 Continuous supplier performance improvement

Continuous supplier performance improvement addresses the buyer's process to sustain continuous improvement of its supplier performance, with the aim to maintain long-term buyer-supplier relationships. Attention is given to how the buyer takes a series of aggressive actions in a continuous basis to increase supplier's contribution and thus to settle for incremental performance gains [50]. In supplier performance monitoring, the contribution of continuous supplier performance improvement is an ultimate purpose to maintain the integration of SQM. This category mainly includes the periodic review of supplier's processes and supplier certification.

6.2.1 Periodic review of supplier's process

Periodic review of supplier's process emphasizes the buyer to conduct regular assessment of supplier performance to rectify the current shortcomings for improvement, with the aim to monitor the supplier performance. This critical factor mainly includes the periodically assessing supplier's process, identifying areas for supplier's performance improvement, developing the supplier performance improvement plan, and providing the supplier with the feedback of the result of supplier performance evaluation, with the aim of motivating the supplier to improve their quality of performance [21]. The supplier's progress is periodically assessed to obtain the current result of supplier performance, which is useful for future supplier performance improvement. It is followed by the identification of areas for improvement that the buyer should perform gap analysis to identify the improvement needs and the appropriate areas for improvement. Furthermore, the improvement plan should be developed and the corresponding arrangement should be deployed to support the improvement plan. Finally, the buyer should inform the suppliers with the result of evaluation, and the follow-up negotiation and discussion are suggested to conduct, so that they can realize their quality of performance.

6.2.2 Supplier certification

Supplier certification is to address buyer's confirmation of supply quality through examination of major aspects of supplier performance. It concludes that the supplier's product and services has consistently met the expectation of the buyer. Supplier Certification is the formal process through which the buyer needs a lot of interactive teamwork, and very clear communication between various departments of the buyer and supplier. The implementation

of supplier certification can eliminate the need for incoming inspection of purchased parts [80]. The incoming part goes through a rigorous quality evaluation before the supplier receives "dock-to-stock" status. The net result of supplier certification is that it shifts the responsibility for assuring quality back to the supplier. Furthermore, the buyer is asked to conduct a formalized assessment program that evaluates the systems a certified supplier has in place in order to assure customers a product that consistently meets a defined quality level and an on-time delivery.

7. CONCLUSION: A Hierarchical SQM Framework

The impact of supplier quality management (SQM) has been addressed significantly. Effective SQM practices can enhance product and service quality, eliminate the inspection of supplied parts, and improve the speed of finished goods delivery. Therefore, it is imperative to dissect the fundamental elements embedded in SQM, in order to facilitate successful management of supply quality in the buyer's perspective. In this paper, the core values and concepts are firstly defined as the guidance for establishing SQM critical factors. Then, the critical factors of SQM are identified based on those beliefs and behaviors through the literature review. In this section, a hierarchical framework of SQM, as shown in Figure 1, is structured to integrate all the strategic and operational factors identified. In the framework, strategic alliance, supplier development and supplier monitoring are the three major categories of strategic SQM factors and 19 operational factors are also listed. With regard to the proposed hierarchical SQM framework constructed, SQM self-assessment and implementation systems for the buying organization can be further developed. SQM best practices based on the critical factors can also be identified and organized as guidelines to the industries in managing the suppliers. These further work are being conducted by the authors and the results will be reported in near future.

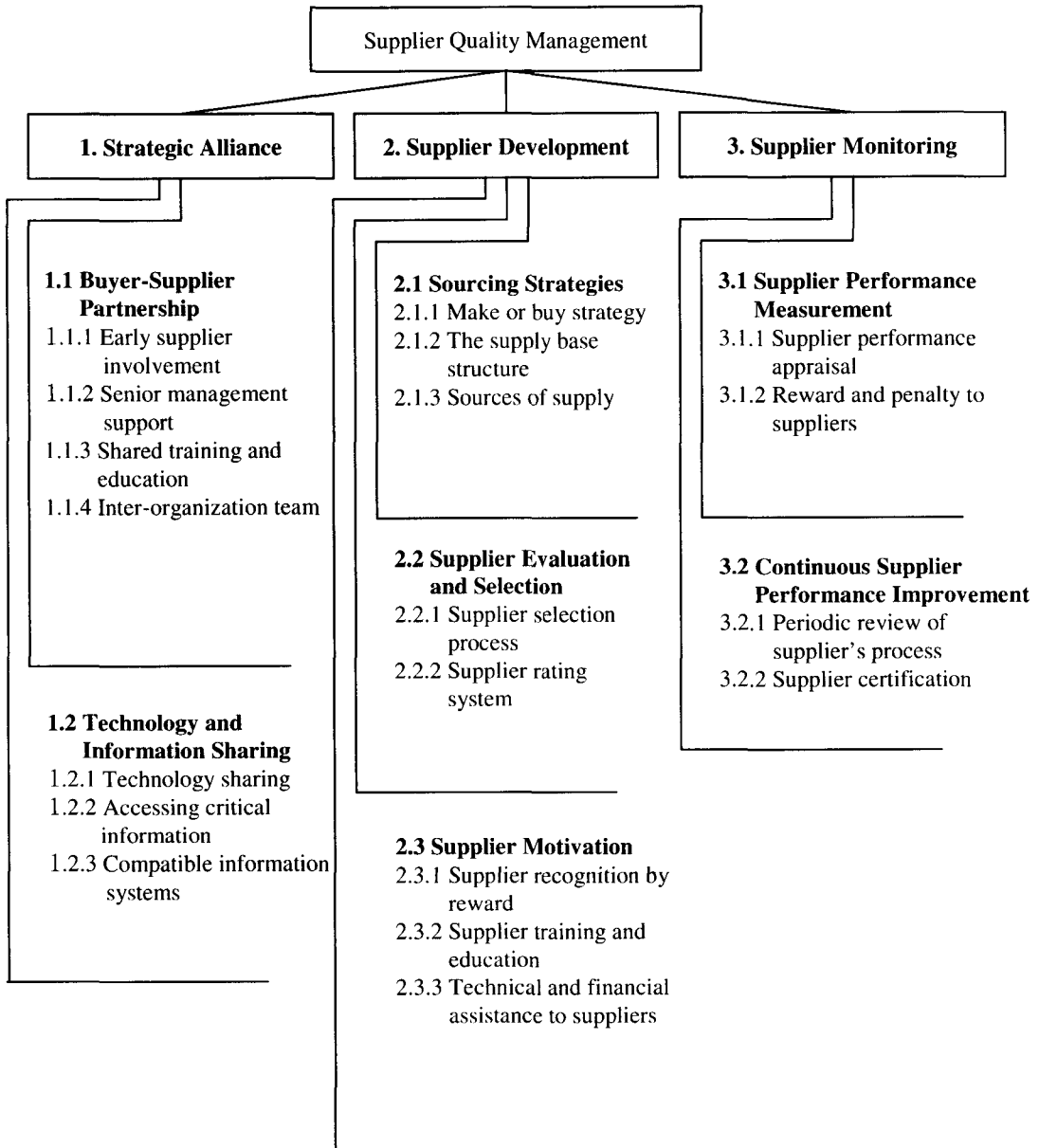


Figure 1. A proposed hierarchical framework of SQM

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