

Research on the Effectiveness Improvement Strategy of Quality Management System of Chemical Enterprises

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The certification of quality management system in chemical enterprises can effectively guarantee the quality of products, enhance the market competitiveness of chemical enterprise and expand the brand effect of the company. This paper presents a strategy to enhance the effectiveness of the certification of QMS in chemical enterprises from several aspects, including: business planning, countermeasures for risks and opportunities, understanding and applying of the planned quality policies and objectives, implement and continuously improving the chemical enterprise's resources, and strengthen the company's internal audit and management review, etc.

1. Introduction

Chemicals are pure substances and mixtures of various elements, whether natural or artificial. According to the American Chemical Abstracts, there are 7 million kinds of chemicals in the world. Among them, more than 10 kinds of chemicals have been listed as commodities. There are more than 70 thousand kinds of chemicals that are commonly used, and there are more than 1000 new chemicals appearing worldwide every year. In the "13th Five-Year Plan for Certification, Permission, Inspection and Detection" released by the General Administration of Quality Supervision (AQSIQ), it's clearly states that it is necessary to take the management system certification as an important starting point for promoting quality improvement and lay a solid foundation for the building of enterprise branding. The ISO 9000 family addresses various aspects of quality management and contains some of ISO's best-known standards. The standards provide guidance and tools for companies and organizations who want to ensure that their products and services consistently meet customer's requirements, and that quality is consistently improved. ISO 9001:2015 sets out the criteria for a quality management system and is the only standard in the family that can be certified to (although this is not a requirement). It can be used by any organization, large or small, regardless of its field of activity. This standard is based on a number of quality management principles including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement. Using ISO 9001:2015 helps ensure that customers get consistent, good quality products and services, which in turn brings many business benefits. The study is of great significance to study the validity of the certification of QMS of chemical enterprises.

2. Literature Review

Oksana et al., (2006) provides an overview of the existing advantages and barriers for chemical management services providers and customers in the European context, identifies conflicts of interest between them, and highlights important lessons regarding the role of chemical management services in shaping these markets. Vianello et al., (2016) tested the newer version of the risk based inspection module proposed by the American Petroleum Institute. Roy and Khastagir (2016) explored role of green management in enhancing organizational efficiency in petro-chemical industry in India. Wan et al., (2015) proposed an indicator based on

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ecological two-sidedness theory and Shannon entropy, which is intended for analysing informational complexity in a decision network of the chemical insecticide pollution management. Røyne et al., (2015) investigated the practical significance of life cycle-based environmental strategy development using a chemical industry cluster in Sweden as the case study. Lee et al., (2017) discuss the changes in approaches to handle chemical accidents from various perspectives and present a case in which the relevant agencies succeeded in responding relatively efficiently to a major chemical accident because of these changes. Zhang et al., (2017) discussed how to improve the quality of inspection body. Zuo et al., (2017) discussed the strategy of inspection industry of China to improve the effective of quality management system. Zuo and Tang, (2017) research the influence of the certifications on the enterprise performance.

According to ISO Survey, a total of 1,106,356 valid certificates were reported for ISO 9001 in 2016 (including 80,596 issued to the 2015 version) an increase of 7% on last year. Worldwide total ISO9001 certificates from 1993 to 2015 is shown in Figure 1.

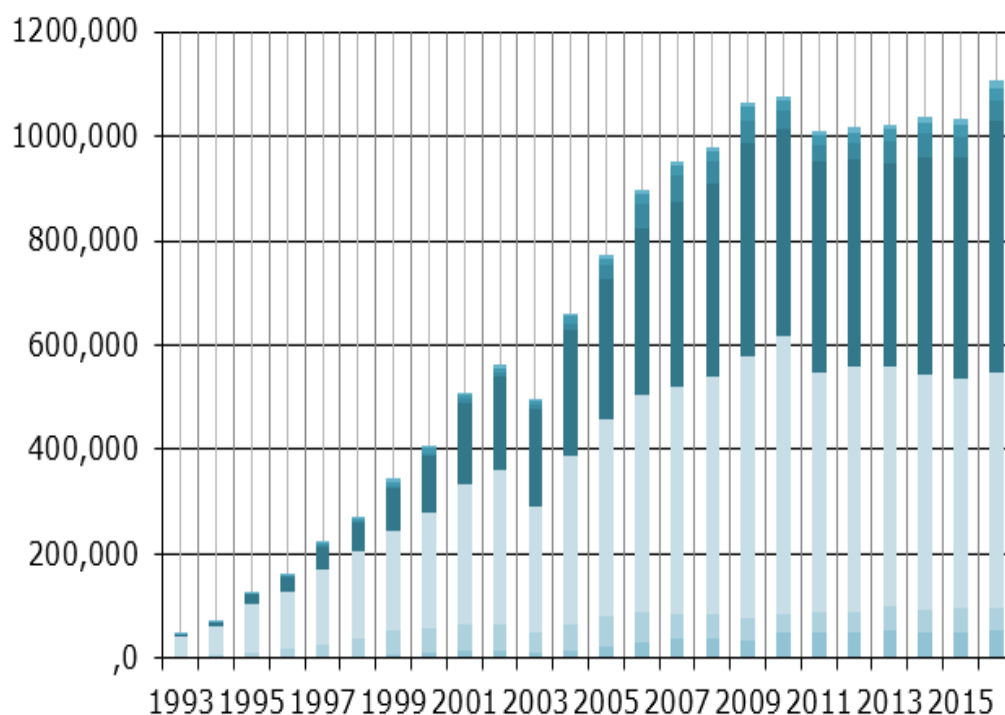


Figure 1: Worldwide total ISO9001 certificates (1993-2015)

Top 10 countries with ISO 9001 certificates in 2015 has been shown in Table 1.

Table 1: Top 10 countries with ISO 9001 certificates in 2015

No.	Country	Number of certificates
1	China	292559
2	Italy	132870
3	Germany	52995
4	Japan	47101
5	United Kingdom	40161
6	India	36305
7	United States of America	33103
8	Spain	32730
9	France	27844
10	Romania	20524

Number of ISO9001 certificates in the sectors of chemicals, chemical products & fibres worldwide has been shown in Table 2.

Table 2: Number of ISO9001 certificates in the sectors of chemicals, chemical products & fibers

Year	Number of certificates
2007	29924
2008	15925
2009	31880
2010	29557
2011	30278
2012	33583
2013	33610
2014	33432
2015	29744

In the past decade, the number of ISO9001 certificates in China has been shown in Table 3, showing that the ISO9001 certificates in China have shown a steady growth trend and reached the peak in 2015.

Table 3: Number of ISO9001 certificates in China in the past decade

Year	Number of certificates
2007	210773
2008	224616
2009	257076
2010	255052
2011	258830
2012	254162
2013	257256
2014	288389
2015	292559

3. Enterprise quality management system implementation quality

3.1 Planning and countermeasures of risks and opportunities of chemical enterprises

Uncertainty is the source of risks, and there is certainty in the uncertainty, chemical enterprises should find and grasp the implicit certainty from the uncertainty; consider various laws and regulations, technology, market, society, economy and other external environmental factors from international, national, district and local levels; at the same time, they should also pay attention to the internal environmental factors such as the values, culture, knowledge and performance of the enterprise. In addition, they should also consider the relevant aspects of the company's QMS, apply risk thinking to the planning and implementation of ISO9001 QMS. This helps to determine the range and extent of documented information, and it is the basic, fundamental, and overall work for planning, designing, command and control. For risks and opportunities of the chemical enterprises, we can use several tools to identify them, such as SWOT analysis, Michael Porter's Five Forces Model, PESTEL analysis model, etc. Chemical companies should form a risk-based way of thinking, build a proactive improving and forward-looking culture, pay attention to the risk management knowledge reserve and resources construction, strengthen the construction of risk-related information channels and timely collect relevant information for risk identification and evaluation. Risk-control can be planned to eliminate the risks or the conditions that lead to risks, and to protect the process from being affected. Risk avoidance is to pre-control the way to reduce the frequency and degree of loss, so as to avoid the risk of possible losses. In the process of implementing the measures in the chemical enterprises, the implementation of the measures should be supervised according to the relevant requirements, and if necessary, the methods of target management can also be used to optimize the objectives and adjust the measures. After the implementation, the validity of the measures can be confirmed by comparing the risk scores before and after the implementation of the measures. If the risk after the implementation of the measures is less than before, it indicates the measures are effective; if the risk after the implementation of the measures is greater than or equal to the before, it means the control measures need to be re-established.

3.2 Understanding and applying of the planned quality policy and quality objectives

The quality policy of the chemical enterprises is the general purpose and direction of the companies, it was officially released by the top management to determine the expected effect and help the company to utilize its resources and to achieve its desired results. It is the driving force for implementing and improving the QMS for chemical enterprises, and providing a framework for the quality objectives. The quality policy documents can be published in any media and methods such as paper, electronic and network sharing platforms according to the management habits of the chemical enterprises, suitable ways and methods should be considered and arranged for different distribution methods. The formulation of quality guidelines for chemical companies can be initiated, selected and summarized by all employees in the enterprises. Then special meetings for discussing, revising, and finalizing the quality guidelines need to be organized by the top management of the chemical enterprises. This can both reflect the intent of the top management on the quality management of the enterprise, and enable participants to learn the quality policy earlier and promote the implementation of the quality policy more efficiently during the process of fully discussing and revising the quality policy. Quality objectives are the judgement basis for evaluating the effectiveness of QMS, and the business-related function and tomography are in need of establishing quality objectives. The quality policy and quality objectives are not only the code of conduct for the quality of all employees, but also the fundamental criterion or basis for evaluating the effectiveness of the QMS established by the chemical enterprises. It is also one of the most important contents in the planning of the enterprise QMS. The development of enterprise quality objectives should be based on the company's own development strategy, while keeping in mind the business-related political, economic, cultural, technological and other changes which will affect the quality objectives of the enterprise. Balanced scorecards and strategic maps are effective ways to break down the quality objectives. Enterprises can use technologies such as SMART to assist in planning objectives, ensuring that quality objectives are specific, time-bound, relevant, measurable and achievable, also responsible personnel needs to be identified and provided with adequate resources to accomplish the task, as well as evaluate the effect afterwards.

3.3 Implement and Continuous improvement of chemical enterprises' manpower, monitoring and measurement resources

The preconditions and prerequisites for the Effectiveness of QMS are to make reasonable arrangements to ensure the effective operation of QMS and continuously improve the quality of chemical enterprises, thus enable the chemical companies to provide products to continuously meet the customer requirements and satisfaction. The resources needed for the implement and the continuous improvement are measured throughout management reviews, product requirements reviews, design and development reviews, unqualified or potentially unqualified causes investigations. Both product quality and the quality of work can be achieved through the process, the process is completed by the employees of the enterprise separately. The significance of the staffs' quality awareness and their participation lies in saving supervision costs and releasing their personal potential. These are necessary success factors for QMS certification, people at all levels are the foundation of the organization, and their full potential can only be released once they are fully involved, so that their talents will bring the greatest benefits to the organization. Without the active participation of the staff, the QMS is just a hollow system with a formal shell. In addition, the leader should know whom to choose as the right person for the right work, and be good at cultivating people's ability and motivating their work potential. With the continuous refinement of specialization in the enterprise, emerges labor-outsourcing, temporary employment and other low-cost staff management methods, so the enterprise needs to consider the risk control and necessary due diligence in the service-outsourcing process, especially the technology-sensitive and classified positions, the risk management needs to be improved in the allocation of staff, and specific employment standards need to be further clarified. In order to improve staff's quality awareness and participation level, employees need to be regularly trained and evaluated according to their needs. To some extent, staff awareness determines the depth and breadth of the QMS, which not only affects the QMS compliance, but also the performance of QMS certification. For those incompetent staffs that failed to meet their job requirements, the enterprise should organize apprentice training, off-job training, business training, and other possible training methods. The evaluation methods and contents of training effectiveness should be designed around the training objectives and can be evaluated by means like theoretical knowledge, practical operation, performance appraisal, etc. to determine whether the trainees have the ability, knowledge and skills for the job. Retraining could be considered if necessary. Measuring equipment is used to verify compliance with the accuracy of the measurement results. When providing confidence, it should be calibrated or verified against measurement standards traceable to international or national standards, and the calibration or qualification cycle should meet relevant requirements. When there is currently no relevant international or national measurement standard for measuring equipment, the enterprise should formulate the self-school

procedure of the equipment and calibrate it by personnel with appropriate abilities and qualifications within specified time intervals.

3.4 The process control of chemical enterprise products in accordance with planned guidelines

The content of control includes access to ensure that relevant personnel or department could obtain the product characteristics in a timely manner, if necessary, develop and implement the work instructions for the realization process of specific products; release products according to provisions; conduct control over the product delivery and afterwards activities. This process is consisted of a series of interrelated processes, such as product and service development, external provision, and protection, etc., it is a direct value-added process for the enterprise. To operate effectively, companies need to manage these processes according to the PDCA's method of operation. The starting point of these processes is the planning of product realization. The enterprise also needs to understand, determine product requirements and confirm that it has the ability to meet these requirements. For the development stage, each stage has its detailed requirements for planning, inputting, outputting, reviewing, verifying, confirming and change-controlling. For the external delivery stage, guidelines for the selection of external suppliers of products should be formulated, evaluated and re-evaluated in accordance with the requirements of the QMS and verify the externally provided products; For identification and traceability, the company should identify the product in a proper way throughout the product realization. For product protection, the company should internally conduct and deliver the product to the intended location; for customer property, the business should identify, verify, protect and maintain the customer property for which it is used or forms part of the product. Attention should also be paid to the use of process methods, which is to manage the related resources and activities as processes. Enterprises should identify all the processes, especially the key processes, and define the relationship between the processes to determine the quality control points in the process chain. The process of development and control is to determine the process of input, output, activities and resources, so as to effectively manage the process, conduct continuous control to the process, thus improve the performance level of enterprise. With the increasingly fierce market competition, enterprises need to examine the business process with a critical eye, to re-think, re-combine, re-sequence, re-position, re-quantify, re-assignment and re-assembly, to break the balance, and to achieve PDCA spiral rise.

3.5 Strengthen the chemical enterprises' internal audit and management review

The internal audit of the chemical enterprises is to confirm the compliance and effectiveness of the QMS of the companies, and take corrective measures on the problems found to eliminate the nonconformity and the cause of it. It is also an important means of self-improvement and self-perfection of chemical enterprises. Internal auditors should be objective and fair. To determine the suitability, adequacy and effectiveness of the QMS, managers need to conduct review on the management system according to the planned time intervals. The management review is also a value-added process. The input of the management review includes customer feedback, audit results, process performance and product conformity, follow-up measures of previous management review, suggestions for improvement, etc. The output of management review includes the improvement of the effectiveness of the QMS and its process, human resources monitoring and the supplement measurement resources. With economic globalization and internationalization, the competition among enterprises become fiercer. If the internal audit of a chemical enterprise merely makes a symbolic suggestion of nonconformity and improvement suggestion according to the checklist, it will not be able to enhance the quality and ability of the enterprise. The enterprises need internal audit which can put forward valuable audit opinions and point out the weaknesses of the company, so as to enable the chemical enterprises to continuously improve their customer satisfaction, QMS and effective operation. The quality of internal audit team will directly affect the internal audit value-adding, to achieve the above activities we need to select and train excellent internal audit teams. A good internal auditor is the one with the right review method and core idea of thinking, his/her understanding of system documentation and standards should be correct and he/she should have a relevant technical background. Enterprises should select staffs who act impartially, with professional knowledge and skills, rich management experiences, as well as good personal qualities and sense of responsibility, to be the internal auditors. And the company should provide relevant training for the internal auditors. Top management should regularly evaluate the results of internal audit and external audit to find out the key weaknesses in the QMS or propose improvements to the areas that need to be adjusted and enriched and require the responsible departments to formulate corrective and preventive measures. Then, analyse the customer complaints and their potential dissatisfaction. Chemical enterprises should establish the concept of customer satisfaction, improve the QMS, and create quality products in order to enable the company to maintain market competition advantages. At the same time, the QMS should also be updated according to the changes of the company and the market.

4. Conclusion and research prospect

The study of this paper is of great significance for the chemical enterprises to strengthen the implementation of the QMS certification. It can also serve as a reference for the certification organizations to improve their service quality, as well as for the government to strengthen their supervision on the QMS of chemical enterprises. Follow-up studies include the study of effectiveness of environmental management system certification, occupational health and safety management system certification and other related aspects.

Reference

- Lee K., Kwon H. M., Cho S., 2016, Improvements of safety management system in Korean chemical industry after a large chemical accident, *Journal of Loss Prevention in the Process Industries*, 42(8), 6-13.
- Oksana M., Pranshu S., Zinaida F., 2006, Chemical Management Services in Sweden and Europe: Lessons for the Future, *Journal of Industrial Ecology*, 10(1-2), 279-292.
- Roy M., Khastagir D., 2016, Exploring role of green management in enhancing organizational efficiency in petro-chemical industry in India, *Journal of Cleaner Production*, 121, 109-115.
- Røyne F., Berlin J., Ringström E., 2015, Life cycle perspective in environmental strategy development on the industry cluster level: A case study of five chemical companies, *Journal of Cleaner Production*, 86, 125-131.
- Shirinova H.A., Luca D.P., Sarasini F., Tirillò J., Ramazanov M.A., Hajiyeva F., Sannino D., Polichetti M., Galluzzi A., 2016, Synthesis and characterization of magnetic nanocomposites for environmental remediation *Chemical Engineering Transactions*, 47, 103-108, DOI: 10.3303/CET1647018.
- Vianello C., Milazzo M.F., Guerrini L., 2016, A risk-based tool to support the inspection management in chemical plants, *Journal of Loss Prevention in the Process Industries*, 41, 154-168.
- Wan N.F., Ji X.Y., Jiang J.X., 2015, An ecological indicator to evaluate the effect of chemical insecticide pollution management on complex ecosystems, *Ecological Indicators*, 53, 11-17.
- Zhang Y., Wang Y., Zuo Z., 2017, Research on the Evolution Game of National Supervision on Inspection Body, *Revista de la Facultad de Ingeniería*, 32(8), 182-188.
- Zuo Z. Y., Wu S., Li H., 2017, Evaluation of ISO9001 implementation effectiveness based on AHP-FUZZY comprehensive evaluation method, *Boletín Técnico/Technical Bulletin*, 55(70), 354-366.
- Zuo Z., Sun J., Chang Z., 2017, Research on Development Strategy of China's Certification Industry, *Revista de la Facultad de Ingeniería*, 32(14), 894-898.
- Zuo Z., Tang D., 2017, Research on the Impact of ISO9001 Certification Effectiveness on Organizational Performance in China, *Boletín técnico/Technical Bulletin*, 55(4), 644-655.