2017 International Nuclear Atlantic Conference - INAC 2017
Belo Horizonte, MG, Brazil, October 22-27, 2017
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR – ABEN

Agência Brasileira do ISBN
ISBN 978-85-99141-07-6

EVALUATION OF THE IMPROVEMENT SUGGESTION SYSTEM IN A NUCLEAR FACILITY

João Paulo Rodrigues Carnaval[1] and Geice Almeida Moraes[2]

[1] Indústrias Nucleares do Brasil S.A - INB
Gerência de Engenharia do Produto
Rodovia Presidente Dutra, km 330
27555-000 Resende, RJ
joaocarnaval@inb.gov.br

[2] Indústrias Nucleares do Brasil S.A - INB
Coordenação de Garantia da Qualidade
Rodovia Presidente Dutra, km 330
27555-000 Resende, RJ
geice@inb.gov.br

ABSTRACT

This work evaluated methods for processing improvement suggestions of a nuclear factory, with the intention to verify those which best fits to the company purposes. Two methods for processing improvement suggestions were applied in the studied organization. The first one was guided to the processing suggestions by specific independent sectors of the company and the second one was conducted to the processing of suggestions by a multidisciplinary team. It has been concluded that a multidisciplinary team focused on research and development would be the best option to the implementation of improvement suggestions and technological innovation on this facility, instead of multisector processing which revealed to be excessive bureaucratic before the expected goals.
This study can be used by nuclear facilities to optimize an existing system of improvements analysis or even guide them for the implantation of a new one. It´s more significant for the companies certified on ISO and OHSAS standards for the quality management, environmental and safety and occupational health systems which requires that the continuous improvement must exist and to be demonstrated. But it´s also relevant for nuclear plants aiming to implement an Integrated Management System certified on ISO Standards.

1. INTRODUCTION

The isomorphic management models adopted in several areas and types of organizations have emerged through the institutionalization of geographically situated demands for global governance over time. From the creation of the concept of quality after World War II and its evolution to the present time, several management models were developed and institutionalized among organizations. An example of the use of these models is the implementation of standards-based management systems [1].

There are currently many standards for the implementation of management systems, certifiable or not. Internationally known examples in various areas are ISO 9001 (Requirements for Quality Management Systems), ISO 14001 (Requirements for Environmental Management Systems), ISO 26000 (Guidelines on Social Responsibility), ISO TS 16949 Of Quality Management for automotive area), ISO 27001 (Requirements for

Information Security Management Systems) and OHSAS 18001 (Requirements for Occupational Health and Safety Management Systems). In these and other norms, the concept of management by the use of the PDCA cycle (Plan-Do-Check-Act) associated to the concept of continuous improvement.

The etymological concept of the term continuous improvement can be obtained by concluding the terms improvement, derived from the Latin *meliore*, which expresses the transition to a better state or condition, and continuous, from Latin *continuu*, which means constant, uninterrupted and always in the same sense [2]. By associating the two terms, continuous improvement expresses a shift to a higher state of improvement, designating a permanent state of positive change.

Cycles of change in organizations are caused by shifts to better levels (commonly associated with disruption) with bond (control and maintenance of improvement) to performance standards. This alternation between moments of rupture and control allows organizations to promote, implement, and perpetuate change over time as part of the same cycle, PDCA [3].
The PDCA cycle (Plan-Do-Check-Act), original of Walter Shewhart's works dating from 1920, is seen by Shiba et al. as a vehicle for the continuity of improvement and one of the most important concepts in this process [3]. It is composed of four phases, which can be described as follows when applied to the context of continuous improvement: (a) Plan - planning, establishment of the target for improvement and definition of the action plan; (B) Do - implementation, implementation of the action plan; (C) Checking - checking, monitoring, determining whether the implementation provided the expected improvement; (D) Action, establishment and standardization of new procedures to avoid recurrence of problems or establishment of targets for further improvements [4].

In the current standardization for management systems, continuous improvement is related to the recurrent use of management systems in order to increase their performance, using several methods chosen by the organizations where such systems are implemented [5].

The existence of continuous improvement as a requirement of management system standards is derived from quality movement, influenced by Japanese experience with Kaizen practice, which can be translated as continuous and gradual improvement of processes, implemented through the involvement of all Members of an organization, what it does and how things are done [6].

For Bessant et al., continuous improvement can be understood as an incremental, focused and uninterrupted process of innovation involving all organizational levels. Its small increments, in small cycles of change, even if very frequent, when seen separately have small impacts, but added together can make a significant contribution to the performance of an organization [7].

The continuous improvement of processes, present in the routine of the organizations, can occur in a formal or informal way. Often there is a concern in structuring methods to ensure that improvement spreads and in fact becomes continuous and, in general, this focuses only on the methodological issue. Some authors affirm that only structured methods do not guarantee that the improvement is actually continuous in the organizations, and may even cause the frustration of those involved in this process. The ideal situation is to develop a culture that values organizational learning to engage those involved with the improvement programs implemented [8].

Zampini and Toledo seek to demonstrate in Fig 1, adapted from Bessant's works, how the improvement cycle can evolve in an organization. This evolution is associated to the evolution of routines and behaviors, where the improvement of such behaviors is associated with learning and this leads to the change of stage in the cycle of continuous improvement. This process goes from the transition from the natural method of improvement promotion to a structured method, the interconnection of the improvements to the organizational objectives, the adoption of experimentation, even allowing the use of Research and Development Centers (R&D), until the arrival at Improvement levels that promote the organizational learning [9].

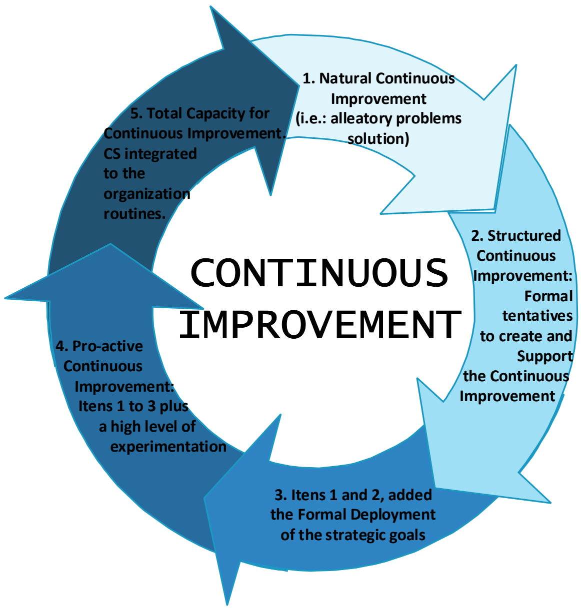

Figure 1: Evolution Cycle of the Continuous Improvement

A R&D sector must be formed of multidisciplinary team of employees with different levels of expertise and business scope, in order to cover the various possibilities of evaluation of the proposed improvements.

According to Nesta, Innovation teams - often referred to as innovation labs, funds or units - come in a variety of sizes, use the range of techniques, are equipped with different resources, and try to tackle different issues and challenges [10]. What unites innovation teams and labs - and differentiates them from other well run organizations or teams - is that they are all adopting experimental methods to tackle both social and public issues.
An example of a case is that of Faber-Castell, whose fundamental concept was that of Graham (2008) which says "Innovation is the implementation of the idea profitably". In this way, two basic measures were adopted: the pilot application of the Agile Project Management (APM) and the training of the product engineering and research and development team in the proposed tool, APM. Thus, the report states that "focusing on value generation, one of the strategies is to support the use of techniques that can convert hypotheses into feasible projects" [11]. Thus, in order to carry out the process of constructing

the projects and interaction cycles, the company has set up a room of collaboration and creativity, where the multidisciplinary team develops the improvements from its entry, in concept form, to its exit, which can be in the form of prototype.

The nuclear sector focused on the production of nuclear fuel has leading companies around the world working in the areas from mining to assembly of fuel elements, among which we can exemplify CAMECO, NECSA, URENCO, AREVA, KNF, INB, among others. As for the research itself, it is worth mentioning names like ORNL and IPEN. Driven by global energy demands, many companies invest in the formation of R&D centers, laboratories and specialized units in the development of improvements and innovation. An example of a case is the Westinghouse Nuclear, which has internal R&D projects and also open to the public, as in the case of *Welink* [12].

In the nuclear area, by the very nature and necessity of controls, the existence of specific standards is something expected. With reference to the standardization of the International Atomic Energy Agency (IAEA), focused on management systems, the standard GS-R-3 entitled "The Management System for Facilities and Activities" stands out. This standard, as well as the future ISO 19443 (Quality Management Systems), under development to meet the needs of existence and management of integrated management systems in the nuclear area, associating the present requirements in GS-R-3 with those present in the most recent version of ISO 9001, the concept of improvement is not far from the concept presented previously, in the ISO 9000 standard.

With reference to the standardization of the Brazilian nuclear area, the CNEN-NN-1.16 standard for Quality Assurance System for Operations Security stands out. In this standard, mandatory in Brazil for the purpose of elaborating a Quality Assurance Program for the licensing of nuclear installations, there is no concept of improvement associated with its requirements, precisely because its wording is of the era of quality assurance, whose last revision dates from 2000.

If by compulsory the installations of the Brazilian nuclear area must comply with the standards of the National Nuclear Energy Commission (CNEN), by voluntary strategy they can choose to seek certification in norms applicable to any type of organization. In an attempt to be in line with the international normalization in force in the nuclear area, Nuclear Industries of Brazil (INB) looked after certification in standards for management systems.

Since 2007, INB, an industrial facility in the Brazilian nuclear area, which holds a monopoly on uranium extraction and nuclear fuel production, has maintained an Integrated Management System (IMS) certified in OHSAS 18001:2007, ISO 9001:2008, And ISO 14001:2004 (SQE - Safety, Quality and Environment respectively), at its nuclear fuel plant, located in Resende-RJ. The scope of this integrated management system comprises the Manufacturing and Commercialization of Uranium Oxide, Fuel Element, Components, Items and Related Services of the Reactor and the Fuel Element for Nucleoelectric Plants. Its structure to meet regulatory requirements is defined in a Management Manual. Which includes the concept of process management, expressed by management standards through the use of the PDCA cycle associated with regulatory requirements at each stage of the cycle.

From the point of view of the regulatory requirements of these three standards in which the INB IMS-SQE is certified, it is noted that efforts to improve must be made through the use of the management system's policy and objectives, audit results, data, corrective and preventive actions, and critical management review [13,14,15]. In the case of the INB, in addition to the usual tools established by the standards, a channel for receiving proposals was developed, which allows company employees to suggest improvements to the processes of the Integrated Management System, regardless of their association with a potential deviation or effective. These suggestions are analyzed from a pre-established method and documented in the system document.

The objective of this work is to evaluate two methods of processing suggestions for improvement as an initial form of structuring a continuous improvement processing mechanism. The first one, the INB IMS-SQE's current method of processing suggestions for improvement, uses a multisectoral analysis structure, with independent evaluation of the improvement, by each sector. The second, applied with success cases in other organizations, is a method where the suggestion for improvement is evaluated by a single multidisciplinary team.

The methodology used in the organizational diagnosis, presented in this article, can be classified as qualitative, within an organizational research perspective, insofar as it seeks to treat the performance vision in the organization in an autonomous way, engaged in problem solving and search of solutions "at different levels of reality, with the central purpose of providing information for improvement of the management processes used, mainly, for interaction of aspects of institutionalization and operation [16]. The collection of information about the current method in the INB IMS-SQE occurred through participant observation of the authors in the processing of suggestions for improvement. The participant observation "consists of the insertion of the researcher within the observed group, becoming part of it, interacting for long periods with the subjects, seeking to share their daily life to feel what it means to be in that situation" [17]. The information collected, the diagnosis and the result of the evaluation of the methods are presented below.

2. EVALUATION OF METHODS

2.1. Analysis of the Multisectoral Improvement Processing Method

The multisectoral processing of improvements occurs with the evaluation of suggestions for improvements, issued by company employees, by sectors responsible and directly involved in classification activities, data collection and forms registration, pre and post implementation information management, and execution of the opportunity.

The improvement opportunities identified by the employees were submitted to the receiving channel made available by the company on the intranet. The sector responsible for the initial treatment of the suggestions, called the Committee for Technological Innovation (CINTEC), has an information management tool inserted by the collaborators in the network. On the other hand, the members of this team do not have exclusive function, exercising the activity in parallel mode. Thus, the typed text is automatically recorded on the server, organized by a case-archiving application, and a receipt protocol is sent to the author's email.

The case received is identified as new and assigned to a team member, who is responsible for obtaining more information about the coherence of the proposal with the interests of the

organization. If the adequacy is verified, a paper form is issued and sent to one of the management areas of the Integrated Management System for management of the information until its implementation. In case of proposals not pertinent to the interests of the company, wording is written in form informing the non-applicability, for registration.
The management area of the IMS evaluates the completeness of the information before the norms of ISO norms and the internal system of the company and sends the form to the area established as more applicable for execution, according to the content of the proposal. This area can be, in principle, any sector of the company, be it manufacturing, support, administrative, among others. The IMS staff as well as the executing areas, responsible for the actions described, also do not have an exclusive function, exercising them in parallel with their primary functions.

The executing area must evaluate a set of factors for the decision making regarding the implementation of the proposal, considering for example the applicability, compatibility with future projects, cost-benefit ratio and technical realization capacity. A first evaluation must be carried out within 10 days by this area which should, in the second moment, establish an effective deadline for implementation of the proposal. With this, the form containing information relevant to the decision made returns to the management area (IMS), which will verify with the executing area the status of implementation of the opportunity, at the time of expiration of the proposed term. If implementation is verified, the form is closed and the opportunity is considered successful, being the insertion of annexes of objective evidence of the implementation. Otherwise, a new deadline can be stipulated to enable proper implementation until it is implemented.
In case of non-implementation, due to technical, financial or other impossibility, the executing area reports its decision in a form, which is subject to a final evaluation of the management area (IMS), prior to closure.

The cases of improvement proposals submitted by the collaborators, which were analyzed by this method, took significant processing time, considering the moment of entry of the information by the manager until the IMS registration, with or without implementation of the improvement. The high time of this method is the result of the sum of the times consumed in the exercise of the activities of each sector, that carry out their actions according to availability of resources. In addition, a delay was detected due to lack of synchronism in the time intervals between the sectors, since the emission of the product of a sector usually does not coincide with the availability of resources, at the moment of receipt by the consecutive sector, and evaluation of the data, causing pause in the flow of information. This response time, added to the main activities of the employees of each sector, results in the accumulation of improvement opportunities sent by the employees, generating a cascade effect that implies in the increase of the degree of difficulty of processing.

To exemplify this method, one case is described as follows. The employee suggested that the valve used to control the rate of uranium hexafluoride during AUC precipitation should be substituted for an automated one, which could provide online information about the amount of UF_6 mass being transferred, increasing the quality and safety of the operations. The proposal was analyzed by CINTEC and a form containing appropriate information was sent to the Quality Assurance Coordination (IMS area) to registration and information management. The form was registered and forwarded to the Process Coordination sector, to evaluate the possibility of implement the action. It was concluded that wouldn´t be possible, at the time, to execute the improvement proposed and the form should be closed by the IMS sector. It took 7 months to the described opportunity be evaluated as not beneficial to the company, making it clear why the multisectoral method isn´t efficient.

2.2. Analysis of the Multidisciplinary Team Improvement Processing Method

The processing of improvements by multidisciplinary team, evaluated in this case study, was based on the methods established by leading companies to implement innovations from research and development centers.

A multidisciplinary team was designated as an experimental team to carry out actions aimed at evaluating proposals prepared by the company's employees. These improvement opportunities were submitted by a previously standardized electronic form, seeking to standardize as much relevant information as possible about the proposal. When detected the lack of data considered primary, either because it is technological innovation or absence of history that allows an analysis, the search for pertinent references was made.

The development of the proposal of improvement, at conceptual and basic level, involved the research itself, comprising the analysis of bibliographical references being low the level of application of tests, by how much are foreseen the equations and guidelines of what will be accomplished until the achievement of an adequate experiment planning. For the executive stage, the tests and developments pertinent to the generation of data are made for adjustments of a current model, replacement of a method or even the implementation of a new process. Besides these, additional prototypes or tools are foreseen, which can become products to be tested in practice, until they are standardized by material and / or product specifications, and become commercially accepted, leading to the implementation phase.

In order to implement the improvement, timely actions were considered necessary in process, with documentation usually known as Plans for Incorporation to production, as well as Commissioning stages (when they involve significant design change to verify the precepts of each installation), licensing (in that the entire scope should be submitted to regulatory bodies for approval) and eventually to the validation and/or qualification stages, when the modifications resulting from the implementation of the improvement directly modify process parameters, material properties or engineering acceptance criteria that impact on the manufacturing methods and product quality. After completion of all phases, the project is archived, being denominated implemented (if successful) or non-implemented (if not possible implementation).

The cases of improvement opportunities submitted by the employees, processed by this method, were significantly agile based on the activities carried out by the R&D team for the development of the proposals. The high degree of relevance of the members for the exercise of related duties implied in the directed flow of information and consequent productivity gain. In addition, the focus on the result, applied by each member and the objectivity in the information transfer induce to the minimization of the idleness of the system. With this, proposals considered pertinent to the scope of the organization were treated with greater priority and led to the implementation in a shorter time, promoting anticipation of the return. At the same time, improvements classified as not relevant in the context of the organization were marked with a degree of 'for information', reducing the consumption of time and resources.

This method can be exemplified by the following case. An employee suggested that every improvement proposal submitted by all the employees should return a protocol number and be available for consultation, aiming to know if it has been implemented or not. A team was formed with two engineers and a technician from the Technology of the Information sector. The proposal was approved and carried out in 7 days. Every suggestion submitted to the system by the employees return an email containing the registration number of that proposal, as well tittle and whole description, setting a receipt protocol. Also, it´s possible to check it´s status in the system to know if it´s implemented or not. This analysis was fast and precise, and it proves how this method is beneficial for the company.

3. CONCLUSIONS

The analysis of the processing of proposals for improvement by the multisectoral method showed that the establishment of independent sectors responsible for serial activities in the treatment of cases is the least effective method in the implementation of proposals. This conclusion is based on the high total processing time of the information as a result of the sum of the partial execution times of the activities of each sector combined with the time spent by the lack of synchronicity between the delivery of the result by a sector and the beginning of the consecutive activity, by the serial sector. Such effects may be direct results of the development activity of the improvements being secondary to the sectors studied, and may characterize the lack of effectiveness detected. The continuity of the generation of suggestions by the employees sent to the system whose processing capacity is found deficient could, in a short time, lead to the collapse of the mechanism. This method, although low viability, could be optimized by increasing the priority of the activities carried out in the processing of improvements by the employees of each sector involved.

The processing of suggestions for improvements by a multidisciplinary team, modeled on the precepts of the R&D centers of leading organizations, has proved to be effective in implementing results and generating value for the organization, as well as reducing time consumption for cases of lesser interest. This mechanism could be further optimized by the formation of an official sector for the treatment of improvement opportunities, as well as in the technical improvement of the team members to raise technical level and analytical capacity. In addition, investments in infrastructure and tools would allow the company to increase its capacity for innovation, generating a potential highlight for the increase in competitiveness resulting from completed projects.

It was concluded that a multidisciplinary team focused on research and development would be the best option for the implementation of suggestions for improvement and technological innovation in this facility, rather than multisectoral processing that proved to be excessively bureaucratic considering the goals sought.

This study can be used by nuclear facilities to optimize an existing system of analysis of suggestions or even guide them in the implementation of a new one. In light of the results, it is concluded that it is more significant for companies certified in ISO and OSHAS standards for the management of quality systems, environment and safety and occupational health that require that the continuous improvement exists and is demonstrated. These results are also considered relevant for nuclear installations seeking to implement an integrated management system certified to ISO standards, since the formation of teams focused on this activity can imply efficient compliance with regulatory requirements.

ACKNOWLEDGMENTS

Thanks to Indústrias Nucleares do Brasil for the permission on this work.

REFERENCES

1. G. A. Moraes, “Integração de Normas de Gestão: Uma Abordagem Orientada ao Setor Nuclear Brasileiro” *Dissertação de Mestrado – Programa de Pós Graduação em Tecnologia do Centro Federal de Educação Tecnológica Celso Suckow da Fonseca*, Rio de Janeiro, 2013.
2. A. Houaiss; M.S.Villar, *Dicionário Houaiss da Língua Portuguesa,* Editora Objetiva, Rio de Janeiro, Brasil (2001).
3. S. Shiba; A. Grahan; D. Walden, *TQM: quatro revoluções na gestão da qualidade*, Artes Médicas, Porto alegre, Brasil (1997).
4. T. C. P. Ferraz, “Proposta de Sistematização e avaliação das competências organizacionais para melhoria contínua” *Dissertação de Mestrado – Programa de Pós Graduação em Engenharia de Produção da Universidade Federal de Itajubá*, Itajubá, 2007.
5. ABNT, NBR ISO 9000: Sistemas de Gestão da Qualidade. Rio de Janeiro, 2015.
6. P. Wellington, *Estratégia Kaizen para atendimento ao cliente,* Editora Educador, São Paulo, Brasil (1998).
7. J. Bessant; S. Caffyn; M. Gallagher, “An evolutionary model of continuous improvement behavior”, *Technovation*, **Volume 21**, pp.67-77 (2000).
8. R. D. V. Gonzalez; M. F. Martins, “Melhoria Contínua e Aprendizagem Organizacional”, *Revista Gestão da Produção*, **Volume 18**, pp. 473-486 (2011).
9. C. S. Zampini; J. C. Toledo, “Proposta para estruturação da gestão da melhoria contínua em um fabricante de bebidas”, *Revista Gepros*, **Volume 2,** pp. 107-138 (2010);
10. “Innovation Teams and Labs: A Practice Guide”, http://www.nesta.org.uk (2017).
11. “Faber-Castell: fortalecendo sua cultura de Inovação e buscando soluções tecnológicas integradas ao futuro da companhia”, http://acervo.ci.fdc.org.br/AcervoDigital/Casos/Casos%202013/CF1302.pdf, (2013).
12. “Welink, the Westinghouse innovation acelerator”, http://www.westinghousenuclear.com/welink/About (2017).
13. ABNT, NBR ISO 9001/2008: Sistemas de Gestão da Qualidade. Rio de Janeiro, 2008.
14. ABNT, NBR ISO 14001/2004: Sistemas de Gestão Ambiental. Rio de Janeiro, 2004.
15. ABNT, BS OHSAS 18001/2007: Sistemas de Gestão da Saúde e Segurança Ocupacional. Rio de Janeiro, 2007.
16. M. Thiollent, *Pesquisa-Ação nas Organizações*, Editora Atlas, São Paulo, Brasil, 1997.
17. D. T. Queiroz, J; Vall, A. M. A. Souza; N. F. C. Vieira, “Observação participante na pesquisa qualitativa: conceitos e aplicações na área de saúde”, *Revista de Enfermagem*, **Volume 15**, pp. 276-283 (2007).