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Large Scale Training of Quality Professionals

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The purpose of this white paper is to outline the meaning, scope, major concerns, and perspectives around “Large Scale Training of Quality Professionals”. It is the third paper in a series of thoughts collected, organized, and promoted by the Quality in Education Think Tank (QiETT) of the International Academy for Quality (IAQ). The first paper addressed a broader scope of topics and put into perspective the overall field of “Quality in Education”, which set a common ground for further reflection and guidance of QiETT activities. The forthcoming papers, such as this one, focus around more specific subjects and delve deeper into particular topics based upon the collection of international inputs from quality and education experts. The collected thoughts compiled in this paper are presented in the following pages, according to headings that correspond to clusters of contributions received from the authors. Each author has a different background and is from distinct continents, but all share in common, as core QiETT members, a passion to promote Quality in Education.

To date, the collection of white papers comprises the following titles:

“Quality in Education: Perspectives from the QiETT of IAQ”

“Large Scale Training of Quality Professionals”

“Inclusive Quality of Education”

ABSTRACT

Quality plays a key role globally in realizing economic transformation in many developing and other countries. Governments of such countries are trying hard to enhance product quality as well as service quality so as to improve their economic development. To achieve this transition, a large number of quality professionals are urgently needed. However, currently many countries do not have enough quality professionals to meet this demand. Though there are some quality professional certifications and training programs, they are not recognized by the public in general and in some countries they were even stopped by the governmental administrative organizations because they considered these trainings and certifications as not generating high quality professionals. Based on this situation, the present paper addresses the following topics with regards to large scale quality training of quality professionals: 1) Training concept, transfer process, and strategies to enhance training transfer for quality professionals; 2) Action learning process for developing quality professionals; and 3) Development of train-the-trainers (TTT) systems for large scale quality professional training.

Keywords: Quality Professionals, Large Scale Training, Transfer, Lean Six Sigma, Train-the-Trainer

1. Introduction

The world is facing a quite impressive number of older as well as new challenges, in many cases demanding, in a short period of time, for the training of large numbers of well qualified quality professionals. Such quality professionals are needed and will play a major role namely with regards to the implementation of the well-known United Nation (UN) agenda and goals for Sustainable Development. In accordance with the Report of the UN Secretary-General, “Progress towards the Sustainable Development Goals” (E/2016/75), the United Nations declared that “Sustained and inclusive economic growth is necessary for achieving sustainable development.” As such, the UN will support countries in achieving a transition to green economies and increase their capacities to meet their commitments to the Paris Agreement on Climate Change, which was adopted in December 2015. The economic development model, which is dependent on excessive resource consumptions, must therefore be changed. Under this context, many governments are realizing that there is an urgent societal need to develop a large number of well-prepared quality professionals in order to achieve sustainable development by improving economic growth quality. One can thus easily understand why “Quality Education” has been recognized by the UN as one of the 17 goals needed to transform our world, under the aimed Sustainable Development paradigm. Therefore, proper large scale training of quality professionals is certainly a part of this tremendous effort ahead of us.

Similarly, under the “UNESCO Strategy for Technical and Vocational Education and

Training (TVET, 2016-2021)”, UNESCO “will support the efforts of its member states to enhance the relevance of their TVET systems and to equip all youth and adults with the skills required for employment, decent work, entrepreneurship and lifelong learning, and contribute to the implementation of the 2030 Agenda for Sustainable Development as a whole”.

Other examples of international and national organizations, pointing in the same direction, could be enumerated, but these sufficiently highlight and stress the relevance of the topic. Thus, this white paper is an additional contribution to a collection of topics related to Quality in Education that the International Academy for Quality (IAQ) Quality in Education Think Tank (QiETT) is building and promoting.

Through this white paper, the QiETT hopes to share and promote discussions around several ongoing initiatives in certain countries, as well as challenges ahead with regards to the large scale training of quality professionals. As a key driver for facing the multiple demands of an economic, social, and environmental nature, the aim is to help quality professionals develop the skills needed for employment and value creation, as well as for promoting equitable, inclusive and sustainable economic growth, and supporting transitions to green economies and environmental sustainability. This will require also permanent attention to the sets of skills and bodies of knowledge that quality professionals must take into account, including for instance entrepreneurial mindsets, proper understanding of advanced information and communication technologies, and engineering and mathematics capabilities. Recent trends of the so called “fourth industrial revolution” and the emergent roles of digitalization played by big data, digital production (Industry 4.0), Internet of Things, Artificial Intelligence or Shared Economy set serious challenges to the quality profession and the related training and education of its professionals in larger and larger scales.

The large scale quality education can be considered within three learning domains: the individual, organizational and societal (nation-, country- or region-wide) learning. They correspond to fundamentally different learning areas and phenomena. Individual learning consists of formal, non-formal and informal learning. According to the educational experts, most of learning takes place through informal learning, for instance through on-the-job learning. Top expertise in the quality discipline also means and requires lifelong learning. Professional quality awareness and skills are important not only to quality professionals, and professional quality related education is also needed for business leaders and other professions, for instance with regards to product designers, governmental authorities, lawyers, etc. Organizational learning should strive for the strategic business targets and be driven by top management, leading also to the creation of “learning organizations”. Society-wide learning takes place in a broader context, through diffusion from the learning achievements of the individuals and organizations at a given societal level. In this white paper we will namely present some country-wide experiences and thoughts about large scale

learning, education and training of quality professionals.

In order to achieve such challenges, goals, and ambitions, especially when dealing with the specific needs of the large scale training of quality professionals, no single person or organization alone is able to address them. Therefore, cooperation, partnerships, and the possible use of state of the art IT based platforms, including long distance learning tools, and contents, are part of the solution. One must focus then on possible ways to create effective individual and institutional collaborations, shared efforts and partnerships between quality organizations and other organizations that may also get involved and promote large scale training of quality professionals, either at the local, national, or international levels. International as well as national or regional based quality related entities (such as IAQ, EOQ, JUSE, and ANQ) may also be quite important in this regard through the roles that they already play. Further, this collaboration can lead to increased levels of cooperation and harmonization of training needs, efforts, and content to support large scale training of quality professionals that can be cascaded and deployed at the level of individual organizations. It is also important to realize that eventually new sets of training tools will be needed to assist companies in designing and implementing appropriate and effective strategies regarding the requirements, supply, and use of skills to achieve the expected development outcomes in priority areas of quality development.

In order to assess the competencies of quality professionals under such large scale training of quality professional environments, it is also essential to ensure comparability of certified quality professionals at the worldwide level. Approaches based on clearly defined certification schemes and common bodies of knowledge and procedures should be adopted by certification bodies that take into account existing good practices and accumulated knowledge. An internationally recognized competence certification model could be issued on the basis of common grounds, which would facilitate communication, knowledge exchange, and international mobility or career development for quality professionals. This would provide a unique worldwide system of training and certification.

When addressing quality professional training, and even more so when dealing with large scale training of such professionals and its quality, the focus must be on the overall purpose of these training activities. Therefore, it is necessary to first define a set of proper expectations about the types of quality professionals needed, particularly by taking into account the current realities facing territories and organizations. This leads to a compatible set of outcomes and goals that should be accomplished through appropriate training quality targets and achievements. The final objective of quality professional trainings is the achievement of readiness levels of quality specialists to manage a set of activities and achieve a certain goals. As such, creating the capabilities of these professionals to recognize and understand problems in the field of quality and to creatively seek their rational solution, as well as the creation of self-education practices must be appropriately addressed. The aim of training is,

therefore, a combination of satisfaction of the training needs of the individuals as well as the needs of organizations and societies to prepare professionally trained specialists in the field of quality.

Given the generic scope of this paper, the next sections will describe several international experiences. In addition, some of the most critical topics that need to be taken into account to support and reinforce “Large Scale Training of Quality Professionals” will be discussed.

2. Learning processes and efforts for developing quality professionals

The formation of quality professionalism is connected with the need to have competent personnel in the areas of quality, which is now regarded as a fundamental strategy for company management and societal development. As companies and organizations of all kinds plan for today and tomorrow, they have an urgent need for well-trained and experienced quality personnel in all aspects of their business operations. Recognition of these competences based upon national and/or international frameworks is also an ongoing effort.

The process of formation of quality professionals is based on the quality of the content and technology of training, the control of the training process, and the teaching staff motivation, as well as the creativity and effectiveness of the training activity. However, it also depends on the quality of students' attitudes toward training as well as the methods of presentation of knowledge, where interaction, multimedia content, and project based learning can play a significant role, even more so when we are dealing with large scale training projects. The quality of training, therefore, includes quality of training standards, training programs, material and technical basis of the training process, teaching staff, and participants as well as information and learning methodological choices. The quality of training must also be concerned with the creation of a complex set of characteristics, skills and knowledge, competencies, and professional consciousness reflecting the ability of a given specialist to carry out professional activities in the field of quality. Taking into account the requirements of the current stage of economic or organizational development, with an understanding of the interests of all stakeholders, and including also social responsibility for the results of their professional activity.

A first level of professional training may concern the development of a set of mandatory regulations and standards, as well as a socio-psychological attitude to quality problems, an atmosphere of creativity and initiative. At a second level, one may consider the profound mastery of the subject, the ability to transform knowledge into various areas of cognition, and practical activity. Finally, a third level can reflect the formation of a stable professional consciousness, which reflects the ability of creative activity based on learned knowledge applied even under complex and depth environments. For that to happen, certain abilities for effective professional activity

are quite critical (such as design, effective operation, use of resources, and consideration of relevant factors).

Some of these concerns are being addressed, under large scale training efforts, at many different organizations and countries, with some illustrative examples being briefly mentioned in the forthcoming paragraphs.

2.1. China Experience and Challenges

Nowadays China is trying hard to realize “Three Transformations” and “Supply-Side Reform”. Three Transformations include the transformations from “China speed to China Quality”, “Made in China to created in China”, and “Chinese products to Chinese brands”. Supply-side reform is expected to generate sustainable, quality growth, and importantly to improve the supply quality so as to meet increasing customer demand. Quality will play a key role for China to realize the economic transformation in the New Normal period in which the quality of economic development overrides growth speed. The Chinese government is trying hard to enhance the product quality of “Made in China” as well as service quality so as to improve its quality of economic development. To achieve this transition, a large number of quality professionals are urgently needed, with several thousands of such professionals being trained every year, given the lack of certain types of qualifications. With a well-known and ambitious national quality plan, China is one of the countries facing the “Large Scale Training of Quality Professionals” initiatives and challenges. Therefore, in this paper, attention will be devoted to this specific reality.

In 2015, the China Association for Quality conducted a country-wide survey on the quality management status quo in the manufacturing industry. 1,830 manufacturing companies provided valid responses. The survey shows that less than 50% of the employees received training on quality. About 55% of the companies claim that they did not invest enough money on quality training. In addition, approximately 75% of middle level managers claimed that they are not confident in deploying quality management programs due to a lack of professional knowledge on quality management and quality engineering. Compared to the big demand for quality professionals in industry, effective quality professional development is urgently needed, and must be implemented at a large scale under demanding standards of training quality.

In 2000, the Ministry of Personnel and General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (PRC) jointly announced the start of a quality professional examination and registration and related regulations and policies. The first quality professional examination started in 2001 and from 2001 to 2013 more than 123,000 people passed the quality engineer examinations (including assistant quality engineer and quality engineers) and registered as certified quality engineers. The quality engineer registration program had some positive impact to quality professional development in China. But in 2014, the State Council of PRC

decided to cancel a number of administrative approval programs including the quality engineer registration. To our understanding the major reasons of the cancellation are two folds. One is because the Chinese government is under reform and wants to eliminate those unnecessary administrative approval program or projects (some approvals may also cause corruption opportunities). The other reason is because of the ineffectiveness of the registration. The prerequisite for becoming a registered quality engineer is passing an examination and most of the test questions were too theoretical. Most of the registered engineers received training before taking their examinations, but the purpose of such training was mostly to prepare for the tests. Therefore, there was not enough evidence to show that those registered quality engineers did indeed have the capability to solve their real life quality problems.

In 2008, the China Association for Quality (CAQ) collaborated with the China Enterprise Confederation and started a certified quality manager (CQM) registration program. Similar to the certified quality engineer program mentioned above, the prerequisites for the registration consisted of passing the CQM examination and providing related working experience materials. As such, the effectiveness of such certification is also questionable.

The CAQ also provides annual Six Sigma Black Belts and Green Belts examinations and certifications. Six Sigma Black Belts and Green Belts are trained to solve real world problems. Therefore, in order to be certified as a Black Belt by CAQ, apart from passing the Black Belt examination, one needs to provide two projects that the candidate has finished as a team leader and orally present how these projects were conducted using the DMAIC (define, measure, analyze, improve, control) or DFSS (design for Six Sigma) methodologies. The CAQ is now using a similar approach for reliability engineer certification purposes. Further, for quality audits and auditors in China, as a registered auditor, one must receive 40 hours of training and pass the nation-wide examination for registered auditors.

In addition to the quality professional training and certification programs mentioned above, there are numerous other organizations (i.e., quality associations, consulting companies, and academies as well as universities) that provide training and/or certifications to quality professionals. However, the effectiveness of these activities is not totally satisfactory. Survey results show that the application of quality tools is still quite limited in China. For example less than 5% of the companies use quality function deployment (QFD) or design of experiments (DOE) in product design. Some engineers are certified as quality engineers but they do not have the capability to solve their quality problems or understand the basics of statistical process control (SPC).

Given the tremendous challenges of large scale training of quality professionals that China is facing, some of the ongoing initiatives, their outcomes and limitations, there is still a number of important challenges that need to be faced that demand the involvement of several key actors. These will be discussed next.

To develop quality professionals, systematic and rigorous academic teaching with real world quality problem solving training and experiences is needed. But in China, there are many problems that hinder the development of such professionals. Therefore, a joint effort from both from universities and companies is necessary.

Though there is a big demand for quality professionals to improve product and service quality in China, only a few universities have bachelor, master, or doctoral programs in quality management or quality engineering. Some universities cultivate quality professionals under the broader field of Industrial Engineering, which has been growing quickly in China. Another problem of teaching students in universities is that students do not have working experience; thus, they do not know how to apply quality management theory and methodology in practice. Comparatively, MBA students, who have at least three years of working experience, are more likely to transfer what they learn in the classroom to their daily jobs. In China, the Ministry of Education (MOE) approved nine universities to start MBA programs in 1991. Currently there are more than 237 universities with MBA programs. Unfortunately, quality management is just a small part of such programs, usually occupying no more than a module or so under the MBA's Operations Management courses.

There are several ways for companies to train their quality professionals. The first way is conducted by internal instructors. This kind of training is popular for on-the-job training of quality inspectors and technicians. Some companies have internal instructors to conduct training on quality control and basic quality tools. A second way of training companies is to hire or invite external experts to help train their quality professionals. The topics of such training are more advanced quality management theory and methods. A third way companies use is to send their quality professionals for training in quality management organizations or universities. For example, companies send their internal auditors to training organizations to receive training and certification.

The biggest problem for quality training in most companies is that they do not have a holistic quality training system. Most training programs or activities within a company are conducted *ad hoc*. Therefore, there is no system to track if the training is transferred to practice.

2.2. Quality Professionals Training in Kazakhstan

On a similar note, some of the experiences in Kazakhstan will be discussed, where the KOQIM organization has had success in training quality professionals for the past 20 years. Since 2011, its quality professional training activities have been carried out in accordance with the requirements and categories approved by the European Organization for Quality (EOQ), which will be discussed later, in accordance with the ISO 17024:2011 standard.

In Kazakhstan, the National Accreditation Agency runs a well-established national system for certification of personnel since 2015. This system includes the certification of specialists in the field of quality management (ISO 9001), environmental management (ISO 14001), occupational health and safety (OHSAS 18001), and energy management (ISO 50001). This national system of certification is based also on the requirements of the international standard ISO 17024, which were sequentially adopted according to the requirements of the national legislation of Kazakhstan. In accordance with this action, the accreditation of the first national body for certification of personnel in the field of these management systems was carried out. The main guidelines, which are used for testing and certification of personnel, were approved according to the guidelines and normative documents of the European Organization for Quality. In this regard, a contract was signed between EOQ and the National Accreditation Agency of Kazakhstan, for mutual recognition of the results of certification of professionals in the field of quality management.

Since that time, a qualitative professional expertise and registration system of personnel who have passed the certification procedures has been created both at the national level and also connected with the EOQ database of certified quality professionals. As a result of this cooperation, all certified specialists receive two certificates (Kazakh and EOQ). This provides a significant additional motivation for specialists working in the field of quality management. Thus, over the past three years, hundreds of specialists have passed through this certification procedure, and have gained recognition not only locally but also at the European level.

2.3. Categories of Quality Professionals and Professions

As stated previously, a considerable number of important new opportunities, needs, and possibilities are facing present and future of quality professionals. This includes increasing numbers of qualified people in different parts of the world, as well as the availability of international mobility, projects and exchanges, made easier and easier as more and more content or IT based platforms become available for learning and sharing quality. This is sometimes coined as “e-quality” at a worldwide level. This implies that eventually the bodies of knowledge, categories of quality professionals, and corresponding certifications need to be updated, revisited, or even substantially redesigned, on one hand, and that benefits might derive from having broader international agreements among different organizations and countries in this regard.

Next, some of the available categories of quality professionals and professions will be reviewed to illustrate what they may have in common and also how far we are from having stronger convergent options made at the world level. This value becomes clearly stronger as we move into a larger demand for the large scale training of quality professionals.

The American Society for Quality (ASQ) has a long lasting and well-known experience of training that also includes the certification of quality professionals

according to a variety of possibilities. In addition, ASQ has over thirty years of an annual salary survey data that also takes into account a quite large number of quality roles played by professionals. Further, ASQ classifies jobs associated with quality careers as follows

(<http://asq.org/learn-about-quality/quality-professionals/overview/overview.html>):

- (1) Analysts initiate and/or coordinate quality related data from production and service activities, and reports these data using statistical techniques. The key responsibility for analysts is to extract information from quality related data of various sources. The tools that are used for data analysis are not limited to statistical techniques. Today, with the wide application of sensors and online automatic measuring instruments, quality related product and process “big data” can be easily collected; thus, big data analytic tools should be an important part of the analysts’ toolkits. Generally analysts need systematic, comprehensive training in statistics and computer and data science.
- (2) Associates are involved in quality improvement activities or projects but not necessarily full time. Many companies may not have job positions entitled associates, but the functions of associates are close to quality improvement project leaders and/or project champions. The associates need to know some knowledge of project management as well as quality management.
- (3) Auditors systematically inspect and examine a quality system to ensure compliance to requirements. Auditors include internal and external auditors. External auditors work for the quality system accreditation organization and conduct periodic quality system audits based on quality system standards (e.g. ISO 9001, IATF16949). Internal auditors generally work inside quality management departments and their responsibility is to make sure business processes are executed in compliance with quality system requirements. Auditors are trained and certified by quality system training organizations.
- (4) Inspectors audit and report materials, processes, and products using variable or attribute measuring instruments and techniques to ensure conformance with the organizations’ quality standard. Inspectors can be engineers, technicians, or front-line workers. Technical training and/or professional certifications are needed to become an inspectors. In addition to certain engineering knowledge about inspection, some theory and knowledge about metrology and measurement system capability analysis are needed for inspectors.
- (5) Quality engineers design, install, and evaluate quality assurance process-sampling systems, procedures, and statistical techniques; design and specify inspection and testing mechanism and equipment; analyze production and service limitations and standards; recommend revision of specification when indicated; and formulate quality assurance policies and procedures. Quality engineers play very important roles for quality assurance and improvement. Most companies have quality engineer job positions. Some countries have quality engineer certification and registration systems, such as ASQ certified engineers. To be a quality engineer, one needs systematic training in the field of quality management and quality engineering.

- (6) Quality managers oversee the administration of quality, process, and/or business improvement efforts. They typically have authority over a clearly defined area of an organization and a number of direct reports. In most companies, quality managers report directly to quality directors or vice presidents in charge of quality. They play a vital role in quality management since they are responsible for the overall design, implementation, and maintenance of an organization's quality management system. Quality managers should receive comprehensive training on quality management and quality engineering. Apart from the expertise of a quality professional, a quality manager needs to develop soft skills such as leadership, team building, coaching, and facilitating.
- (7) Specialists perform specific functions within a quality initiative, such as statistical analysis and testing. They have extensive experience or training. Specialists generally have professional training in areas such as SPC, reliability, DOE, QFD, and FMEA.
- (8) Technicians perform basic quality tasks to track, analyze, and report on materials, processes, and products to ensure they meet organizational standards. Apart from the technical skills required for fulfilling the job position, technicians need to receive basic training in statistical data analysis.

EOQ also has a certification framework for quality professionals, with particularly high numbers of users coming namely from Germany. In addition, EOQ offers courses regarding the following categories of quality professionals:

QO - Quality Operator

QAS - Quality Assistant

QMT - Quality Management Technician

QSM - Quality Systems Manager

QSMSS - Quality Systems Manager in Services Sector

QSMPSA - Quality Systems Manager in Public Administration

QA - Quality Auditor

ESM - Environmental Systems Manager

ESA - Environmental Auditor

OHSSM - Occupational Health and Safety Systems Manager

OHSA - Occupational Health and Safety Auditor

IQESM - Integrated Quality and Environment System Manager

IQEHSM - Integrated QEHS Systems Manager

CSRM - CSR & Sustainability Manager

TQMA - TQM Assessor

TQML - TQM Leader

QSMH - Quality Systems Manager in Healthcare

OP - Occupational Physician

FSM - Food Safety System Manager

FSA - Food & Safety Auditor

ISMMSM - Information Security Management System Manager

ISMMSA - Information Security Management System Auditor

LQAM - Laboratory Quality Assurance Manager

LA - Laboratory Assessor

MSC - Management System Consultant

MSSC - Management System Senior Consultant

PSM - Process Manager

More examples could be provided, but a comparison of ASQ and EOQ quality professionals certification possibilities shows that: i) possible revisions may be needed to update such frameworks according to the present and future needs for quality professionals; ii) although there are several similarities and many points of convergence, we are still far away from having a single worldwide system for the qualification and certification of quality professionals, developed and implemented at the worldwide level.

Furthermore, most companies only have a small fraction of the above sets of quality professional categories. Some companies may have quality professional positions with titles other than those listed above, as well as their own internal certification schemes. In companies that implement Six Sigma or Lean Six Sigma, typically the job positions of specialists, analysts, and associates are replaced by Master Black Belts, Black Belts, Green Belts, and/or Yellow Belts, and certifications are now also available for such quality roles. In China some companies set a high level position called Chief Quality Officer (CQO). This is someone who is in charge of quality management at the corporate level, something that in the USA is typically named of Quality Vice-President. In other countries or companies an even larger variety of combinations can be found. Not only that, but also the corresponding job descriptions and roles change substantially from one organization to another, or one country to the other, depending upon cultural differences and approaches to quality.

Therefore, as quality becomes increasingly global, we find different names associated with similar quality professional job descriptions. In addition, there are different interpretations for how the job description corresponds to a certain specific common name (e.g., regarding the detailed duties of a quality manager, quality engineer, or black belt), either from one organization to another, or from one country to another. Leading international quality organizations can play a major role in helping to overcome some of these variations through joint efforts to develop worldwide bodies of knowledge, names/titles, and certifications for appropriate categories of quality professionals. In this regard, an interesting project is being carried out by the IAQ Designed Improvement Think Tank. After detailed comparison and benchmarking of different problem solving structured approaches already available, under the leadership of Gregory Watson, this team of IAQ members has created a common conceptual model for Continual Improvement, together with contents that may end up being used for large scale training of quality professionals according to this attempt to define a unified and internationally accepted framework. Based on the original request made by EOQ, the outcomes will also be shared with ASQ and JUSE. Training

materials are under preparation, together with pilot projects to validate the methodology being planned to take place in a number of companies located in different countries. Other examples, such as this one, may help the quality community to develop common ground, defined and accepted at broader international contexts, which will also leverage the potential for better delivering large scale training of quality professionals.

All of the previously mentioned quality professionals play important roles in creating quality in a company. Therefore, these quality professionals need appropriate training to develop and update both their skills and knowledge. Not all companies invest sufficient time and money in quality training. Some companies have spent considerable time and money on training quality professionals, but the training effectiveness is questionable. On the other hand, many studies show that leading companies take the need to invest well seriously. These companies focus heavily on the effective and large scale training of all the different categories of quality professionals that they need to assure sustainable success and competitiveness at the local and international level.

3. Quality Professionals and Training Knowledge Transfer

How to ensure that trained skills and knowledge are used in the workplace, transferred to the job, and help to transform organizations remains of critical importance (Burke & Hutchins, 2008). Research shows that only 10 to 15% of what is learned in training is actually transferred back to the job (Kontoghiorghes, 2014). This is also the case regarding training and large scale training of quality professionals.

Therefore, one of the keys to developing quality professionals concerns the improvement of training transfer. There are numerous studies on training, learning, or knowledge transfer (Kontoghiorghes, 2014; Baldwin & Ford, 1988; Huczynski & Lewis, 1980; Burke & Hutchins, 2007; 2008; Ford et al., 1992). Research shows that the training transfer process is complicated and transfer effectiveness is affected by many factors. Broad and Newstorm (1992) prioritized the main training transfer barriers from high to low as follows: 1) lack of reinforcement on the job; 2) interference from immediate work environment; 3) non-supportive organizational culture; 4) trainees' perception of impractical training programs; 5) trainees' perception of irrelevant training content; 6) trainees' discomfort with training change and associated effort; 7) separation from inspiration or support of the trainers; 8) trainees' perception of poorly designed/delivered training program; 9) pressure from peers to resist change. They also present three types of transfer strategies: 1) transfer strategies before training; 2) transfer strategies during training; 3) transfer strategies following training. Such factors and types of transfer strategies may also be taken into account when training quality professionals and even more so with large scale training of quality professionals.

As for quality professional training transfer, a strong management commitment is needed before training takes place to improve training transfer. Top management should be supportive to quality management training and participate in developing holistic quality training and transfer plans. These plans should cover everybody in a company; however, different people at different levels or job positions should receive different training solutions. For example, top level managers may be trained with strategic quality management, including quality planning and deployment, as well as quality management. On the other hand, middle level managers can be trained with more specific quality tools, based on their job functions. Product and/or process design managers and engineers need to receive training regarding for instance integrated product design, concurrent quality engineering, QFD, FMEA and design for six sigma. In addition to training content design, top management needs to define a training transfer plan. For example, the design manager and its engineers are assigned a project to reduce product design cycle times before they receive training on design quality. With the motivation to finish the project, trainees will be more likely to study the training materials in advance.

Several studies have also shown that leading companies in the world look into quality training as a strong and interesting investment, covering different goals, content, and opportunities not only all of their employees, but quite often also suppliers or other kinds of stakeholders.

During the training process, training transfer depends on the effectiveness of the knowledge transfer from trainers to trainees. Under the flipped classroom paradigm knowledge also transfers from trainees to other trainees, or even from trainees to trainers. Some quality training topics, such as some statistical topics, may not be easy for some trainees to be properly understand. Looking for appropriate content, other international experiences, or case studies can help to overcome such possible difficulties. It is also important to build strong interaction between trainers and trainees, as well as trainees and trainees, since peer learning and sharing are powerful ways to learn quality. For that to be promoted, trainers may use some team activities, simulations, exercises, case studies, and project based learning, including problems brought to class by trainees. Trainees can also be encouraged to raise questions, especially regarding questions related with their projects or daily quality duties. Broad and Newstrom (1992) recommend that the training process be free of disruptions and not lose its sense of continuity, rhythm, and flow. When training is arranged inside a company, quite often management training courses are interrupted due to business meetings. One way of avoiding this is to have high level management training take place in a venue located outside the company.

Training transfer generally happens mostly after training, thus building transfer training strategies following training can significantly influence the transfer success. First, the trainees should get support from their upper level management to apply what they learn in their workplace. Upper level management may also require and provide

the trainees with opportunities to implement their new knowledge. Second, to facilitate the transfer process, a company needs to provide coaching to help the trainees in the practical application of what they learned, under the help of internal or external mentors. Third, the company may have a review system to evaluate the performance of the training transfer. The review results are essential for the continuous improvement of the training contents design and delivery. Lastly, a promotional policy and recognition system that awards the application of training knowledge are necessary (Kontoghiorghes, 2014).

Closing the improvement cycles is a critical feature, present in almost all quality approaches or methodologies. Such a principle should also be seriously taken into account when one is addressing the large scale training of quality professionals. This cycle should be considered across the global training life cycle, from the definition of its goals all the way to follow-ups conducted after conclusion of formal training opportunities. Assuring that besides personal development of the quality professionals indeed appropriate training transfer does take place, leading also to organizational improvement and transformation.

4. Lean Six Sigma as an action learning model for quality professionals

As an example of what can be done in order to develop efficient, effective, and impactful large scale training of quality professionals, we will now draw from the experiences in China regarding Lean Six Sigma, although many others might also be presented.

Based on the analysis of the quality professional transfer process, from such an experience we may find that the widely-used Lean Six Sigma (LSS) training can provide a good way to achieve training transfer and develop large scale training of quality professionals. In China, as in other countries, it is hard to estimate how many companies are implementing LSS or Six Sigma, but more and more companies have begun their LSS journey, leading to the large scale training of LSS quality professionals.

Currently there is no well-accepted definition of LSS, with different interpretations being made in different organizations and countries. However, broadly speaking, one may say that LSS is a synergy of Lean and Six Sigma: 1) Lean focuses on streamlining work flow, customer value, and eliminating waste; 2) Six Sigma focuses on satisfying customer requirements and minimizing waste by reducing and controlling variation. As such, LSS has been widely implemented as a strategy for continuous improvement and innovation in China and many other countries.

LSS is also about large scale quality professional development, given the demand for such quality professionals, and it offers an action learning process for developing these quality professionals. From the quality professional training perspective, LSS provides a good way for quality professionals to transfer class-room learning to workplaces through real LSS projects and applications.

From the large scale LSS training experience acquired so far, namely in China, one can extract a number of practices that should be taken into account by any country or organization that wants to develop quality professionals and increase the effectiveness of quality management training transfer, especially when dealing with large scale training scopes:

- (1) Top management commitment. LSS deployment is a top down process and management commitment plays the most important role for LSS success (Brady & Allen, 2006). Top management must be committed to provide resources to train its people to be quality professionals (e.g., Master Black Belts, Black Belts, Green Belts, and Yellow Belts). Top management oversees such quality professional development process by attending Six Sigma projects reviews.
- (2) Structured approach. LSS adopts the structured DMAIC (define, measure, analyze, improve, control) approach to solve business problems and Design for Six Sigma to achieve product/process design and innovation. The structured approach facilitates the trainees to apply the knowledge learned to practice.
- (3) Projects driven. Unlike traditional training, LSS projects should be selected before training starts. The purpose of LSS training is to help trainees solve their problems. The LSS approach to developing quality professionals is based on action learning models that combine classroom instruction with real-time project implementation. Trainees are required to apply LSS knowledge to their projects after each training phase. For example, after the trainer finishes the Define phase for DMAIC, trainees should apply what they learned and define their own projects immediately. Training transfer effectiveness is measured by projects results achieved.
- (4) Systemic training based on LSS role structure. LSS quality professionals lead the organization's efforts in business continuous improvement to form a role structure including Champions, Master Black Belts, Black Belts, Green Belts, and Yellow Belts. In addition to these roles, the LSS executive committee or steering committee is generally formed to lead LSS deployment. Financial analysts are assigned for evaluating projects financial results. People of different roles receive different training programs. LSS companies have a systemic training structure including different training programs targeted at different roles.
- (5) Trainees' motivation to learn and transfer. Literature on training transfer shows that unless the trainees are motivated to learn during training and transfer what they learn back to the job, even the most sophisticated training programs will not be successful (Axtell et al., 1997; Burke and Hutchins, 2007; Kontoghioghes, 2004). In LSS companies, before DMAIC or DFSS training starts, it is very important to form project teams based on selected LSS projects. Project team members or trainees are called Belt candidates (e.g., Black Belt candidates). Black Belts or Green Belts are big honors in the company, and thus the trainees are strongly motivated to learn and transfer what they learn.
- (6) Recognition and awarding system for training transfer. LSS companies have recognition and awarding systems to motivate LSS project teams. After the Six Sigma projects are finished and evaluated to be successful, the team will be

rewarded based on the hard savings of the projects that were achieved. Team leaders might be also certified as Black Belts or Green Belts, which are highly recognized titles for the trainees.

- (7) Culture for training transfer. Research on training transfer shows that organizational culture and training transfer climates are relevant to training transfer. In companies implementing LSS, typically a stronger culture of cross-functional team work, management support for transfer, opportunity to practice and tolerance to failure can be found. All these environmental factors positively influence training transfer and the outcomes for large scale training of LSS quality professionals.

5. Implementation of Large Scale Training of Quality Professionals

In order to address the specific challenges of large scale training of quality professionals, one must understand right from the beginning that it is not by any means an easy task to be achieved, either at the level of a certain organization or territory. Coming up in a short period of time with hundreds or thousands of well-trained quality professionals is indeed a difficult task, where one must try to assure that quantity and quality of training activities can be both assured in a consistent, impactful, and well deployed way.

We will not mention all the key factors that need to be taken into account for a successful implementation of such large scale training of quality professionals. Besides the topics already discussed before, we will just briefly enumerate three critical factors to be taken into account for properly defining and implementing such large scale training projects: 1) Training the Trainers; 2) Knowledge Clusters; 3) Information and Communication Technology (ICT) Tools.

Training the Trainers

In China there is a well-known old saying: “Teach a man how to fish rather than just giving him a fish”. Most Chinese companies invite external trainers to conduct training for quality professionals, the same also being the case in other countries. For instance, when companies start to implement LSS, they also contract some consulting companies or universities to receive training services provided by them. It is acceptable for companies to invite external people to deliver top management training or some cutting-edge topics. But it is expensive and sometimes difficult to develop large scale training by relying on external sources. For large scale training, dealing for instance with the magnificent seven tools or the so called new seven quality tools, it may be better to use internal trainers. Internal trainers are trained through train-the-trainer (TTT) solutions. Internal trainers may work full-time or they may conduct internal training part-time. Internal trainers can work more flexibly and they can provide more professional on-site consulting because they know their business better than external trainers. Many LSS companies in China such as Haier, Fosite, and AVIC have set up their own TTT systems. One should not forget either that in some

topics, such as Six Sigma, concepts and training were actually started within the scope of specific companies, with vast large scale training programs implemented.

In order to assure large scale training of quality professionals, a critical issue regarding cascading and deployment of training efforts has got to do with a need to establish a well-defined structure for levels of training and consecutive layers of high quality TTT initiatives. This can be seen, for instance, if one looks at the levels of knowledge connected with the different types of roles played in LSS implementation, the corresponding trainees, trainers, and trainers of trainers, with the possibility of having also reversed roles, with some trainees becoming also trainers for other kinds of trainees. A strong quality in the hierarchy or network of TTT programs must be appropriately taken into account whenever large scale training of quality professionals is involved.

Knowledge Clusters

Under the same large scale environment, both at the company and country level, one needs to find appropriate ways for knowledge management, identification, and sharing. For instance, by building and mapping where specific quality knowledge is available at universities, in quality related or other types of organizations. The stronger this network of key agents, and the better it is characterized, the easier it will be to make proper use of it in order to put together and deploy large scale projects of training of quality professionals.

Since, for such large scale goals, no single person or organization is likely to have all the needed resources for putting together and implementing such projects. Furthermore, certain specific or advanced knowledge will always be available just in some nodes of the network, and every one gains a lot by knowing easily where knowledge is located, who are the right partners for exploring such knowledge and how one can have access to them. Therefore, both at the level of a country as well as of large companies, it is critical to adopt appropriate knowledge management tools, find out where certain clusters of knowledge are located and how they can be mobilized for specific training projects. The stronger this network of quality knowledge, the easier it will be to put together all the resources needed to achieve high quality in the implementation of large scale projects for training quality professionals.

Information and Communication Technology Tools

In all fields of quality training, but even more so when dealing with large scale training of quality professionals, one may benefit significantly by exploring the possibilities opened by e-learning or blended learning and ICT in general. Excellent training programs can then be shared worldwide, globalizing some of these activities. This is part of the window of opportunities related to “e-quality”, which may also lead to “equality”, in the sense of quality professionals having access to similar training possibilities, regardless of where they are located. However, to fully take advantage of

such ICT tools for promoting large scale training of quality professionals, one must not forget that: 1) the development of high quality contents for e-learning demands specific knowledge and considerable amounts of initial investments; 2) language differences are still a considerable barrier, at least for considerable parts of the world; 3) long distance learning may demand strong mentoring and coaching components to support its quality and effectiveness; 4) broader international consensus and collaborations about bodies of knowledge, as well as shared contents would help the diffusion and impact of these learning mechanisms and approaches.

Training of quality professionals in the face of future challenges

In accordance with Armand V. Feigenbaum, “Powerful new global economic forces were radically changing the concepts of quality and how it was managed. These forces now make it essential that quality managers face the future with quality-based management programs that fit the new business era, rather than continuing with systems that may have worked in the recent past. Several trends will impact quality management in future.” As this global economy reaches out to world businesses, it becomes clear that quality is becoming not only the international business language for worldwide trade networks but also that worldwide economic and social forces are fundamentally changing quality concepts and management. Improved quality now means an increase in value as well as right performance, service, design, and economy for global customers. This differs from quality control as former focus on defect reduction alone. Understanding and speaking this new quality language and transforming quality processes accordingly is a principal goal of successful companies that are becoming sales growth and earnings profitability leaders in the new global economy.

Changes in the role of labor in the future. Concerning to the ASQ study “The Future of Quality” training for the next generation of quality professionals should be conducted taking into account changes in the role of the workforce in the future. Changes in the business environment based on new innovative technologies are developing at an unprecedented pace. Our usual framework for training quickly becomes obsolete.

Advanced quality professionals should also have the ability to conceptually thin of quality with a valid scientific basis, which is a prerequisite to sustained relevance of the quality profession in the changed environments and conditions that organizations and whole societies are facing in the 21st century. Today’s acute topics of expanded application areas for quality include the challenges of the Industry 4.0 and particularly also new challenging professional practices of quality management under the contexto of SMEs and startups. This also emphasizes a need for stronger research involvement of quality professionals and research activities related with the development of new quality concepts, principles and methodologies.

Personalize the training of quality professionals. The goals and objectives as well as the structure of the trainings should be arranged taking into account the personalized registration of the participants' requests. It is advisable to apply integrated approaches to the organization of training to enhance its focus to provide the knowledge needed for each quality professional to solve his/her own problems.

Quality professionals and digital technologies. Quality professionals should be ready to use large databases, apply analytical information tools to make appropriate business decisions. Creation of a modern corporate infrastructure of training centers that will adapt to the constantly evolving business landscape. It is necessary to create an effective global system of supply chains of training services, ensuring the continuity of the learning process from the basic levels to quality professionals. Intensive development of digital technologies, large amounts of data and settings will increase the effectiveness of all types of training: in the classroom, online, and remotely. The improvement of training technologies will lead to a change in the space and the learning process. The use of modern information technologies for trainings will allow to train of quality professionals are located in different geographical regions, countries, and continents. The application of new educational technologies and digital resources changes the attitude of trained quality professionals to learning process. The presence of smartphones, tablets, and personal computers increases the possibility of using mobile learning technologies for learners.

Changes of the roles of trainers and trainees. The development of modern educational technologies changes the content of trainings and learning process as well as the role of the trainer and trainees. The role of the coach will be much broader than that of a traditional teacher. Therefore, participants of training will have access to more content via of a global connection to the Internet and the wide possibilities of online technologies. Participants will require that their training be increasingly more independent. The needs for learners' independence will grow. Methods and opportunities for feedback from trainees will be significantly changed. In accordance with Prof. Sung H. Park (2017) the ways of learning will change. For example, using of massive online open courses (MOOC) will be more popular and science, engineering, engineering, mathematics (STEM) will give more possibilities for trainees.

New models of quality professionals trainings. Currently, the trainer provides knowledge and trainees are the recipients learning together in the group at the same time and same space. In the future, the space in which the training takes place will change. There will not be a need for 100% training in the group. Applying the same training schedule to the whole group limits the freedom of trainees. Of course, it is very important for quality professionals to gain the experience by teamwork with the skills of practical application of knowledge. For personalized training, self-learning will be important. In addition, students will be able to learn at their own production

bases and build the learning process to solve their own business problems using their own schedules.

Independent and impartial assessment of the competence of quality professionals.

Based on the results of training in the future the need for independent evaluation of the professional competence of quality professionals will increase based on the application of the certification procedure for personnel in accordance with the requirements of ISO 17024. Specialization in the areas of quality management will continue in the future. Therefore, it is very important to consolidate the relationship of training diplomas with an objective and independent evaluation of the theoretical knowledge and practical skills that the employer will be able to obtain from the trained quality professional.

Quality professionals training for the development of brands. In the future, quality professionals' attention should be paid not only to inculcating theoretical knowledge and to practical skills for improving the quality of products and services but also the ability to promote brands in local and international markets. In training programs it is necessary to take into account the interests of stakeholders and create loyalty to the brand for getting successful competition.

The ability of quality professionals to create a new organizational culture. When quality becomes as a fundamental concept for every company it integrates as an organizational philosophy that supports innovations, positive customer experience, and promotes talent development. Quality professionals should be able to consistently achieve successful results; which must become organizational thinking not just a set of policies, rules, and tools that are managed by a quality function. When quality management integrates into how we do business finance, marketing, design, development, manufacturing operations, supply chains, and customer interactions we can feel the benefits of all this for business growth. Quality should be fundamental to the culture of the organization, from the CEO to all employees.

Quality management and business globalization. More and more organizations are becoming "global" due to the development of new markets and also because of global and regional supply chains. Globalization leads to a change in the competitive factors in local and international markets. In this regard, it is necessary to review the market policy for small and medium-sized businesses that will require the changes of the goals and objectives for quality professionals in order to successfully resist against of global competition and achieve sustainable development.

Threats of economic, political, and natural crises. It is becoming increasingly difficult to forecast evolving and potentially destabilizing socio-economic factors, from exchange rates and natural resources to politics and demography. Training programs for quality professionals should include concepts, methodologies, and tools for risk management.

Partnership and leadership of quality professionals. The role of quality professionals will be developed more successfully if their activities are based on partnerships with leaders and company personnel. Leadership of quality professionals should be built at each level of management of the organization in each structural unit. Under the new conditions the role of international and regional quality organizations, such as ASQ, EOQ, and others should also be changed. Cooperation with the quality organizations will enable an increase in the role of quality professionals as they are partners and leaders and not just technical specialists actively cooperating with enterprises, business schools, the scientific community, professional societies, industry groups, and government agencies. The creation of new knowledge networks and interfaces will facilitate new solutions and applications. First, it is necessary to integrate innovation and quality for faster innovation. Second, the integration of quality and social responsibility should be ensured in order to promote a more holistic approach to the results of cooperation.

Shifting requests and expectations of customers. In this regard, training for quality professionals should be carried out on the basis of a flexible business strategy that can adapt to the changing needs and expectations of consumers. For business customers this attitude is due to the need to improve living standards, which also requires reliable and predictable quality. These customers expect that the level of quality shall be appropriate for their needs and expectations. This demand for full customer satisfaction indicates a profound social shift for both global and local consumers.

Economic pressure. An important factor is the economic pressure on business organizations. One of which is the growing competition in the market requiring lower costs as well as resource saving. The other is a serious pressure on commodity prices due to inflation of national currencies.

6. Conclusions

Large scale training of quality professionals is necessary for sustainable quality improvement in any organizations or territories. In many countries, there is a large demand for such quality professionals. Finding an effective way for large scale professional training in this area is still a challenge ahead of us. This paper analyzes some of the critical issues for facing such a challenge. To meet the requirements of job positions, quality professionals need to receive appropriate training and transfer the knowledge learned to their work places. Top management plays a critical role in organizing quality professional training and building strategies for training transfer in the phases of before, during, and after training. As for training transfer models, we believe that LSS implementation provides an excellent example for developing quality professionals with proper knowledge transfer to practical results, although others might also be provided. Training with real time projects and problem solving facilitation helps knowledge transfer and yields business results.

There are some topics that may need to be further studied in depth for properly addressing and promoting the future of large scale training of quality professionals, such as the following: 1) empirical studies are needed to further explore quality professional training transfer processes and how to build good environments to facilitate knowledge transfer, training impact, and outcomes; 2) find new ways to design training courses for people at different levels in an organization, located in different places and with a large scale of trainees; 3) define the new bodies of knowledge for quality professionals that are needed worldwide, as well as what knowledge is more difficult to transfer.

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