An Integrated Sustainable Quality Management Framework for Quality-Related Research

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Abstract

The existence of synergies between several quality management systems and sustainability has spurred great interest in better understanding the sustainable quality management (SQM) concept over the past decade. This paper aims to design and develop a sustainable quality management framework (iSQMF) that integrates the quality management practices with the Whole System Design (WSD) practices, including the environmental, social, and economic sustainability aspects. The relevance of the designed iSQMF in supporting quality management research and sustainable initiatives is detailed and reported. In addition, the research presents a twelve-stage planning system as a tool for monitoring and controlling the implementation of SQM programs. The proposed framework holds great potential in not only bringing sustainability concepts actionable but also addressing the institutional and developmental processes in a management system.

Keywords: Quality management, sustainable quality management, integrated quality management framework, sustainability, environmental management, Total Quality Management.

1. Introduction

Since the early 1980s, a plethora of contributions has been observed in the field of quality (Pleban, 2013). These contributions were documented as standardization protocols and legal actions that perceived quality as a product and production-oriented concept. This included specific modus operandi, processes, distribution of authority, and resources for imposing quality management; rather than a system concept. The early 1990s after the earth summit showed a shift in this concept. The concept of "quality" was replaced by a "quality management system (QMS)" that defines quality management as a system for managing and monitoring an entity with an allusion to quality (Podgórski et al., 2001). A wide range of management system has been created over these years, extending the focus on quality management theories and sustainability concepts such as environmental management systems (EMS), organizational sustainability (OS), and occupational health and safety (OHS) management system. These systems are often targeted in achieving organizational goals under the umbrella of an integrated management system.

Several frameworks have been developed and presented over the past two decades focusing on quality management principles to attain prolonged and sustainable results. Most of these research works have addressed the quality management perspectives on specific domains such as big data science (Taleb et al., 2018; Dong et al., 2018), food and health care sectors (Pité, et al., 2017), nascent technologies (Kotian and Meshram, 2017; Pahl, 2017), entrepreneurial and industrial sector (Saad and Khamkham, 2018; Azarov, Mayboroda, & Leokhin, 2018). From the vast existing literature on quality management, a very few studies have attempted in integrating the quality management concept with environmental management (Molina-Azorin et al., 2009) and sustainable concepts (Martínez-Jurado and Moyano-Fuentes, 2014) or concepts of QMS (ISO: 9001) with EMS (ISO: 14001) (Heras-Saizarbitoria and Boiral, 2012). These fields are linked through specific management practices like using concepts of lean management, quality, sustainable management, and environmental systems. Coglianese, (1999) and Isaksson, (2004) highlight the growing importance of using EMS and QMS in stimulating sustainable development. Thus, integrating these concepts beyond the traditional boundaries of any management system gives rise to a new concept; the “Sustainable Quality management” (SQM), a management system that is perceived as an intersection concept of EMS, QMS, Total quality management (TQM) and sustainability.

This paper intends to push beyond the conventional channel structures of quality management or integrated quality management practice and tries to implement the concept of SQM into practice by developing an integrated framework that supports SQM systems towards achieving sustainable development and other desirable outcomes. This integration is not on a product basis, rather on a functional basis. The research thus aims to design and develop a generic integrated sustainable quality management framework (iSQMF) for SQM research and practical implementation. The development of the iSQMF is based on the observations and analysis from experts working in this area of research obtained through a methodical review, international standards and regulations and, the author’s conceptual point of view. The spur for developing an integrated framework was also based on several perceptions, such as: (a) Quality management systems should focus on achieving sustainability targets and sustainable development goals. (b) Evidence from previous literature studies conducted by Molina-Azorin, et al., 2009; Yang et al., (2011); Bergenwall et al., (2012); Heras-Saizarbitoria and Boiral, (2012); Wiengarten and Pagell, (2012) reveals the considerable benefits that can be achieved by integrating management systems with standards such as ISO 9000 and ISO 14001. (c) Quality management systems and sustainability follow the goal of achieving not only environmental performance, but also the social and economic performance as well (Nguyen et al., 2018). Thus, taking principles from these systems and integrating with prominent international/industrial standards and regulations can promise improved quality, system sustainability, and enhanced system effectiveness, where the integrated entity functions as a single efficient system that helps in achieving the economic bottom line.

The study also develops a 12-stage planning system that can assist in undertaking sustainable quality management (SQM) pilot studies. This planning system can be used to ensure if the objectives of the SQM are achieved, and whether or not the performance is improved.

2. Literature gap and novelty

The literature study reveals that there are numerous frameworks, models, and tools that attempt to integrate QMS with EMS. However, only a very few among them focus on achieving sustainability through an integrative approach and that too on a product basis with less emphasis on a functional basis. Integrating the concepts of EM systems into existing models, methodologies, methods, tools, and techniques focusing on QM system principles is not a recent development in the field of quality (Pullman et al., 2009; Rusinko, 2005). Hart, (1995) and Roome, (1992) have attempted to conceptualize a link between Total Quality Management (TQM) and greenhouse emission reduction pathways. Since then, experts have started initiating the integration of EM systems with QM systems, adopting sustainable and innovative practices in environmental management such as zero-emission, zero carbon and zero waste goals (Siva, 2016; Corbett and Klassen, 2006) and supporting management perspectives through life cycle analysis and life-cycle costing approaches for domains that deal with quality (Gmelin and Seuring, 2014). These frameworks that emphasize on the functional basis of the integrative approach considers a very specific area of application like the public urban traffic, supply chain management, health care sectors, virtual enterprises, tourism, educational sectors, environment, pharmaceutical industries, etc.

Management practices such as Environmental Continuous Improvement (ECI) acts as an integrator between EM systems and QM systems to improve system efficiency. Thus, EM systems act as an enabler in achieving desired sustainability and sustainable development goals, while supporting the bridging process of EM systems with the QM systems. Whilst, research evidence shows the existence of the use of quality management system tools and approaches in achieving sustainability like life cycle assessment (Siva, et al., 2016) in several domains, in practice, this approach has been dictated by the shifting focus of organizations and research community to integrate systems and system implementation parameters of quality. This lack of focus poses a threat to system stability (Siva, et al., 2016; Silva, et al., 2013). Despite these conceptualizations, the sustainability efforts are pointing around product development and operations, less focusing on environmental management (Tingström et al., 2016), although proven to have great potential and shown slight developments in the early stages. Thus, the quality management models that exist do not aim to properly synergize sustainability concepts with the quality elements, despite the identified potential. Hence, the operationalization of these concepts requires a holistic approach, a general skeleton of interconnected elements that serve to integrate the QM systems, EM systems, and sustainability aspects under an umbrella, for which an integrated framework is essential. Thus, justifying the rationale of developing an Integrated Quality Management Framework to make the concept of “Sustainable Quality Management” more actionable and research-active.

Based on the identified research gap and formulated research objectives, specific research questions are identified namely;

1. How can sustainability be better linked to QM systems on a functional basis using TQM and Juran's management philosophy?
2. What perceptions of management thinking, and international standards can best address the paradigm of SQM ?
3. What are the several elements that constitute the iSQMF, and how do they foster sustainability on a functional basis? How can these elements bring sustainable practices when integrated with existing management systems?
4. What are the stages involved in the planning process that ensure the objectives of the SQM being achieved, and whether or not the performance is improved?

3. The Integrated Sustainable Quality Management Framework (iSQMF)

3.1 Method

The iSQMF has been planned, designed, and developed in accordance with the Whole System Design (WSD) approach, including the Triple Bottom Line (TBL) approach of environmental, social, economic, and governance pillars of sustainability. The WSD, combined with the TBL approach, assesses solutions based on problems observed in existing management systems. The theoretical literature analysis conducted formed the basis of this assessment, helping choose parameters that aid in sustainable management design. In addition, the framework construction as a whole adopted the Results-Based Management (RBM) tool combined with philosophies of management thinking, with a broader emphasis on the quality elements. Certain international standards and regulations such as the ISO 9000 series: QMS and ISO 14001 series: EMS and, minimal adaptions from ISO 31000: risk management system, ISO 26000: Corporate responsibility, ISO 19011: audit management systems and OHSAS 18001: Health and safety management systems were used as the basis while developing the framework. Complying with these standards will aid the system in achieving sustainable goals and targets (ISO family, 2015).

The elements selected in the designed framework also considers the four main phases of the TQM approach: planning, implementing, monitoring, and improving; and the quality control process of the Juran's philosophy of management. Based on Juran's philosophy, the elements chosen were in accordance with the "fitness for use" sociable to managers. These elements were selected to facilitate the integration of the QMS with relevant management systems; thus, building a multidisciplinary SQM system. In addition, TQM holds great potential in fostering sustainability in existing management systems. All the elements in the framework are theoretically validated based on expert judgments and in support to the existing literature in the field of management systems where the relevance of each element in support to an integrated approach is substantiated, thus validating the whole framework. Figure 1 shows the framework outlined in the study.

3.2 Inputs and Outputs of the iSQMF

The desired inputs and outputs describe and impel the integrated management system as a combination of interrelated processes.

a) Inputs: Monitoring data, quality deterioration parameters and source information, quality control measures and strategies, International standards and protocols, quality metrics, risk register, organizational process assets, performance data, project management plan, stakeholder registry, statistical samplings, environmental factors, changelogs, process improvement plan and, communications management plan.
b) Outputs: Standardized quality levels, Total Quality Management, total system sustainability, minimized risks, hazards and negative impacts on management system and, the inclusion of social and economic prospects of management with the existing EMS.

3.3 Basic elements of iSQMF

3.3.1 Validity and reliability assessment of parameters

Validity and reliability assessment are fundamental test procedures used in management support systems (U.S. Department of Labor, 1999). These procedures are often complex and demanding while used in testing multi-dimensional processes (Abdella et al., 2019). These test procedures are used to test the repeatability, suitability, precision, reproducibility, and full traceability of the final results and parameters that are in correlation to the selected elements of the proposed iSQMF, i.e., the related data, input/output parameters, outcomes, and subjective judgments. Thus, a crucial element in the designed iSQMF.

3.3.2 Data collection and database management system

Data collection and its analysis are perceived as key aspects of an integrated management system acting as inputs and outputs of the selected system. Most standards and specializations employed in quality assurance and environmental management programs like Total Quality Environmental Management (TQEM) and Automatic Identification and Data Capture (AIDC)-related technologies need data to monitor overall system progress, to measure sustainability, to procure standardization and to achieve targeted outcomes (Smith & Offodile, 2008). A proper database management system is essential to support an integrated management system (Murata, 2016). Data are deemed reliable if the techniques adopted to collect, compile, analyze is stable over time (Sandberg, 2007), translating the need for efficient data quality policies and efficient database management system. Thus, data collection tools, techniques, methods, and associated methodologies, along with a database management system, form an integral part of the iSQMF.

3.3.3 Monitoring and Assessment system

The monitoring and assessment system aids in identifying system changes, recognizing areas that need performance improvement, and spotting variations in system characteristics (EPA, 2015). These systems contain a subset of core elements and indicators for comprehensive monitoring and evaluation of a management system (Wang, et al., 2014). The monitoring and assessment system ensures compliance with important environmental aspects (Ridgway, 2005), quality system characteristics (UNODC, 2018), legal requirements, and helps in accomplishing the desired vision and objectives (Ershadi et al., 2019). Thus, translating its relevance for the proposed iSQMF.

3.3.4 Process control measures

According to World Health Organization (2010), process control is best defined as a management measure that examines processes within a system to ensure accuracy and reliability of operational variables. The existence of inconsistency in these operational variables are automatically adjusted to achieve the desired level of production through process control engineering. While, according to the survey and prospective study conducted by Daoutidis, Zachar, & Jogwar (2016), process control is perceived as a means to attain safety and efficiency in operations and to improve the overall sustainability for the energy and environmental management process systems, thus facilitating the achievement of sustainable development goals. Empirical research is used to assess the positive impacts of process control (Miyagawa & Yoshida, 2010; Baird, Hu, & Reeve, 2011; Zehir, et al., 2012). Process control using computational methodologies like statistical analysis detects all possible process variance, thus helping to mitigate the existing flaws (Phan, Abdallah, & Matsui, 2011; Abdella, Yang, & Alaeddini, 2012). This results in enhancing the overall performance of the management system. Hence, process control can be seen as an integral element of the designed iSQMF. For a better understanding of several process control techniques used in quality monitoring and controlling, interested readers can refer Abdella et al., (2016); Abdella et al., (2017); Kim et al., (2019).

3.3.5 Environmental Impact Assessment

Environmental Impact Assessment (EIA) is a long-term impact assessment tool that identifies both positive and negative impacts of environmental management systems (Htun, 1990), quality management systems (Richardson, 2017) and proposed development programs, thus helping in mitigating the negative impacts to drive improvements (Ness et al., 2007). EIA has also been recognized as an essential tool for fostering sustainability (Soni et al., 2010). Adhering to the guidelines of EIA, participants in the EIA process can gauge the effectiveness of the anticipated outcomes, proposed management strategies, and established priorities, thus offering several cost and time-saving benefits. Thus, an integrated quality management framework must attempt to integrate EIA practices with Quality Management Strategies (QMS) into the planning, implementation, and decision-framing phase in order to achieve sustainable development goals confronting with the ISO 14001:2015 standards.

3.3.6 Strategic Environmental Assessment

Strategic Environmental Assessment (SEA), which is an extension of the EIA, is a strategic decision support tool used to assess the performance of systems that are highly uncertain and less concrete (Ness et al., 2007). This includes taking into due consideration the interests of public, legislative actions and, decisions from political bodies and policy enforcers. Although SEA and EIA have slight differences, both these processes are quite similar in their mode of assessment and principles (as cited in Ness et al., 2007). SEA compliments EIA and other prudent management approaches, strategies, and perspectives (OECD, 2006). Thus, SEA is of great role in integrating sustainability considerations with existing QMS.

3.3.7 Quality management standards, strategies, and protocols

Proper quality management standards support the integration of environmental management considerations for the implementation of sustainable practices in management systems (Siva, et al., 2016). Integrated quality management systems must be designed in compliance with ISO 9000 quality assurance (QA) standards, environmental management standards ISO 14001, quality management strategies, and protocols. Quality management strategies are pivotal for determining quality techniques that are crucial in achieving desired quality levels and sustainability goals (Sahoo, 2019), translating the need for efficient management standards, strategies, and protocols for integrated quality management frameworks.

3.3.8 Capacity development process

Matheson & Giroux (2011) contend that capacity development in areas of environmental and quality management is "an endogenous process of change"p.3, which prioritizes achieving quality and sustainability goals for deciding the capacity requirements for development. Development models that deal with quality, performance, and sustainability considerations require proper institutional capacities for growth (OECD, 2010). The capacity development processes in an integrated management system are a set of skills that are used for designing, developing, implementing, executing, and analyzing initiatives for growth (UNDP, 2009). Thus, the capacity development process is an essential element of the designed integrated quality management system.

3.3.9 Regulatory Compliance Management System (RCMS)

A regulatory compliance management system (RCMS) is an element of quality management initiated to correct actions and risks associated with noncompliance. It is a strategic decision support tool that aids in reducing quality and compliance risks, increasing operational accountability, minimizing compliance costs, and ensuring transparent supply chain operations. This account to meet the development goals for sustainable governance in a competitive environment (Gardner, et al., 2019). Hence, an efficient RCMS must be structured based on forward-thinking approaches, transparency, continuous evaluation, corrective action plans of management systems (Kulkarni & Vemuri, 2015), and sustainability principles. In case of nonconformity, corrective action plans which are a part of quality management strategies need to be initialized to ensure proper compliance.

3.3.10 Multi-level governance system (MLGS)

A multi-level governance system (MLGS) includes a set of strategies for improved policy implementation (Gollata & Newig, 2017) and several jurisdictional interactions that require proper coordination across the horizontal and vertical levels of the governance system (Newig & Koontz, 2013). These interactions must attempt to produce comprehensible management plans. Participatory governance empowers effectual policy issuance (Koontz & Johnson, 2004) and is thus seen as a key element in implementing policy directives. Participatory governance is also seen as a tool to achieve sustainable development goals and environmental objectives (EU, 2003). Thus, the MLGS in the proposed iSQMF mandates shared aspects of policy planning, policy implementation and, participatory governance approaches unlace the SQM concept.

3.3.11 Policy Model (PM)

A proper policy model backs the capacity development process and acts as a support in piloting new experiences and system improvements. Quality and sustainability management policies need to be reconcilable with the proposed objectives, and their suitability needs to be reviewed occasionally. An effective policy model must include a combination of elements from multi-level governance and participatory system of approaches for policy planning and implementation (Newig & Koontz, 2013). Effective, as in this context, refers to the system's ability to achieving sustainability. Thus, the policy model in an iSQMF must address several policy opinions, must be legally acceptable, politically feasible and, should attempt to provide incentives for making an actionable Sustainable Quality Management (SQM) concept.

3.3.12 Financial Viability

A proper financial plan is essential to assess whether the outcomes of the implemented management strategies of a quality/environmental management systems are cost-effective. An effective financial plan complements the PAF model when attempting to understand the quality costs.

3.3.13 Quality evaluation and performance review system

Evaluating the quality and performance of a management system is essential yet demanding (Sikora & Nowicki, 2012). Quality evaluation involves tackling the efficiency of the QMS by monitoring the quality costs, effectively managing the processes, and identifying the process variability and nonconformities (Abu-Salim et al, 2019). A widely accepted quality evaluation method is the Prevention, Appraisal, and Failure (PAF) model and the process model (Keogh & Dalrymple, 1995). The performance review process involves monitoring, measurement, assessment, evaluation, internal audit, and management review. It helps in identifying possible changes, undesirable effects, challenges, and areas of improvement in the management system (Matto, 2019). The degree of tolerance to errors, system stability in terms of process variability, the level of system complexity and, the intensity of impact varies significantly for different management systems. Thus, an efficient evaluation and performance review system for the designed iSQMF must include a quality evaluation and management plan that must confront the management standards and regulations such as ISO 9000:2000, ISO 14001:2015, BS 6143 and industry standards such as ISO 9001 and ISO 13485.

3.3.14 Corrective action plans based on strategies
A corrective action plan (CAP) forms an integral part of a successful management system that attempts to rectify detected nonconformances. A Corrective and Preventive Action Plan (CAPA) is an analysis and mitigation tool used to identify quality and management related problems and bring about corrective or preventive actions to eliminate the problems (Tartal, 2014). CAPA attempts to direct management strategies to be in compliance with performance standards and regulations such as 21 CFR 820.100, 21 CFR 211.180, ISO 9000:2000, ISO 14001:2015 standards, and several other regulations. The CAP based on management strategies complements the performance review process, where the performance review process helps in identifying the undesirable effects while the CAP eliminates these effects. Thus, CAP serves as an inevitable element for the designed integrated quality management framework to achieve sustainable outcomes.

3.3.15 Risk assessment and management
Risk can be defined as "an effect of uncertainty on management objectives" (ISO, 2018) that has occurred as a result of certain vulnerabilities. Risk assessment can thus be defined as "an analysis of these uncertainties," and risk management can be defined as "the process of reducing or eliminating these uncertainties." Risk assessment and management are important aspects of project planning (Arabshahi and Fazlollahtabar, 2019) and need to comply with ISO 9000, ISO 22000, ISO 14001, ISO 26000, and OHSAS 18001. It helps in achieving system stability and supports decision making in practice (Aven, 2016). The risk assessment process is characterized by initially examining the scenarios and identifying the risks within the management process/system. These risks are then assessed using certain qualitative, quantitative, or combined approaches of assessment that lead to strategic decisions for mitigating/managing the identified risk. Risk management and Corrective and preventive action plans (CAPA) are complementary elements of a quality management system. ISO 31000:2018 presents a clear picture of how to undertake a risk assessment and manage the outcomes in order to minimize potential risks and achieve sustainable goals.

3.3.14 Risk communication and public awareness system
Risk communication is an effective management tool within the risk management process (Radovic & Mercantini, 2015). An efficient public awareness system is an important element of the risk communication process, and Effective Program Management (EPM) forms an integral part of the public awareness system due to the complexity of assessing the impact of the messages. For understanding more on improving risk communication and public awareness, interested readers can refer to the National Research Council (1989).

4. SQM Study Process Implementation Plan

The 12-stage implementation plan was developed as a basis for the designed iSQMF and provided a step-by-step approach for successfully implementing the SQM practice to any quality management pilot study, where the designed iSQMF can be used as a tool/framework to achieve the said outcomes. To implement the iSQMF, an SQM pilot study needs to be carried out. This paper also extends its attempt to outline a generic step-by-step approach for executing any SQM study process (see Figure 2).

Step 1. Analyzing goals, objectives, and strategies

The first stage corresponds to the identification of goals, objectives, and strategies for an integrated sustainable quality management study by taking into consideration the preferences of different stakeholder groups. The strategies for the SQM study process need to be designed integrating all the prime aspects of environmental, social, economic, and governance pillars of sustainability and international standards and regulations that focus on integrating quality, sustainability, and other prime aspects of management. The designed objectives will regulate the approach to several processes outlined in the iSQMF; while the goals for the SQM study process addresses a particular objective from the SQM's strategic plan.

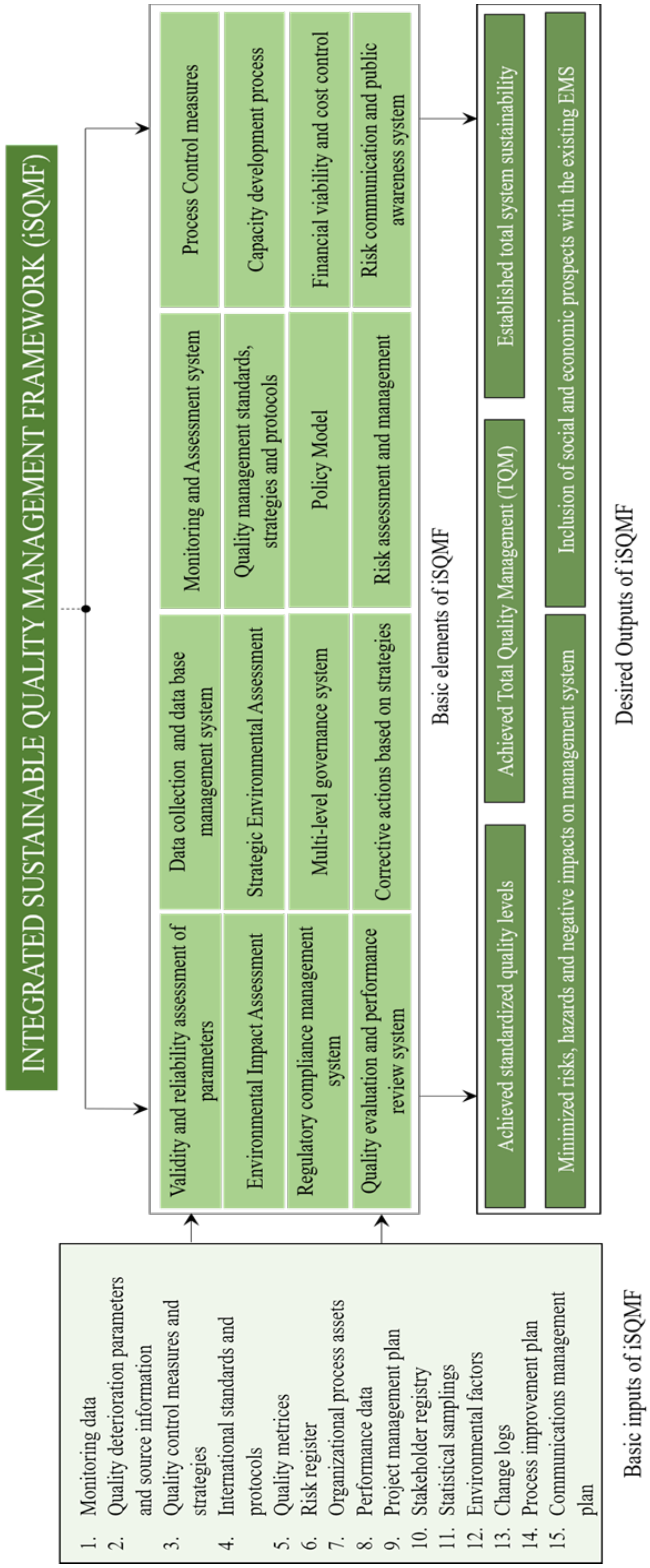

Figure 1. The integrated sustainable quality management framework

Step 2. Characterizing the SQM study process

One of the prime factors that need to be taken into due consideration while characterizing the SQM study process is to decide the context of the study. In this stage, proper procedures for redesigning the integrated quality management framework (iSQMF) to a more specific framework need to be considered. Since the designed iSQMF is a generic framework and certain modifications need to be made to fit the context of the adopted study process based on the type of study. All the 12 stages within the SQM pilot study need to be linked to the elements in the designed iSQMF, where the tasks corresponding to the four phases of the TQM approach in each process stage, corrective and preventive measures and monitoring indicators are to be identified.

Step 3. Complying input data with the international standards and regulations

This stage accounts for the data that is required to carry out the empirical research using the designed iSQMF based on the identified goals, objectives, and strategies of the study. Data and information are deemed reliable if the techniques adopted to collect data is stable over time (Sandberg, 2007). Although several techniques exist in collecting data, information and, incorporating standards and regulations reliable for the study, the SQM study process mandates aggregating the inputs from relevant scientific literature, technical and monitoring reports, operational guides and also gathering insightful information on approaches and methods used for functionalizing the selected elements in the iSQMF. Information on the existing audit and risk assessment, and process characterization references also need to be collected.

Step 4. Allocating optimal resources for all SQM's study stages

At this stage, all the resources that are required to carry out the SQM study process need to be identified, which includes, but are not limited to, the financial resources, human capital, social capital, infrastructure, and time resources. After identifying the necessary resources, optimal resources are to be allocated corresponding to each stage identified in the SQM study plan so as to achieve the intended results and complete the study.

Step 5. Developing a planning model for quality management based on allocated resources and adopted strategies.

This stage deals with developing a planning model for the designed iSQMF based on the allocated resources and adapted strategies to proceed with the SQM pilot study. A proper planning model for sustainable quality management serves as a frame of reference for the implementation of integrated quality and sustainability objectives. The planning model shall define:

a) The essential resources needed to undertake the SQM study processes and meet the objectives such as financial resources, human capital, infrastructure, and time resources.
b) The key performance indicators (KPI) needed to assess performance improvement effectively and efficiently.
c) The requirements for implementation and improvement, including, but not limited to, the methods, approaches, techniques, and tools.
d) The processes and the mode of support required in terms of capital for carrying out the four phases of TQM and the SQM study process.

Step 6. Designing a policy model (PM) that supports the policy revision process.

A shift in the existing processes within a management system can have an impact on the existing policy thus, mandating a policy revision. Thus, a policy model is designed to support any such policy revision process. The sustainable quality policies, which are a part of the policy model, need to be compatible with the overall strategies and policies of the management system. The policy model must:

a) Be designed in such a way that the model is compatible with the vision and strategies outlined in stage 1 so that any futuristic goals can be achieved.
b) Be an inclusive model that considers the necessities and anticipations of customers and different stakeholders, and engaging means for proactive communication.

c) Be supporting continuous improvement programs were the designed model must commit to quality, reliability and sustainability considerations.

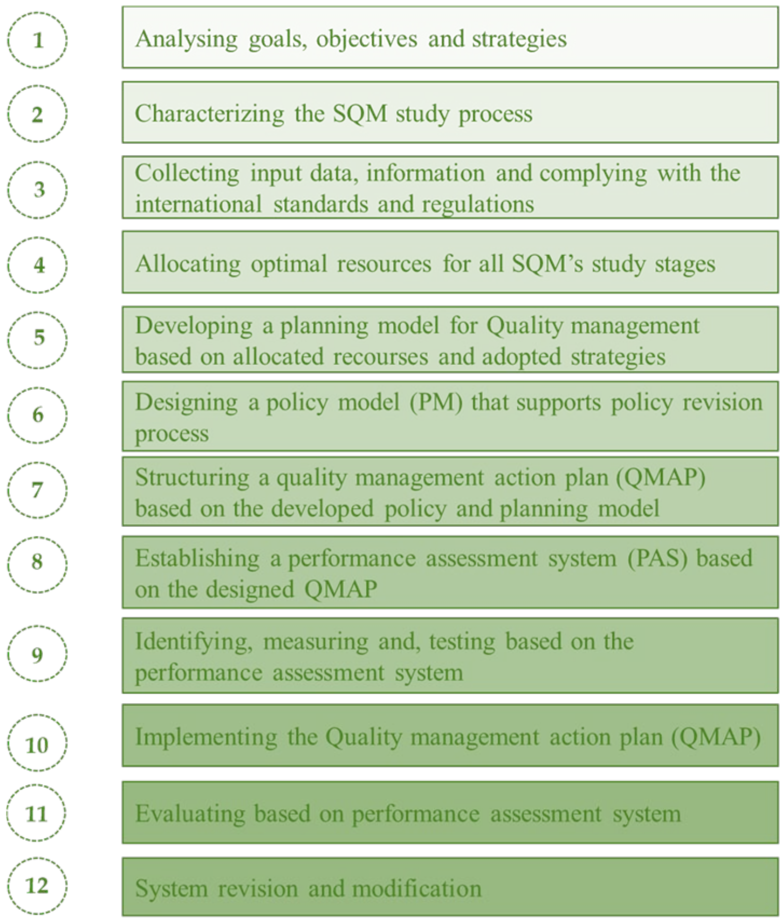

Figure 2. The twelve-stage study process implementation plan

Step 7. Structuring a quality management action plan (QMAP) based on the developed Policy and planning model.

The action plan provides a systematic approach for the successful implementation of the iSQMF, evaluation of services, and improvement based on priorities. For proactive improvement, a subset of the QMAP, which is the quality improvement action plan (QIAP) needs to be designed. A QIAP at the minimum must include:

a) Particulars of quality and sustainability-related problems/system noncompliance.
b) Findings related to the Root Cause Analysis (RCA)- A systematic approach for identifying the root cause of events with quality, reliability, and environmental impacts (Rooney & Heuvel, 2004).
c) A Corrective and Preventive Action Plan (CAPA).
d) Containment Plan for immediate correction.
e) Improvements awaited as a consequence of planned actions.

Step 8. Establishing a performance assessment system (PAS) based on the designed QMAP

In this stage, a robust performance assessment system (PAS) needs to be established. The PAS requires a systematic performance measurement plan (PMP) that contains measurable indicators for monitoring the progress of the system towards achieving the targeted goals and objectives. The KPIs of the PAS for the SQM study process are categorized as main categories (input measures, output measures, outcomes, process measures, effectiveness, sustainability, and quality) and sub-categorized (quantitative, directional, and actionable indicators). The KPIs are developed based on the integrated considerations of the three main pillars of sustainability, QMS and EMS.

Step 9. Identifying, measuring and testing based on the performance assessment system

According to the PMP, the KPI’s are identified, measured, and tested during the practical implementation phase. The KPI’s can be used to monitor the performance of SQM systems (Kutty et al., 2020b).

Step 10. Implementing the quality management action plan (QMAP)

After developing the QMAP, the next stage corresponds to its implementation. The implementation of the QMAP is crucial and often stays as the fundamental outcome of the planning process. Every step in the QMAP after implementation is closely monitored to support the future strategic planning process and system revision. The key pillars that govern the effective implementation process are sound leadership styles, proactive communication channels, and transparency in the concurred system.

Step 11. Evaluating based on the performance assessment system

The KPI values can be used to analyze whether the results of the SQM study process comply with the proposed strategies, goals, and objectives that were anticipated in stage 1. If the targeted goals and objectives are not achieved, then a system revision and modification process are necessary.

Step 12. System revision and modification.

The system revision and modification stage encompass a comprehensive reassessment of all the previous stages to identify the gaps and weaknesses by conducting a periodic review. The system revision and modification at the minimum must: a) Attempt to measure the progress made in accordance with the developed plan. In case of noncompliance, modifications are to be made to level up the system to align with the plan. b) Measure the effectiveness of the accomplished actions. c) Include metrics that keep track of the performance and ensure the success of the developed plan.

5. Conclusion and Future Works

A sustainable integrated quality management framework (iSQMF) and a 12-stage sustainable quality management study process implementation plan were presented in this study to effectively evaluate and implement the concept of SQM and, to make the concepts more research-active. The synergies between the environmental, social, economic and institutional pillars of sustainability along with the international standards and regulations such as the ISO 9000 series: quality management systems and ISO 14001 series: environmental management systems and, minimal adaptions from ISO 31000: risk management system, ISO 26000: Corporate responsibility, ISO 19011: audit management systems and OHSAS 18001: Health and safety management systems; formed the basis for developing the framework. The designed framework and implementation plan, in addition to sustainability, addresses the institutional and developmental processes. Consideration of stakeholder involvement in the elements of the designed system provides adequate participation and involvement for futuristic improvement. The study also recommends integrating Triple Bottom Line (TBL) approaches of sustainability with quality management models like TQM and management philosophies like Juran’s philosophy, which can be seen; a) financial and cost control processes with the economic pillar of sustainability b) focus on governance, compliance and, capital with social sustainability and, c) biotic focus like EIA and SEA with environmental sustainability.

Despite the merits of the framework, certain pessimistic views also act as possible barriers for the successful implementation of the iSQMF into an organization namely; a) Presence of cultural influences that play a vital role in shaping administrative decisions forming a crucial part of the iSQMF implementation process. b) Absence of KPI evaluation criteria and centralized coordination that leads to employee incitement. c) Absence of financial resources within the organization. d) Existence of cognitive biases in managerial judgements.

Integrated and holistic frameworks based on machine learning techniques becomes necessary when addressing the sustainability concerns from multiple dimensions (Abdella et al., 2020) to support the holistic system effectiveness concept. Kucukvar et al. (2019) and Kutty et al., (2020a) applied statistical techniques to provide a comprehensive understanding of four sustainability metrics, including carbon footprint, to globally analyze the environmental and socioeconomic impacts of service management systems. In the context of statistical techniques, the authors suggest applying time series analysis, factor analysis, correlation, and online control charts for detecting any fluctuations that might occur in quality control processes over time (Abdella et al., 2017; Kim et al., 2019). Multiple objective-based best-subset approaches adopted by Abdella et al. (2019) can also be used to promote the accuracy of quality and sustainability performance assessment in service system design. Combining Life cycle assessment with management systems can comprehensively support sustainability assessment (Tatari and Kucukvar, 2012; Park et al., 2015; Egilmez et al., 2016; Onat et al., 2017; Kucukvar et al., 2016a; Kucukvar et al., 2016b; Kucukvar et al., 2019). To better understand several empirical assessment techniques that can widely be applied in the field of sustainability research with quality control and quality management practices taken into account, the readers can refer; Abdella et al. (2016), Kutty et al., (2020b), Kutty et al., (2020d), Abdella et al. (2019a), Abdella and Shaaban, (2020), Abdella et al., (2020a).

The proposed framework and the implementation plan support iterative modifications to support integrated management strategies while practically executing the concept by several policy players, different departments, and auditors. Here, the strategies are well connected with the vision of SQM. Through the system revision and modification process outlined in the SQM implementation plan and the CAPA action system incorporated in the iSQMF, the goals of sustainable quality management can be achieved. Every element incorporated in the iSQMF will ensure that any management actions corresponding to the functionality of that element will be effectively implemented by monitoring their stand to the existing KPIs.

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