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Assessment of ISO 9001:2015 implementation factors based on AHP: Case study in Brazilian automotive sector

Diogo Almeida, Ninad Pradhan, Jorge Muniz Jr,

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QUALITY PAPER

Assessment of ISO 9001:2015 implementation factors based on AHP

ISO 9001:2015
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Case study in Brazilian automotive sector

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Diogo Almeida

*Department of Production, Faculty of Engineering Guaratingueta Campus,
Universidade Estadual Paulista (UNESP), Guaratingueta, Brazil*

Ninad Pradhan

*Department of Industrial and Systems Engineering, University of Tennessee,
Knoxville, Tennessee, USA, and*

Jorge Muniz Jr

*Department of Production, Faculty of Engineering Guaratingueta Campus,
Universidade Estadual Paulista (UNESP), Guaratingueta, Brazil*

Abstract

Purpose – The purpose of this paper is to discuss factors to support ISO 9001:2015 implementation. A framework for identification and prioritization of factors is applied in Brazilian power train suppliers (Tier 1). Brazil is the eighth largest vehicle manufacturer in the world.

Design/methodology/approach – The data analysis presented in this paper is grounded in an empirical study involving ISO 9001 certified Brazilian companies (47 plants) that supply auto parts to power train assembly plants. They represent almost 50 percent of the Tier 1 Brazilian power train suppliers. Data collection and analysis is performed with the participation of managers who are experts in quality management systems and ISO 9001. Analytic hierarchy process (AHP) supports the mixed methods approach. The data analysis is broken down by electrical components, machining, sub-components and small parts manufacturers.

Findings – The factors assessed are top management commitment, team commitment, training, responsibilities and authorities defined, schedule for implementation, quality culture, resource availability, integration between departments, level of bureaucracy as well as level of awareness regarding the ISO 9001 significance. A new factor was identified, which was not cited in the literature, quality staff reliability.

Research limitations/implications – The research is applied to suppliers of powertrain manufacturers and could reflect other sectors. It is important observe that the automotive sector represents a microcosm of the organization in general and many production models stem from there.

Practical implications – Understanding the critical factors is important to ensure that managers allocate resources appropriately during implementation and maintenance of ISO 9001:2015.

Social implications – Organizations around the world have, until 2018, to upgrade their quality systems to ISO 9001:2015 and the results of this paper can support strategies and decision making about that.

Originality/value – This paper evidences the relative importance among factors and ranks item in order of importance for ISO 9001:2015 implementation. Prior studies indicate the need to develop a mixed methods study to examine the role of the critical factors to support the ISO 9001:2015 implementation as done in this paper.

Keywords ISO 9001, Brazil, AHP, Automotive suppliers

Paper type Research paper



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1. Introduction

This paper aims to discuss factors to support ISO 9001:2015 implementation. A framework for identification and prioritization of factors is applied in Brazilian power train suppliers (Tier 1). Brazil is the eighth largest vehicle manufacturer in the world. Organizations around the world have, until 2018, to upgrade their quality systems to ISO 9001:2015 and the results of this paper can support strategies and decision making about that. Prior research has focused on identification of factors critical to success of the implementation, but not on their ranking/prioritization, which have importance to guiding managers in allocating resources appropriately during implementation and maintenance of ISO 9001:2015.

ISO 9001:2015 has become the leading industry standard for eliminating waste, improving productivity and efficiency, providing greater customer satisfaction and streamlining daily organizational routines (Camfield and Godoy, 2004). Organizations are motivated to seek ISO 9001 certification (Zaramdini, 2007) because its potential benefits span all internal and external aspects of their operations (Karipidis *et al.*, 2009). An effective implementation results in benefits exceeding costs, mainly due to improved operational performance (Aba *et al.*, 2016), increased process effectiveness (Allur *et al.*, 2014), process standardization (Boiral and Heras-Saizarbitoria, 2015), reduced operational costs (Dwyer, 2002), increased market share (Arauz and Suzuki, 2004), improved customer confidence, reduced customer complaints (Dwyer, 2002) and sustained competitiveness (Augustyn and Pheby, 2000). Organizations that work toward adopting ISO 9001 with the aim of making quality products and services develop an effective quality management system (QMS) in the process (Gotzamani *et al.*, 2007). This results in establishing a continuous quality improvement system, which spans the organizational hierarchy (Cebeci and Beskese, 2002; Yahya and Goh, 2001; Heras *et al.*, 2002).

This research incorporates specifications from the ISO 9001:2015 version of the standard, which has been updated to reflect the dynamic needs of the industry. This version of the standard includes additional organizational needs such as leadership engagement, risk evaluation, and integration of safety and environment management systems (ISO, 2015). Some of its mandatory requirements, such as the inclusion of a knowledge management clause, may require substantial organizational changes (Wilson and Campbell, 2016).

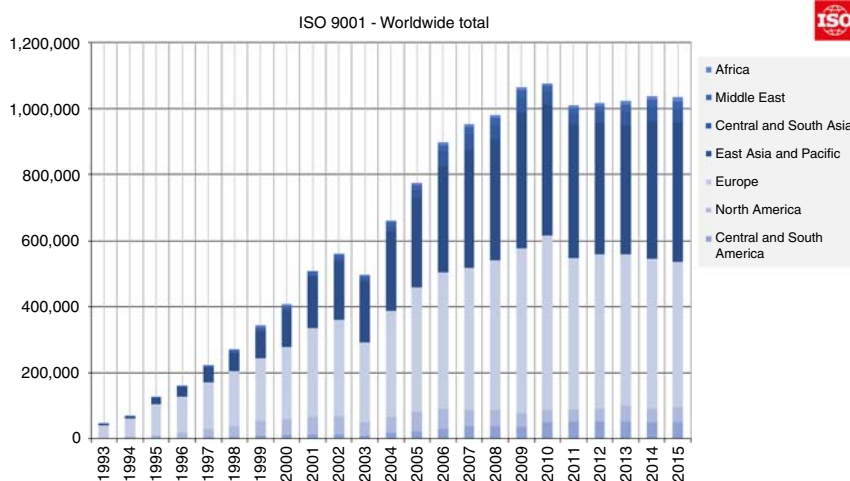
Personnel and organizations can experience the benefits of ISO 9001. The participation of all personnel is required to meet certification demands such as improvements in product design and product flow management (Huo *et al.*, 2014). The resultant training improves their skills in developing and delivering new products, enables employees to communicate with each other and serves as a foundation for the systematic improvement of company routines. Employee training also includes clarifying strategic directions and business goals for employees, which enhances individual clarity and involvement. Information flow between personnel is enhanced by way of documentation and internal auditing process requirements, which provide the means for collecting and storing frequently used knowledge and information. ISO 9001 improves decision flow management by directly improving the policies, procedures and mechanisms of corporate governance.

ISO 9001 can, therefore, be a catalyst for change at all process levels and across personnel hierarchies. Its benefits, summarized in Table I, have resulted in widespread adoption of ISO 9001. According to the 2015 report published by ISO, 1.1m ISO 9001 certificates have been issued around the world in 184 countries (ISO Survey, 2015). Figure 1 shows annual historical and regional trends in ISO 9001 certification. The unique advantages of ISO 9001 and challenges in implementation across countries and cultures have been studied; for example, the motivations, benefits and difficulties related to ISO 9001 implementation have been analyzed for Brazil (Maekawa *et al.*, 2013) and Spain (Allur *et al.*, 2014). The appeal of the certification and research on its implementation is not limited to a specific industrial sector. The challenges associated with the implementation of ISO 9001 have, for example, been examined in the food sector (Angelogiannopoulos *et al.*, 2007;

Table I.
Benefits of ISO 9001
implementation

Internal factors	External factors
Awareness of quality	Improvement of products
Diagnosis of the problems	Improvement of services
Administrative control	Increased market share
Discipline	International competitiveness
Cohesion inside the organization	Conformity to regulations
Customer's needs knowledge	Relationships with customers
Work standardization and productivity	Relationships with suppliers
Reduction of non-conformities	Customer's satisfaction
Internal relations	Customer's claims and returns
Inter-company communication	Market requirements
Lower quality costs	Identification and traceability
Inducement for executives	Trade facilitation
Remaining in business	Transaction costs
Operating quality costs	Information on quality
Retention of executives	Image and promotion
Reduction of control and inspections	Introduction to new markets
Risk control	

Source: Adapted Karipidis *et al.* (2009)



Source: ISO Survey (2015)

Figure 1.
Historical and
region-wise adoption
of ISO 9001

Karipidis *et al.*, 2009). In healthcare, an evaluation of the effects of introducing an organization-wide QMS at a large rehabilitation hospital has been performed (Van Harten *et al.*, 2002). It has been shown that there is a positive correlation between participation in quality management activities and work satisfaction in hospitals (Wardhani *et al.*, 2009; Carman *et al.*, 2010). In the service sector, research has focused on investigating critical factors for effective implementation in small and medium enterprises (Psomas *et al.*, 2010).

Despite its numerous successes, ISO 9001 implementations can be susceptible to short or long-term failure. In the absence of effective implementation, the introduction of a QMS may fail to provide the desired results (Psomas *et al.*, 2010). Studies have shown that organizations which deploy the standard merely as a marketing or promotional strategy

(Sampaio *et al.*, 2009) without internalizing the process of ISO 9001 implementation and sustenance (Allur *et al.*, 2014) do not enjoy the benefits of ISO 9001, which assumes a complete understanding of the standard. There is a need for the certification and its accompanying continuous improvement culture to be implemented in a manner, which creates differentiation or heterogeneity between companies (Huo *et al.*, 2014). Zeng *et al.* (2007) indicated that management often has exaggerated expectations about implementation results. Organizations in which ISO 9001 often fails tend to focus on meeting external certification requirements without adequate and pervasive organizational changes (Boiral and Heras-Saizarbitoria, 2015).

Factors that affect the success or failure of ISO 9001 implementation, and QMSs as a corollary have been studied in the literature. The focus on implementation factors is essential because the complete benefits of ISO 9001 can be experienced by an organization only after it has established the appropriate conditions for its implementation and sustenance (Huo *et al.*, 2014). Prior work has focused on the identification of factors influencing effective implementation (Psomas *et al.*, 2010), and evaluation of factors that impact organizations which plan to implement ISO 9001 (Augustyn and Pheby, 2000; Lin and Jang, 2008). Several factors which may lead to implementation roadblocks have been identified (Karipidis *et al.*, 2009), including: national identity (Huo *et al.*, 2014), employee engagement (Allur *et al.*, 2014), top management commitment (Huo *et al.*, 2014; Allur *et al.*, 2014), training (Maekawa *et al.*, 2013; Karipidis *et al.*, 2009) and team commitment (Boiral and Heras-Saizarbitoria, 2015; Kim *et al.*, 2011; Psomas *et al.*, 2010).

A purely quantitative or qualitative identification of the factors is, however, insufficient in guaranteeing the success of ISO 9001 implementation. This is because all identified factors are attributed a similar level of importance during the implementation process, leading to subjective prioritization from specific managers. A better understanding of the priority of ISO 9001 implementation factors is needed so that it results in improved managerial decision-making process. Research opportunities in this scenario include the quantitative study development to examine the role of the critical factors between rhetoric and practice (Boiral and Heras-Saizarbitoria, 2015), and to evaluate the best practices for more effective implementation to encourage more research about the relevance of factors for ISO 9001 internalization in different countries and organizations (Downey *et al.*, 2015; Allur *et al.*, 2014; Huo *et al.*, 2014).

The presented research addresses the quantitative-qualitative gap by combining the first, the identification and subsequently the prioritization of implementation factors in a single framework. Factors that impact the ISO 9001 implementation are evaluated by ranking their relative importance using analytic hierarchy process (AHP). AHP is a hierarchical method used to support multi-criteria decision-making processes that incorporates attributes of a decision and available alternatives (Saaty, 1980). Subramanuan and Ramanathan (2012) have indicated that the use of AHP in factor evaluation for quality management would be an original research opportunity in the industrial sector.

The data analysis presented in this paper is grounded in an empirical study involving ISO 9001 certified Brazilian companies (47 plants) that supply auto parts to power train assembly plants. They represent almost 50 percent of the Tier 1 Brazilian power train suppliers. Brazil is world's eighth largest vehicle manufacturer (Anfavea, 2016). Data collection and analysis is performed with the participation of subject matter experts (managers) in QMSs and ISO 9001. The data are presented to satisfy the objective of quality system internalization in participating companies from the Brazilian automotive industry. It allows companies seeking certification to focus on developing quality management practices, which are better aligned with their anticipated certification goals.

This paper is structured as follows: Section 1 introduces ISO 9001 and its benefits and sets up the research contributions of the work; Section 2 reviews ISO 9001 implementation

factors based on an analysis of relevant literature; Section 3 describes the research methods and details the steps performed to conduct factor evaluation; Section 4 shows the research results and discussion about the ranking of factors within the automotive industry; Section 5 concludes the paper with observations about the ranked factors and highlights the implications of the research from a theoretical and management standpoint.

2. ISO 9001—critical factors for implementation

The first phase of the research consisted in identifying ISO 9001 implementation factors based on a systematic literature review, which was guided by the approach of Tranfield *et al.* (2003). Table II summarizes the factors identified in the literature during the period 1997–2016 and their supporting references. Some factors were cited using words or phrases, which differ from the presented version, but were grouped together since they carried the same meaning.

The ten factors identified in the literature review are summarized as follows:

- Top management commitment: Psomas *et al.* (2010) stated that the level of commitment of top management is related to the support provided by the management during the implementation process. Top management has the responsibility to establish a rewards system to boost employee morale and motivation and is also responsible for giving direction to employee efforts. They are responsible for advocating ISO 9001 and for setting a standard for communication in which everyone is speaking the same certification-specific language (Huo *et al.*, 2014). Leadership is crucial to the success of any effort to change the operating philosophy of an organization since they can help overcome the tendency of employees to be reluctant to change (Sumukadas, 2006; Karuppusami and Gandhinathan, 2006).
- Team commitment: Boiral and Heras-Saizarbitoria (2015) identified that the gap in the implementation effectiveness for different organizations with same structure was explained by team commitment. They showed that an implementation is put in place by an external consultant with little internal collaboration results in employees and company management being disconnected from the modified practices. A recent survey done by Boiral and Heras-Saizarbitoria (2015) established that 80 percent of certified SMEs use consultants to help with implementing ISO 9001. Generally, organizations that have shown only a superficial level of system adoption have had ISO 9001 implementation driven by a consultancy firm, without the active involvement of employees. A lack of internal competency and training required for ISO 9001 implementation could be the principal reason for this.
- Training: companies looking for an effective ISO 9001 implementation arrange training programs for employees to improve their skill on quality standards, clarifying strategic directions and business goals (Huo *et al.*, 2014). Training focused on quality and information programs is provided to ensure that there is a learning process in place for the success of the implementation. Parra-Lopez *et al.* (2016) investigated ISO 9001 enterprises in the Spanish olive oil industry and identified the organizational learning process as a key factor to guarantee the effectiveness of a QMS.
- Responsibilities and clearly defined authority: the implementation process cannot be started without adequate planning. This includes the need for the leadership to determine an implementation team with clearly defined responsibilities and authority. This creates a sense of employee integration within the organization (Gimeno *et al.*, 2015).
- Schedule for implementation and maintenance: developing a well-defined implementation schedule plays a significant role in mitigating the difficulties and efforts related to this process. A maintenance plan post-implementation is also essential;

Table II.
Critical implementation factors identified in literature

Factor	Description	Authors
1. Top management commitment	Top management defines the ISO 9001 implementation as a high priority activity, following up and support the process	Giatman (2015), Boiral and Heras-Saizarbitoria (2015), Huo <i>et al.</i> (2014), Allur <i>et al.</i> (2014), Maekawa <i>et al.</i> (2013), Kim <i>et al.</i> (2011), Psomas <i>et al.</i> (2010), Karipidis <i>et al.</i> (2009), Wahid and Corner (2009), Wardhani <i>et al.</i> (2009), Magd (2008), Bhuiyan and Alan (2005), Mezher <i>et al.</i> (2005), Khoo and Tan (2002), Augustyn and Pheby (2000) and Tang and Kam (1999)
2. Team commitment	Team involved with the ISO 9001 implementation is engaged in achieve the targets defined by the top management	Giatman (2015), Gimeno <i>et al.</i> (2015), Boiral and Heras-Saizarbitoria (2015), Kim <i>et al.</i> (2011), Psomas <i>et al.</i> (2010), Karipidis <i>et al.</i> (2009), Wahid and Corner (2009), Wardhani <i>et al.</i> (2009), Pan <i>et al.</i> (2009), Angelogiannopoulos <i>et al.</i> (2007), Mezher <i>et al.</i> (2005), Augustyn and Pheby (2000) and Tang and Kam (1999)
3. Training	Trainings focused in quality to the team involved with the objective to align their knowledge	Parra-Lopez <i>et al.</i> (2016), Huo <i>et al.</i> (2014), Allur <i>et al.</i> (2014), Maekawa <i>et al.</i> (2013), Kim <i>et al.</i> (2011), Psomas <i>et al.</i> (2010), Wardhani <i>et al.</i> (2009), Karipidis <i>et al.</i> (2009), Magd (2008), Angelogiannopoulos <i>et al.</i> (2007), Mezher <i>et al.</i> (2005), Bhuiyan and Alan (2005), Chow-Chua <i>et al.</i> (2003), Khoo and Tan (2002), Augustyn and Pheby (2000) and Tang and Kam (1999)
4. Responsibilities and authorities defined	Clear definition of the responsibilities and authorities of each collaborator, ensuring that the team involved is aware about their assignments	Gimeno <i>et al.</i> (2015), Wardhani <i>et al.</i> (2009), Magd (2008), Zeng <i>et al.</i> (2007) and Chow-Chua <i>et al.</i> (2003)
5. Schedule for implementation	Schedule for implementation, identifying the actions, responsible and forecast dates	Kim <i>et al.</i> (2011), Karipidis <i>et al.</i> (2009), Pan <i>et al.</i> (2009) and Zeng <i>et al.</i> (2007)
6. Quality culture	The organization has a quality culture widespread between the collaborators	Parra-Lopez <i>et al.</i> (2016), Giatman (2015), Valmohammadi and Roshanzamir (2015), Huo <i>et al.</i> (2014), Maekawa <i>et al.</i> (2013), Kim <i>et al.</i> (2011), Psomas <i>et al.</i> (2010), Karipidis <i>et al.</i> (2009), Wahid and Corner (2009), Wardhani <i>et al.</i> (2009), Mezher <i>et al.</i> (2005), Bhuiyan and Alan (2005), Chow-Chua <i>et al.</i> (2003), Khoo and Tan (2002), Augustyn and Pheby (2000) and Tang and Kam (1999)
7. Resources availability	Time, funds and personnel allocation to guarantee the implementation planning	Parra-Lopez <i>et al.</i> (2016), Huo <i>et al.</i> (2014), Maekawa <i>et al.</i> (2013), Kim <i>et al.</i> (2011), Psomas <i>et al.</i> (2010), Wardhani <i>et al.</i> (2009), Karipidis <i>et al.</i> (2009), Magd (2008), Angelogiannopoulos <i>et al.</i> (2007), Bhuiyan and Alan (2005) and Khoo and Tan (2002)
8. Integration between departments	No roadblocks related to the support between the departments	Giatman (2015), Gimeno <i>et al.</i> (2015), Kim <i>et al.</i> (2011), Wahid and Corner (2009) and Tang and Kam (1999)
9. Unbureaucratic management system	System without bureaucracies that avoid the development and actions implementation	Maekawa <i>et al.</i> (2013), Wahid and Corner (2009), Sedani and Lakhe (2009), Khoo and Tan (2002), Augustyn and Pheby (2000) and Tang and Kam (1999)
10. People awareness regarding the ISO 9001 significance	Collaborators know about the ISO 9001 importance to the organization and what are the benefits related	Psomas <i>et al.</i> (2010), Bhuiyan and Alan (2005) and Tang and Kam (1999)

organizations with such plans are more effective than those that simply implement the system without scheduled quality-related maintenance (Karipidis *et al.*, 2009).

- **Quality culture:** culture is a set of shared meanings lying beneath the conscious level of individuals that characterizes the organization behavior. It is based on core values, assumptions, interpretations and approaches, which differ from one organization to another (Valmohammadi and Roshanzamir, 2015). The quality-related work behavior within the organization is determined by its culture (Giatman, 2015). Parra-Lopez *et al.* (2016) highlighted “quality culture” as a critical factor for implementation, which should be reinforced when designing decision-making processes for the entire system.
- **Resource availability:** the managerial and supervisory staff in some industry sectors face economic and financial issues in implementing a QMS. Parra-Lopez *et al.* (2016) stated that the limited access to credit is a structural problem in the Spanish olive oil industry, which may deter acceptance of the ISO 9001 implementation.
- **Integration between departments:** behavioral organization science highlights the importance of integration between departments and personnel for the successful operation of any system (Giatman, 2015). Therefore, an effective integration between departments it is necessary to have a clear understanding of each other’s functions, regularly support one another and have a clear understanding of the vision and mission of their organization.
- **Level of bureaucracy:** Maekawa *et al.* (2013) indicated that bureaucracy in the system is a roadblock to the implementation of programs and quality tools inside the organizations. Special attention is needed from the stakeholders to address this point because it may lead to failure in the implementation process.
- **Awareness of ISO 9001 significance:** this factor is directly related to the quality culture inside the organization. Psomas *et al.* (2010) stated that inadequate perception of the significance of quality systems, including that of ISO 9001, on the part of employees is a critical roadblock for successful implementation.

3. Methodology

Evaluation of the importance of ISO 9001 implementation factors was carried out using the following major steps: (1) identification of relevant factors from the literature, (2) initial review and consolidation of factors using an open questionnaire, (3) comparison and ranking of factors using AHP. To guarantee a reliable evaluation of the implementation factors, steps (2) and (3) required the participation of subject matter experts. This requirement was met by the participation of 47 managers of ISO 9001 certified auto part supplier plants in Brazil, which provide components to power train assembly plants.

3.1 Identification of a set of relevant factors

Tranfield *et al.* (2003) indicated some filters to conduct a systematic review to identify the factors, in our case factors considered important for ISO 9001 implementation. These filters helped to identify and select substantively relevant studies constituting the core set of articles for data synthesis and analysis. The filters were defined as follows:

- ensure relevance insofar as the articles address, and capture the key determinants of successful ISO 9001 implementation, by requiring that they contain the keyword search in their title, abstract or keywords;
- consider only English language articles; and
- remaining abstracts and full papers should be read for substantive relevance.

Since the ISO 9001 implementation, literature consists of factors consisting of well-defined underlying concepts, it is possible to leverage this knowledge for factor identification. This enables subsequent steps in which expert inputs are used to confirm the suitability of the factors identified in the theory (Forza, 2002). It was observed that the literature reviewed focuses on the identification of both success and failure factors through theoretical review and/or quantitative research based on the Likert-type scale.

The literature review was conducted using relevant databases including Web of Science, Emerald and Science Direct, using keywords related to ISO 9001 such as “implementation,” “barriers,” “critical factors” and “benefits.” The initial search did not filter results by either time and/or publication type. The selected abstracts were read to be able to filter out articles, and a total of 85 articles published between 1997 and 2016 were shortlisted.

Ten factors were shortlisted after reviewing and comparing the work in these articles. Details of the shortlisted factors have already been discussed in the previous section.

3.2 Initial review and consolidation of factors—open questionnaire

An open questionnaire was developed to validate the correlation between ISO 9001 literature and practice and to consolidate implementation factors from both sources. This validation was achieved by polling a subset of the expert quality consultants who were participants in the study and had more than ten years of experience as lead auditors for ISO 9001. The subset of eight respondents were asked, using a questionnaire attached to an e-mail, to identify roadblocks and enabling factors for ISO 9001 implementation. The questionnaire introduced the motivation of the study, i.e. it was important to identify the critical factors for an effective ISO 9001 implementation. The open questionnaire then invited the respondents to name critical implementation factors based on their experience. They were not informed about the results of the literature search. At the end of this step, factors identified in the literature and by expert opinion were merged into a single list. The expectation was that the two lists would show a high degree of overlap with the merged list. The final list of factors would now be evaluated for relative importance.

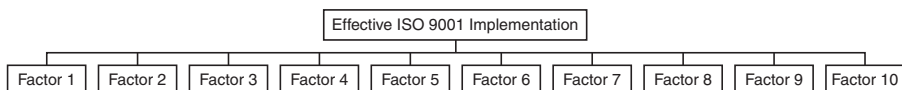
3.3 Comparison and ranking of factors using AHP

The comparison of factors is a complicated decision problem because of the presence of a combination of qualitative and quantitative factors in the consolidated list of critical factors following the open questionnaire. It is not feasible to express some of these factors in measurable units and difficult to structure the evaluation criteria into an analytical framework to facilitate understanding.

The use of AHP resolves these difficulties. Saaty (1990) stated that AHP is a multi-criteria decision method developed to solve complex decision problems, which can be decomposed into sub-problems with hierarchical levels (see example in Nascimento *et al.*, 2017). Each hierarchical level represents a set of attributes or alternatives related to each sub-problem. The top level of the entire hierarchy represents the goal of the problem, which in the presented study, is effective ISO 9001 implementation. Figure 2 represents the AHP structure to support our evaluation of the critical factors.

AHP structure is defined by goals and its evaluation criteria. It then uses pairwise comparisons to model mutual interaction between the elements and then measures and

Figure 2.
Hierarchy structure
designed for the
critical factors
evaluation



ranks their impact on the entire system. The relative order of importance between the elements, which is the objective of the ISO 9001 critical factor evaluation, is obtained.

The constraint in applying AHP based on inputs of subject matter experts is the time required to complete all possible pairwise comparisons. A structure with ten factors would demand 45 comparisons. In a survey study, this high number could negatively impact the response rate. Therefore, a variation of the AHP based on incomplete pairwise comparison (IPC) was used (Harker, 1987). In IPC, pairwise comparisons are restricted to the two upper diagonals above the main diagonal of the comparison matrix. Figure 3 shows the example for the comparisons needed when ten factors are evaluated using complete and IPC-based (or incomplete) AHP. Using IPC, the number of comparison in a ten-factor evaluation exercise is reduced from 45 to 17.

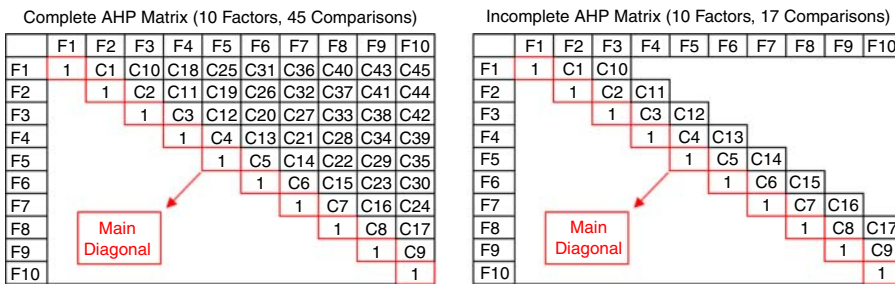
The questionnaire was distributed electronically using Expert Choice, the tool used for AHP evaluation. All the respondents (47 managers) were informed about the final factors selected after the open questionnaire. Figure 4 shows an example of the comparison done using Expert Choice. Once the respondent concluded all the comparisons, the system automatically transferred the results to the database. As soon as all the responses were received, the output reports and analysis provided by the Expert Choice became available.

4. Results and analysis

This section presents the results from the empirical research. First, the open questionnaire results and the results of the literature review are highlighted, which enabled the development of the closed questionnaire. The closed questionnaire was then delivered to survey respondents and subsequent AHP analysis was applied to identify and prioritize critical factors in the Brazilian automotive industry.

4.1 Survey logistics

The AHP questionnaire was mailed to 47 managers in global auto parts manufacturing companies that are Tier 1 or direct suppliers to engine and transmission manufacturers.



Note: F is the factor and C is the comparison

Figure 3.
AHP matrices for complete and incomplete comparisons

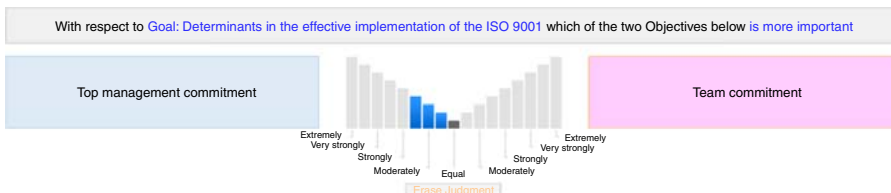


Figure 4.
Expert choice screen for the respondent compare two different factors

All respondents had graduated as engineers and had at least ten years of experience with quality and had led QMSs implementation and maintenance initiatives. Their employers could be classified into four groups: electric component manufacturing, metallurgy, subcomponent manufacturing (e.g. intake manifold, water pump, oil pump, front cover) and small part manufacturing (e.g. bolts, retainers, springs). The open questionnaire was e-mailed to a subset of these managers.

4.2 *Open questionnaire*

The open questionnaire allowed critical success factors to be identified based on the perspective of lead assessors/consultants. The result of the open questionnaire showed that, as anticipated, their observations were in agreement with the academic literature.

For example, the inputs of the respondents indicated that it is important to consider the involvement from leadership in recognizing and motivating people involved with ISO 9001 implementation. Leadership and motivation is important since implementation results are achieved gradually and the motivation helps sustain the process. Respondents also commented about the failure of management to communicate quality guidelines within the organization. Both these observations are directly correlated with the factor “top management commitment” identified in the literature.

There are several other examples where factors from the literature (enclosed in square brackets in this paragraph) and from consultant feedback are equivalent. These include: presence of a hostile environment among the employee teams [integration between departments], lack of knowledge about the system [training], lack of employee awareness about policies and practices [quality culture], failure to follow internal standards [team commitment], lack of resources to improve the process [resource availability], and lack of time to conduct the implementation and lack of time available to the team involved [schedule for implementation].

Out of the 12 factors cited by consultants, only 3 did not appear in the literature:

- Quality staff reliability: related to the perception of reliability of those responsible for the system implementation in the organization.
- Measurement system analysis (MSA): is an experimental design process used to determine the components of variation in the measurement which guarantee its repeatability and reproducibility.
- Process approach: related to viewing the system as a set of processes responsible for transforming inputs into outputs with their respective controls.

All other nine factors were cited in theory, indicating high correlation between the experience of respondents and literature. The shortlisted factors could now be ranked for their level of importance to ISO 9001 implementation.

4.3 *AHP data analysis*

An initial pilot AHP survey was designed and sent to seven suppliers in order to validate the protocol. Once validated, the final AHP questionnaire was sent to a total of 80 potential respondents in 80 companies. In total, 47 respondents answered the questionnaire, resulting in a response rate of 58.75 percent.

The AHP questionnaire included ten factors. Three factors (with their sources in square brackets) were not considered: first, people awareness about the ISO 9001 importance [literature] was not considered because it has blurred boundaries with the factor quality culture within the organization [literature]; second, MSA presence [open questionnaire] and third, process approach [open questionnaire] were also not considered as they are essential requirements of ISO 9001.

Table III presents a summary of the factor selection process, including information about the literature review, open and closed questionnaires.

The results, and the context within which AHP analysis results were studied, are presented in Table IV. There are six different columns presenting the results based on specific criteria: general results, sensitivity analysis, discarding top management commitment and a division by industry sector. General results are results in which all 47 answers were compiled to provide the factor ranking with their respective global priority. The global priority indicator is the AHP output from pairwise comparisons. As seen in global priority results in Table IV, top management commitment was the highest priority factor based on pairwise comparisons. This conclusion is consistent with the experience of ISO 9001 implementation, in which this factor is emphasized for a successful quality system implementation. If the top management is committed during the implementation process, the commitment of the other stakeholders can be achieved and maintained. If the plant leadership approaches ISO 9001 implementation with a sense of priority, then they are likely to provide the necessary support for the process. Employees, in turn, give importance to the process. Without top management commitment, a QMS is likely to fail.

Sensitivity analysis was performed on AHP results. Since top management commitment was the main factor, sensitivity analysis evaluated how other factors are scored when top management commitment is removed from the list. The analysis was also performed according to industrial sector. As stated earlier, respondents came from four groups: electrical component manufacturers (10 respondents), machining industries (12 respondents), subcomponent manufacturers (13 respondents) and small parts manufacturers (12 respondents).

Removing top management commitment from the comparison retained the order of the remaining factors. Team commitment became the key factor for a successful implementation. This can be understood on the basis that both top management and employees need to be committed to guarantee adherence to the actions at the operational

Factors	Factor identification/presence in the referred tool (P) = Present/(A) = Absent			Rationale for the removal from the AHP questionnaire (final version)
	Literature review	Open questionnaire	AHP questionnaire	
1. Top management commitment	P	P	P	–
2. Team commitment	P	P	P	–
3. Quality culture	P	P	P	–
4. Responsibilities and authorities defined	P	P	P	–
5. Training	P	P	P	–
6. Integration between departments	P	P	P	–
7. Resources availability	P	P	P	–
8. Schedule for implementation	P	P	P	–
9. Quality staff reliability	A	P	P	–
10. Unbureaucratic management system	P	P	P	–
11. Process approach	A	P	A	Output from ISO 9001
12. Measurement system analysis	A	P	A	Output from ISO 9001
13. People awareness regarding the ISO 9001 significance	P	A	A	Correlated to quality culture

Table III.
Factors identification overview (literature review, open and closed questionnaires)

Table IV.
Closed questionnaire
results

Factors	General total amount of companies sampled		Sensitivity analysis discarding top management		Electrical components manufacturers		Machining industries		Sub-components manufactures		Small parts manufacturers	
	Global priority (%)	Rank	Global priority (%)	Rank	Global priority (%)	Rank	Global priority (%)	Rank	Global priority (%)	Rank	Global priority (%)	Rank
Top management commitment	34.71	1st	-	-	42.08	1st	29.20	1st	33.13	1st	34.37	1st
Team commitment	11.80	2nd	18.07	1st	8.60	5th	12.17	2nd	10.91	3rd	15.51	2nd
Quality culture	9.73	3rd	14.90	2nd	11.49	2nd	11.33	3rd	7.70	6th	8.21	5th
Responsibilities and authorities defined	9.19	4th	14.08	3rd	8.80	4th	8.36	5th	9.59	4th	9.76	3rd
Training	8.66	5th	13.26	4th	9.72	3rd	8.07	6th	8.03	5th	8.70	4th
Integration between departments	7.96	6th	12.20	5th	5.42	6th	9.00	4th	11.69	2nd	5.81	7th
Resources availability	5.69	7th	8.72	6th	4.86	7th	7.33	7th	6.55	7th	3.85	9th
Schedule for implementation	5.09	8th	7.79	7th	4.52	8th	4.44	9th	4.91	8th	6.48	6th
Quality staff reliability	4.14	9th	6.34	8th	2.07	10th	6.26	8th	3.60	10th	5.34	8th
Unbureaucratic management system	3.03	10th	4.64	9th	2.42	9th	3.85	10th	3.89	9th	1.97	10th

level as per its planning. Downey *et al.* (2015) indicated that team commitment is directly related to the climate of trust within an organization, and implementations work best when there is a high perception of inclusion. So, it can be concluded that it is important to give employees access to decision-making processes during ISO 9001 implementation to earn their commitment to the process.

The global priority gap between the team commitment and the other factors is not big when compared with the top management commitment. It indicates that, beyond the top management factor, lower ranked factors have approximately equal relative importance in ISO 9001 implementation. For example, it is essential to have a quality culture inherent in the organization, making easier the acceptance and transition to an ISO 9001 system. It is also necessary to clearly define responsibilities and authorities within the implementation team. Training should be provided to employees to standardize knowledge within the organization. Factors with lower importance in the ranking sequence also deserve attention, i.e. integration the areas eliminating the barriers between them, resources allocation to achieve the goals proposed, schedule establishment, staff reliability and establishing a management system with low levels of bureaucracy.

In summary, results and analysis across several criteria presented in Table IV indicate that the top management commitment is the base for a successful ISO 9001 implementation and additional factors need to be considered during implementation because of their significant aggregate impact.

5. Conclusions

The study demonstrates that top management commitment is the key factor to guarantee an effective ISO 9001 implementation. In its absence, the entire organization will not be motivated to contribute to the quality management process, which can result in the outcome being negative. Top management must communicate the importance of the ISO 9001 implementation and provide due support and leadership to ensure successful completion of all the steps.

However, this does not imply that other factors may be neglected. Care and attention needs to be paid to other factors, since they are shown to have a higher importance when considered as a combination. If neglected, there is a serious risk of an ineffective implementation.

Organizations that understand the relative importance of each factor are likely to be successful in ISO 9001 implementation and in ensuring its internalization, moving toward a “quality mindset” as characterized by Boiral and Heras-Saizarbitoria (2015).

5.1 Implications for theory and practice

On the theoretical side, the present study contributes to the existing literature, enriching the content about ISO 9001 implementation, specifically in the automotive industry. A new factor, quality staff reliability, which was not cited in the literature, was identified during the open questionnaire and carried forward to the AHP questionnaire.

Another theoretical contribution that differentiates this study from similar ones is the innovative application of the AHP method for ranking of factors. The advantage of using AHP is its ability to organize opinions, intuition and logic using a structured approach. Its ability to mix qualitative and quantitative criteria in the same framework and handle complex problems proves beneficial for a problem such as critical factor ranking and evaluation that has predominantly intangible attributes. ISO 9001 implementation literature does not present any paper based on AHP. Papers have generally used theoretical constructs (Karipidis *et al.*, 2009), either open questionnaires (Sedani and Lakhe, 2009) or closed questionnaires using the Likert-type scale for factor evaluation (Psomas *et al.*, 2010). A pilot study proved that the Likert-type scale was not feasible for the prioritization of factors, as all of them were classified as highly critical.

On the managerial side, the research findings will help to improve the ISO 9001 implementation process. Each factor has a well-understood corresponding implementation cost, which provides managers with a useful guide for prioritization. Top management commitment, team commitment, quality culture, clear definition of responsibility and authority, and training are the top five factors in the automotive industry. A highlight is that this research shows that while other factors may not be neglected, they may be addressed at a lower priority. All the ten factors are relevant for successful implementation.

5.2 Implications for future research

A future version of this work could analyze factors critical for long-term effectiveness of ISO 9001. Some of the influencing metrics for assessing this could be regular use of quality tools in the day-to-day activities and their continuous effectiveness. Although top management and team commitment (consistent with the literature) appear to be the two most critical factors in ensuring successful ISO 9001:2015 implementation, further research should explore the key factors that determine levels of top management and team commitment. Given the sample size and rigorous approach to ranking of the key factors (using AHP), this study's findings can be considered fairly representative for the automotive industry. However, future research ought to test the relative importance of the key factors identified in this research, and their applicability in other industrial contexts.

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Further reading

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About the authors



Diogo Almeida is Master Researcher in Production Engineering at Sao Paulo State University (UNESP), Brazil. He completed his Graduation in Mechanical Production Engineering at UNESP, Brazil. He is Black Belt certified and works in the Brazilian Automotive Industry with focus on Quality Management tools since 2008.



Ninad Pradhan is Postdoctoral Researcher in Industrial and Systems Engineering at the University of Tennessee, Knoxville, USA. He completed his PhD (Computer Engineering) and MS (Electrical Engineering) from Clemson University, USA. He specializes in the application of computer vision and machine learning to the analysis of production processes. Additionally, he has worked on industry sponsored projects in optimization, warehousing and risk assessment.



Jorge Muniz Jr is Associate Professor in the Universidade Estadual Paulista—(UNESP), Sao Paulo, Brazil, Editor in Chief of Production Journal (2015–2017), and Coordinator of Executive Master in Production Engineering (2014–2017). He completed his Doctorate (Operation Management) from UNESP, which was awarded by Production Engineering Brazilian Association (ABEPRO), and MS (Operation Management) from USP, Brazil. Additionally, he has worked on FORD as Quality Manager integrating Lean Thinking to the Quality Operations Systems. He researches knowledge management in production systems, quality management and lean thinking. Jorge Muniz Jr is the corresponding author and can be contacted at: jorge86056@gmail.com