Quality assurance and satisfaction with their results: an application to the implementation of EN 9100 standard in the Spanish aerospace sector

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Abstract

The objective of this study is to analyse how certain factors may influence satisfaction derived from the positive effects of implementing the EN 9100 Standard in the Spanish aerospace industry. A multiple linear regression model has been created, which includes data gathered from 115 valid questionnaires received from companies in this industry. The results of this model show that the length of time since first adhering to the EN 9100 Standard, the predominant motivation (internal or external) driving the implementation of the standard and the level of satisfaction with the prior implementation of ISO 9001 are significant variables that affect the level of satisfaction with EN 9100; whereas the size of the company is not a significant factor.

Keywords: Quality management. Quality assurance standards. EN 9100 and ISO 9000 Standards. Spanish aerospace industry.

JEL codes: L15, M10.
1. Introduction

The aerospace industry is one of the most important sectors in the world economy, as well as in Spain. According to PwC (2011), in 2010, total revenue of the world’s top 100 enterprises amounted to USD 645.800 billion, which is the equivalent of 5% of the worldwide gross domestic product. The Spanish aerospace industry is equally important: according to 2010 data (DBK – a Spanish firm that conducts business and competitive analysis, 2011), it is the fifth European industry in this sector, both in terms of employment (40,262 employees) and for its yearly revenue (6.511 billion euros), with a strong emphasis on exports, which account for just under 75% of total yearly revenue.

In addition, the industry is becoming increasingly competitive, as a result of pressure from customers (mainly airlines and aircraft owners) and from equipment manufacturers themselves (PwC, 2011). Similarly, the increasing complexity of the systems used in this sector and the increasingly large scale of the projects that are undertaken have now made it impossible for any of the end-product (aeroplanes, helicopters, satellites, etc.) manufacturers to produce the entire product themselves. End products are now the result of collaboration between a large number of system and sub-system manufacturers and other specialist companies, which leads to some unique subcontracting relationships, as well as the increasing internationalisation of production and development (TEDAE, 2010).

This level of complexity and the wide-ranging scope of the projects undertaken, together with the fact that “safety” is the key aspect that underpins this industry’s activities, make it necessary for aerospace products to be subjected to very stringent requirements with regard to quality and reliability. The quality standards in this sector, therefore, are some of the most demanding in any industry. In consequence, the ISO 9000 quality assurance standards are widely applied here, as are the EN 9100 family of standards, which is specifically geared to this industry, whereas the ISO 9001 standards are more generic.

These quality assurance standards build on the need to systematise and formalise a series of tasks in order to attain uniform products or services, as well as compliance with the specifications established by the client (Anderson et al., 1999). In short, they standardise procedures, roles and responsibilities (Braun, 2005; Guler et al., 2002). In addition, we should bear in mind that standardisation benefits international trade and exchange, which are characteristic of the current global economy, by eliminating barriers arising from practices prevailing in each country (Heras and Boiral, 2013). Thus, it provides solutions to the international features of collaborative projects between different countries, which are customary in this industry, leading to increased trust between the various clients and suppliers involved, while improving the quality of the relationship between them (Mpinganjira et al., 2013).

Implementing these quality assurance standards entails investing money, time and organisation, both initially and during the maintenance stages, (Whitford and Bird,
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1996); investments which, it is hoped, will lead to maximised returns. However, according to prior studies conducted on ISO 9001, these investments are not always offset by positive outcomes, as shown in section 2 of this paper, which has, on occasion, led to a low level of satisfaction with the application of this standard. The implementation of EN 9100 naturally involves higher costs than for the generic ISO 9001 standard, as it includes a number of additional requirements pertaining to the aerospace industry. These costs should, theoretically, be offset by higher profits arising from adherence to this standard. Failure to achieve these higher returns would lead to increased dissatisfaction.

Prior studies in the field of the EN 9100 standard are scarce. Some of them focus on a description of the general characteristics of the standard, as well as on its main differences with ISO 9000 (Beltrán, 2002; Grijalbo and Prida, 2005b; Gutiérrez, 2008). Others give an account of the extent of implementation of EN 9100 standards, which mainly occurs among the industry’s large manufacturers and suppliers, whereas it is more uneven among second and third-tier suppliers (Grijalbo and Prida, 2005a). While other studies provide a compilation of models and guidelines to use when adhering to the standard (IAT, 2003), a final group describes how EN 9100 was implemented in some of the principal aviation companies, such as EADS, SEN-ER, etc. (Murga, 2002; Vilar, 2003). However, none of these studies specifically analyses the level of satisfaction arising from the benefits caused by the implementation of this standard, nor the factors that determine this satisfaction. Its predecessor in the industry, ISO 9001, has, in fact, been the subject of a number of studies, yet none of them refers specifically to the aerospace industry. Consequently, this research study will attempt to make up for the lack of analysis of the results of applying quality assurance standards in this industry.

The objective of the investigation is to analyse – among enterprises in the Spanish aerospace industry – the weight of the following factors in the satisfaction derived from the positive effects of implementing the EN 9100 standard: a) company size; b) length of implementation of EN 9100; c) type of predominant motivation (external and/or internal) for adherence; d) level of satisfaction with possible prior implementation of the ISO 9001 standard.

The methodology was based on a postal survey circulated among the quality managers of the 353 companies that composed the aerospace industry in Spain at the end of 2008, this being the last full financial year elapsed at the start of the investigation (November 2009). A multiple linear regression model was used to deal with the answers.

Following this introduction, which provides a context for the basic elements of the study, there is a description of the theoretical framework of the investigation under the second heading, including basic aspects of quality management in the aerospace industry and a review of the literature available that is relevant to these standards. In the third section there is a description of the samples and methodology used, and detailed information of outcomes and conclusions is provided in sections four and five respectively.
2. Conceptual Framework

2.1. Quality management in the aerospace industry

The concept of quality management has developed widely as a strategic approach to handling quality in enterprises, building on the principles of customer focus, continuous improvement, people focus and a global vision of the organisation (Merino, 1999; Camisón et al, 2009).

As we have mentioned, the aerospace industry has always been at the cutting edge of quality management system development (IAQG, 2008) and its standards are significantly higher than any to be found in other industrial sectors, except the automotive industry (Gutiérrez, 2008). The “self-assessment template” was the first step in the evolution of quality systems in the industry. Subsequently, companies in the sector have used “second-party audits”, that is, supplier quality system audits based on each client’s own criteria and methods. This system leads to high costs for the sector, since the same company is sometimes audited regularly by several different bodies, which multiplies the expenditure incurred.

The search for greater efficiency led in the nineties to a trend towards the development and adoption of systems based on “third-party audits”, one of which is the ISO 9000 family of standards. These began to spread within the sector to become the only quality management system worth considering. However, these standards did not entirely conform to the specific characteristics of the aerospace industry, so most of the leading companies in the sector continued to produce their own supplements to the standard, which resulted in the multiplication of requirements for suppliers, and led back to the issues arising from second-party audits.

In order to overcome the problems caused by the many requirements confronting suppliers and seeking to promote quality harmonisation and globalisation within the aerospace industry, in December 1998, the major suppliers, manufacturers and commercial associations in Europe, Asia and America came together to form the International Aerospace Quality Group (IAQG), which in 1999 promoted the EN 9100 family of standards for the industry, with the purpose of standardising the sector’s additional requirements to a more specific level than ISO 9001.

The EN 9100 standard (AS 9100 in America and SIAC 9100 in Asia) included both the requirements arising from ISO 9001 and the 83 additional requirements specific to the aerospace industry. In December 2009, the IAQG’s OASIS database, which includes a register of the companies that have implemented this standard, showed a total of 10,765 companies certified worldwide. In short, EN 9100 standards constitute a quality assurance model that attaches particular importance to areas which were considered to have the greatest impact on the security and reliability of aerospace products, such as design, purchasing, process control, inspection and testing and nonconformities control.
2.2. Literature Review

As we mentioned in the introduction, there are few studies that refer to the EN 9100 standard, and none that refers either to the results of its implementation or to the satisfaction arising from these results. The ISO 9000 family of standards, for its part, has been the subject of a number of studies, although none of them refer specifically to the aerospace industry. In view of the purpose of this investigation, we have examined the principal studies that specifically, or as a subject among others, refer to the level of satisfaction derived from the positive effects generated by adherence to ISO 9001 and to the influence upon these effects of the factors we are about to consider for EN 9100; namely, company size, length of implementation of the standard, type of predominant motivation (external and/or internal) for adherence, as well as the simultaneous or subsequent implementation of other quality management models.

2.2.1. Level of satisfaction and the positive effects of implementing the ISO 9001 standard

There is a variety of studies that analyse the general level of satisfaction with the implementation of these standards by means of a five-level Likert scale, in which 5 is equal to highly satisfied with the standard, while 1 stands for highly dissatisfied with the standard (Buttle, 1997; Mezher y Ramadan, 1999; Escanciano et al., 2001; Magd et al., 2003; Calisir et al., 2005; Lundmark y Westelius, 2006; Calisir, 2007). According to the findings of these studies, the implementation of ISO 9000 standards is generally satisfactory, since the percentage of organisations that are satisfied or highly satisfied ranges between 61% (Escanciano et al., 2001) and 93% (Calisir, 2007).

In addition, as numerous studies show (among others, Buttle, 1997; Brown et al., 1998; Neergaard, 1999; Sun, 2000; Escanciano et al., 2001), the level of satisfaction with the implementation of ISO 9001 is very closely linked to the level of positive effects obtained as a result of this standard, to an extent that the stronger these positive effects appear to be, the greater the level of satisfaction with implementation. For this reason, we shall analyse prior studies on the acquisition of these positive effects and to what extent the determining factors that will be the object of analysis in this research have influenced them. Ultimately, this will have an impact on the level of satisfaction with the implementation of ISO 9001, as the previously cited authors have discovered.

In general terms, we observe that most of the studies have concluded that the ISO 9001 standard leads to beneficial effects for companies. However, despite being a minority, there are a few studies in which these positive effects fail to emerge, or at least do not emerge in all cases or circumstances, as shown by Terziovsky et al. (1997), Singels et al. (2001), Heras et al. (2002), Wilson et al. (2003) and Martínez-Costa and Martínez-Lorente (2007).
Many different studies (Tsiontis and Gotzamani, 1996; Vloeberghs and Bellens, 1996) categorise the positive results of adhering to these standards as related to “internal issues” and “external issues”, as shown in Table 1:

Table 1. Typology of positive effects arising from adherence to ISO 9001

<table>
<thead>
<tr>
<th>INTERNAL ISSUES</th>
<th>EXTERNAL ISSUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Related to organizational procedures Control over production management, the</td>
<td>Financial and Commercial Sales volume, market share, revenue per employee ratio,</td>
</tr>
<tr>
<td>establishment of responsibilities and regulations, process documentation, etc.</td>
<td>etc.</td>
</tr>
<tr>
<td>Related to operations execution Better use of resources, reduced inspection</td>
<td>Client-related Client retention rates, complaints received, market image.</td>
</tr>
<tr>
<td>costs, lower logistics expenditure, fewer nonconformities, etc.</td>
<td></td>
</tr>
<tr>
<td>Related to HHRR Job satisfaction, team operations, employee suggestion systems,</td>
<td></td>
</tr>
<tr>
<td>etc.</td>
<td></td>
</tr>
</tbody>
</table>

When ranking these two types of benefits, there are some previous studies that have prioritised the positive effects on internal issues (Brown et al., 1998; Zaramdini, 2007; Martínez-Costa et al., 2008; Lo et al., 2009; Wahid y Corner, 2009), while others have emphasised those linked to external issues (Corbett et al., 2005; Sharma, 2005; Terlaak y King, 2006). Most, however, show the positive results achieved in both internal and external issues (Tsiontis y Gotzamani, 1996; Buttle, 1997; Leung et al., 1999; Casadesús y Giménez, 2001; Escanciano et al., 2001; Gotzamani y Tsiontis, 2002; Casadesús et al., 2004).

2.2.2. Influence of the company size on the positive effects of implementing the ISO 9001 standard

As regards the extent to which the size of the enterprise influences the beneficial effects of implementing ISO 9001, prior research is not unanimous. In this respect, most studies indicate that it is harder to obtain positive outcomes in smaller enterprises, as they often lack certain internal resources that are important to the success of the implementation (at least in relation to internal benefits). Moreover, initial costs and investments related to obtaining certification are proportionally higher in comparison with those that larger enterprises must make (Brown et al., 1998; Lee y Palmer, 1999; Nwankwo, 2000; Gustafsson et al., 2001; Rodríguez et al., 2006).

However, it is also possible to find studies that point out that benefits are similar regardless of size; although in the smaller companies, it may take longer to obtain
them (Rayner y Porter, 1991; Quazi y Padibjo, 1998; Briscoe et al., 2005). In some cases, benefits obtained by the smaller companies may even be superior, in view of the fact that their starting point as regards quality management often tends to be lower (Gotzamani and Tsiotras, 2001).

Because of this, and since the studies that have concluded that the positive effects of implementing the ISO 9001 standard are similar, regardless of company size, are in a minority, we propose the following hypothesis:

*Hypothesis H1* The size of the company is a determining factor in obtaining positive effects from adherence to the EN 9100 standard among companies in the aerospace industry, and, therefore, in their level of satisfaction as a result of its implementation.

### 2.2.3. Influence of the time factor (length of implementation) on the positive effects of implementing the ISO 9001 standard

Similarly, in this aspect prior research is also not unanimous regarding the influence of this factor on the beneficial effects of implementing ISO 9001. In this respect, most studies indicate that time is a positive factor in the appearance of the beneficial effects we have mentioned, which are caused by adhering to ISO 9001 (Romano, 2000; Climent, 2005; Corbett et al., 2005). Nonetheless, it is also possible to find studies that maintain the opposite (Tsiotras y Gotzamani, 1996; Jones et al., 1997; Leung et al., 1999; Casadesús et al., 2004; Gotzamani et al., 2006), which seems to indicate that the time factor may be conditioned by the sector under observation and/or the type of internal or external positive effect being analysed.

Because most studies show that the passage of time has a positive influence on the appearance of positive effects resulting from the implementation of the ISO 9000 family of standards, and because the projects undertaken in the aerospace industry are lengthy and complex, which can condition the appearance of positive effects from the outset, we propose the following hypothesis:

*Hypothesis H2* The time that has elapsed from the moment of certification is a determining factor in obtaining positive effects from adherence to the EN 9100 standard among companies in the aerospace industry, and, therefore, in their level of satisfaction as a result of its implementation.

### 2.2.4 Influence of the predominant type of motivation factor (external and/or internal) that led to adhering to ISO 9001 on the positive effects of implementing it

The motives a company may have for adhering to a standard can be linked both to “external issues” (such as improving the company’s image and position in the
market, or commercial, financial and customer management concerns) and to “internal issues”, such as improving organizational processes, operations execution, and management of human resources of the company (Buttle, 1997; Gotzamani y Tsiorras, 2002; Llopis y Tari, 2003; Terziovski et al., 2003). In addition, we have noted that on the whole research shows that motivation is primarily related to “external issues” (Buttle, 1997; Brown et al., 1998; Terziovski et al., 2003; Costa y Lorente, 2004; Rodríguez y González, 2006), while fewer studies have concluded that there is a balance between both types of issues, or even that “internal issues” predominate (Escanciano et al., 2001; Gotzamani y Tsiorras, 2002; Llopis y Tari, 2003; Yeung et al., 2003; Chang y Lo, 2005).

Likewise, we should point out that prior studies on ISO 9001 that focus on the possible relationship between the predominant type of motive for adherence to the standard (external and/or internal) and the results of this adherence mostly agree that if adherence to the standard arises from an attempt to resolve internal issues in the company, and not only as a result of external pressure (from clients or regulators), or only to improve external issues (a better image / the latest trend), the overall benefits observed after the implementation of ISO 9001 are greater (Jones et al., 1997; Brown et al., 1998; Leung et al., 1999; Gotzamani y Tsiorras, 2002; Llopis y Tari, 2003; Rodríguez y González, 2006; Boiral et al., 2007; Martínez-Costa et al., 2008). In consequence, we propose the following hypothesis:

**Hypothesis H3** The predominant type of motive (external and/or internal) for the implementation of the EN 9100 standard is a determining factor in obtaining positive effects from adherence to this standard among companies in the aerospace industry, and, therefore, in their level of satisfaction as a result of its implementation.

### 2.2.5. Influence of the factor involving the simultaneous or successive implementation of other quality management models on the positive effects of implementing the ISO 9001 standard

Since there were no significant studies prior to the starting date of this research on the relationship between the implementation of ISO 9001 and EN 9100, we have analysed existing work on the possible relationship between the implementation of the ISO 9000 family of standards and the implementation of Total Quality Management models (TQM), and have found that conclusions are not unanimous.

According to some of these studies, the joint implementation of both models provides no added value; that is, makes no difference to the results (Terziovsky et al., 1997; Rahman, 2001), and can even reduce the benefits obtained from implementing either ISO 9001 or the TQM models (Martínez-Lorente et al., 2000; Martínez-Lorente y Martínez-Costa, 2002). However, for the majority of the studies, the implementation of this standard represents a positive intermediate step towards
TQM and even their joint application enhances the benefits that companies enjoy, so long as their adherence to ISO 9001 is performed satisfactorily – that the external, and particularly, the internal benefits arising from implementation are received (Withers et al., 1997; Brown et al., 1998; Gotzamani y Tsiotras, 2001; Escanciano et al., 2003; Han et al., 2007; Martínez-Costa et al., 2008). In consequence, we propose the following hypothesis:

Hypothesis H4: The level of satisfaction with the prior implementation of the ISO 9001 standard is a determining factor in obtaining positive effects from adherence to the EN 9100 standard among companies in the aerospace industry, and, therefore, in their level of satisfaction as a result of its implementation.

3. Methodology

3.1. Sample

In order to determine the population to be surveyed, it was necessary to resort to a compilation of specific industry-related databases that encompass the enterprises in the sector. There is a great deal of diversity among the companies involved, as regards both size and business specialisation. In the first place, we analysed ATECMA’s census. At the end of 2008, ATECMA, the Spanish Association of Aerospace Industries, was a reference point in Spain, with 55 members including the most significant businesses in the industry, which comprised 90% of total revenues. Secondly, we consulted the OASIS database, which maintains a register of all the companies in the aerospace industry that have adhered to the EN 9100 Standard. Lastly, as an ancillary consideration, we examined other industry-related databases. Once we had eliminated duplicated data, the final target population to be analysed was fixed at 355 enterprises, as shown in Table 2:

<table>
<thead>
<tr>
<th>Survey Data Source</th>
<th>Aerospace Industry Enterprises</th>
<th>Auxiliary enterprises</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aviation Sub-Sector</td>
<td>Aerospace Sub-Sector</td>
<td></td>
</tr>
<tr>
<td>AtecmA</td>
<td>34</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Oasis</td>
<td>98</td>
<td>7</td>
<td>73</td>
</tr>
<tr>
<td>Others</td>
<td>87</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>217</strong></td>
<td><strong>18</strong></td>
<td><strong>118</strong></td>
</tr>
</tbody>
</table>
3.2. Questionnaire

After an analysis of previous research studies related to the ISO 9001 standard, a draft questionnaire was designed and categories were drawn up including the possible motives of participating companies for adhering to EN 9100, as well as the positive effects perceived to derive from implementation, on the basis of the various internal and external issues that are shown in Table 1. This draft was subjected to a “pre-test” by circulating it among specialists in the field in two of the participating companies (Airbus España and Iberia LAE Mantenimiento), and in-depth interviews were held with each of them. After their views were incorporated, the final draft of the questionnaire was produced. Next, they were sent by post and e-mail to the quality managers of all 355 of the companies selected.

Once the completed questionnaires had been received, it was decided that 115 of them were usable; that is, 32.4% of the population (355 companies). In addition, we should point out that the EN 9100 standard is widely applied among the companies that completed the questionnaire (70% of the companies; that is, 81). In 86% of the cases, the companies have been implementing the standard for over three years and the level of certification intensity is high – 77% of the companies have adjusted all of their processes to the standard. Both aspects, length of time and certification intensity, strengthen the validity of the answers obtained in the questionnaires. On the basis of all these data, a technical data sheet was produced for the study, which is shown in Table 3.

Table 3. Technical data sheet

<table>
<thead>
<tr>
<th>Population universe</th>
<th>Enterprises in the Spanish aerospace industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling technique</td>
<td>Random: questionnaires were sent to all the entities in the population universe</td>
</tr>
<tr>
<td>Information-gathering method</td>
<td>Information was gathered by means of a postal and an online survey</td>
</tr>
<tr>
<td>Respondents</td>
<td>Quality managers or individuals responsible for this area in the enterprise</td>
</tr>
<tr>
<td>Population</td>
<td>355</td>
</tr>
<tr>
<td>Sample size</td>
<td>115</td>
</tr>
<tr>
<td>Confidence level</td>
<td>95% ( (z=1.96; p=q=0.5) )</td>
</tr>
<tr>
<td>Sampling error</td>
<td>7.5%</td>
</tr>
<tr>
<td>Information-gathering period</td>
<td>From 1 November 2009 to 31 January 2010</td>
</tr>
</tbody>
</table>
3.3. Variables and Model Proposed

In order to analyse the influence of the different factors considered in this investigation on the level of satisfaction resulting from the positive effects caused by the implementation of the EN 9100 standard, a multiple linear regression model was devised, the variables of which are:

Dependent variable Y: Satisfaction with the EN 9100 standard (SatEN). Depending on the answers obtained by the questionnaire completed by the participating companies, the values of this variable may be: 1- very dissatisfied, 2- dissatisfied, 3- satisfied, 4- highly satisfied and 5- very highly satisfied.

Independent variables X:

Variable $x_1$: Company size (Size). Depending on the answers obtained by the questionnaire completed by the companies, the values of this variable may be: 1- small, 2- medium, 3- large (based on the criteria established in EU Recommendation 2003/361/CE).

Variable $x_2$: Length of time since the EN 9100 standard was first implemented (Time). Depending on the answers obtained by the questionnaire completed by the participating companies, the values of this variable may be: 1- length of time less than or equal to 3 years, 2- length of time over 3 years.

Variable $x_3$: Type of predominant motive (external and/or internal) for implementation (TypeMot). Depending on the answers obtained by the questionnaire completed by the participating companies, the values of this variable may be: 1- If “external” reasons predominate, 2- If “internal” reasons predominate.

Variable $x_4$: Satisfaction with prior implementation of the ISO 9001 standard (SatISO). Depending on the answers obtained by the questionnaire completed by the participating companies, the values of this variable may be: 1- very dissatisfied, 2- dissatisfied, 3- satisfied, 4- highly satisfied and 5- very highly satisfied.

Based on these variables, we formulated the following multiple linear regression model:

$$y_i = \beta_0 + \beta_1 \cdot x_{1,i} + \beta_2 \cdot x_{2,i} + \beta_3 \cdot x_{3,i} + \beta_4 \cdot x_{4,i} + u_i$$

$$\text{SatEN}_i = \beta_0 + \beta_1 \cdot \text{Size}_{1,i} + \beta_2 \cdot \text{Time}_{2,i} + \beta_3 \cdot \text{TypeMot}_{3,i} + \beta_4 \cdot \text{SatISO}_{4,i} + u_i$$

4. Analysis of Results

Firstly, we attempted to discover the level of overall satisfaction with the implementation of the EN 9100 standard among the companies in the Spanish aerospace industry. To this end, we asked respondents the following question: Overall, how satisfied are you with the EN 9100 standard? (Choose the appropriate alternative: 1- very dissatisfied, 2- dissatisfied, 3- satisfied, 4- highly satisfied and 5- very highly satisfied). According to the answers we received, the level of satisfaction of compa-
nies in the Spanish aerospace industry with regard to their adherence to this standard is fairly high; 68% of the companies stated that they were highly (58%) or very highly (10%) satisfied, 29% stated that they were satisfied and only 4% stated that they were dissatisfied or very dissatisfied.

The results of the multiple linear regression model were used in order to respond to the *purpose of this investigation*; that is, to analyse the influence on the satisfaction felt by companies in the Spanish aerospace industry with regard to their implementation of the EN 9100 standard of the factors, “company size”, “length of time since the standard was first implemented”, “type of predominant motive (external or internal)”, and “satisfaction with prior implementation of ISO 9001”. Table 4 shows the correlations between the variables analysed in the model, with the purpose of confirming their relative independence.

Table 4. Pearson correlation between the variables in the model

<table>
<thead>
<tr>
<th></th>
<th>Satisfaction EN</th>
<th>Size</th>
<th>Length of Time</th>
<th>Type of predominant motivation</th>
<th>Satisfaction ISO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Satisfaction EN</strong></td>
<td>Pearson Correlation</td>
<td>1</td>
<td>0,043</td>
<td>0,501</td>
<td>0,299</td>
</tr>
<tr>
<td></td>
<td>Sig. (unilateral)</td>
<td>0,000</td>
<td>0,350</td>
<td>0,000</td>
<td>0,003</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>Pearson Correlation</td>
<td>0,043</td>
<td>1</td>
<td>-0,031</td>
<td>-0,012</td>
</tr>
<tr>
<td></td>
<td>Sig. (unilateral)</td>
<td>0,330</td>
<td></td>
<td>0,393</td>
<td>0,457</td>
</tr>
<tr>
<td><strong>Length of Time</strong></td>
<td>Pearson Correlation</td>
<td>0,501</td>
<td>-0,031</td>
<td>1</td>
<td>0,167</td>
</tr>
<tr>
<td></td>
<td>Sig. (unilateral)</td>
<td>0,000</td>
<td>0,393</td>
<td></td>
<td>0,068</td>
</tr>
<tr>
<td><strong>Type of predominant motivation</strong></td>
<td>Pearson Correlation</td>
<td>0,299</td>
<td>-0,012</td>
<td>0,167</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (unilateral)</td>
<td>0,003</td>
<td>0,457</td>
<td>0,068</td>
<td>0,078</td>
</tr>
<tr>
<td><strong>Satisfaction ISO</strong></td>
<td>Pearson Correlation</td>
<td>0,454</td>
<td>0,072</td>
<td>0,213</td>
<td>0,078</td>
</tr>
<tr>
<td></td>
<td>Sig. (unilateral)</td>
<td>0,000</td>
<td>0,261</td>
<td>0,028</td>
<td>0,246</td>
</tr>
</tbody>
</table>

* n sample = 81

According to Table 4, there is no correlation between the dependent variable and the various independent variables, which might prevent including one of them in the model. There is in fact a small correlation between the variable “satisfaction with the implementation of EN 9100” and the variables “length of time since first adhering” (0.501) and “satisfaction with ISO” (0.454), but it is very small and there is no reason not to include them in the model.

Tables 5 and 6 below show the results obtained in the model. Table 5 shows independent variable coefficients, in relation to the dependent variable, “satisfaction with the implementation of EN 9100”. Likewise, Table 6 shows the corresponding coefficient of determination $R^2$. 
Table 5. Results arising from the model: independent variable coefficients

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non standardised coefficients</th>
<th>Standardized coefficients</th>
<th>Confidence Interval for B to 95%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Standard Error</td>
<td>Beta</td>
</tr>
<tr>
<td>(Constant)</td>
<td>0.86047</td>
<td>0.41492</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>0.02667</td>
<td>0.07162</td>
<td>0.03267</td>
</tr>
<tr>
<td>Length of Time</td>
<td>0.72897</td>
<td>0.16824</td>
<td>0.39260</td>
</tr>
<tr>
<td>Type predominant motivation</td>
<td>0.25607</td>
<td>0.10980</td>
<td>0.20687</td>
</tr>
<tr>
<td>Satisfaction ISO</td>
<td>0.30419</td>
<td>0.07766</td>
<td>0.35180</td>
</tr>
</tbody>
</table>

Based on the results shown in Table 5, the final model would look like this:

\[ SatEN = 0.86 + 0.027 \text{ (Size)} + 0.729 \text{ (Time)} + 0.256 \text{ (TypeMot)} + 0.304 \text{ (SatISO)} + u, \]

Where the absolute value of the t-statistic for each of the parameters would be: constant 2.074; size 0.372; length of time 4.333; predominant type of motive 2.332; satisfaction with ISO 3.917.

Table 6. Results arising from the model: coefficient of determination

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>0.64792</td>
</tr>
<tr>
<td>R squared</td>
<td>0.41980</td>
</tr>
<tr>
<td>Standard error</td>
<td>0.45886</td>
</tr>
<tr>
<td>Durbin-Watson</td>
<td>2.25501</td>
</tr>
</tbody>
</table>

Based on the results shown in Table 6, the value of the coefficient of determination \( R^2 \) is 41.98%, which indicates that the model’s independent variables (“company size”, “length of time since first implementing the standard”, “type of predominant motive for adhering” and “satisfaction with prior implementation of ISO 9001”) explain 41.98% of the variability of the dependent variable “satisfaction with adherence to EN 9100”.

As regards each of the model’s independent variables, Table 5 shows the following results:

The “company size” variable is \( t < 2 (0.372) \), which allows us to accept that the relationship between this variable and the dependent variable “satisfaction with EN” is not significant, so we can exclude it from our regression model. We can therefore reject Hypothesis H1 which we proposed above.

The “length of time since EN 9100 was first implemented” variable is \( t > 2 (t=4.333) \), so we can accept that this is a significant variable for “satisfaction with
EN”. When the value is positive, an increase of this independent variable will produce an increase (in growth rate) of the dependent variable; everything else being constant. In other words, an increase of one unit in “length of time since first implementing EN” will produce an increase of 72.89% in “satisfaction with EN”. In short, Hypothesis H2 has been confirmed.

The “predominant type of motivation (external and/or internal) for adherence” variable is t>2 (t=2.332), so we can accept that this is a significant variable for “satisfaction with EN”. When the value is positive, an increase of this independent variable will produce an increase (in growth rate) of the dependent variable; everything else being constant. In other words, an increase of one unit in “predominant type of motivation” will produce an increase of 25.60% in “satisfaction with EN”; that is, the greater the value of the variable – meaning that internal motives are predominant – the greater the satisfaction with EN. Consequently, Hypothesis H3 has been confirmed.

The “satisfaction with prior implementation of ISO 9000” variable is t>2 (t=3.917), so we can accept that this is a significant variable for “satisfaction with EN”. When the value is positive, an increase of this independent variable will produce an increase (in growth rate) of the dependent variable; everything else being constant. In other words, an increase of one unit in “satisfaction with ISO” will produce an increase of 30.42% in “satisfaction with EN”. Therefore, we can accept Hypothesis H4 proposed above.

6. Conclusions

An attempt has been made in this study to analyse the influence of a number of factors, such as company size, length of implementation of EN 9100, type of predominant motivation (external and/or internal) for adherence and, finally, level of satisfaction with the possible prior implementation of ISO 9001, on the level of satisfaction of the companies in the Spanish aerospace industry with their implementation of the EN 9100 standard.

To this end, the first step was to consider the level of overall satisfaction with the implementation of EN 9100 – a satisfaction arising from the positive effects obtained. Participating organisations reported a high level of satisfaction (68% of these companies stated that they were highly or very highly satisfied). These results agree with the studies conducted by Escanciano et al. (2001), Magd et al. (2003) y Lundmark y Westelius (2006) in relation to ISO 9001.

In addition, with regard to the influence that the factors considered in this study have had on this level of satisfaction, a multiple linear regression analysis shows that: “length of adherence to the EN 9100 standard” is a significant variable in “satisfaction with adherence to EN 9100”, and, therefore, the greater the length of time elapsing since the standard was first implemented, the greater the satisfaction caused by adherence to the standard. This result follows in the steps of the work conducted
by Romano (2000), Climent (2005) y Corbett et al. (2005) in relation to ISO 9001, where the positive influence of this factor arises from the learning curve associated with the standard, which must be experienced before benefits appear, particularly those related to internal issues.

The “predominant type of motivation (external and/or internal) for adherence to the standard” is a variable which is significant to “satisfaction with adherence to EN 9100”, to the extent that when the predominant motives for implementation are more strongly linked to the search for internal positive effects, satisfaction with the standard will be greater. This outcome is in agreement with the findings of the studies carried out by Jones et al. (1997), Brown et al. (1998), Leung et al. (1999), Gotzamani y Tsiotras (2002), Llopis y Tari (2003), Rodríguez y González (2006), Boiral et al. (2007) y Martínez-Costa et al. (2008) in relation to ISO 9001, which indicate that the search for internal improvements is a motivation that can lead to genuine improvement in the quality of a company’s operations.

The “satisfaction with the prior implementation of ISO 9001” is a variable which is significant to “satisfaction with adherence to EN 9100”, and, therefore, the greater the level of satisfaction with the prior implementation of ISO 9001, the greater the satisfaction caused by adherence to the standard. This is in line with the findings of Withers et al. (1997), Brown et al. (1998), Gotzamani y Tsiotras (2001),Escanciano et al. (2003), Han et al. (2007) y Martínez-Costa et al. (2008), in which ISO 9001 is considered to be a first stage in the quality improvement process.

However, “company size” is not significant to “satisfaction with adherence to EN 9100”; that is, the level of satisfaction undergoes no significant variations in relation to the size of the enterprises analysed. This result is in line with the work of Rayner and Porter (1991), Quazi y Padibjo (1998) y Briscoe et al. (2005) on ISO 9001, and is consistent with the specific characteristics of the aerospace industry, where security and product quality have always been a fundamental feature in all of the companies, regardless of size.

All of this contributes to making a start in addressing the almost total lack of research related to the aerospace industry, with regard to the positive effects of implementing Quality Assurance Standards and the level of satisfaction derived from obtaining these effects. Also included are the factors that should be considered by the directors of the companies in this industry in order to increase their level of satisfaction arising from the benefits of implementing the EN 9100 standard, thus offsetting initial expenses and the cost of maintaining their adherence to the standard.

In relation to the limitations of this study, the “sampling error” shown in the technical data sheet is 7.5%. As this figure exceeds 7%, results should be interpreted with caution and viewed as approximations, until they can be confirmed by further empirical studies.

With regard to future lines of investigation, a first line should address an increased sample size. To this end, it is our opinion that the various associations that encompass the enterprises in this industry should become involved. In view of the increasingly global nature of this industry, a further line of investigation would
involve extending the geographical scope of this study to the Americas and Asia. This would allow a comparative analysis of results in order to establish whether geography is also a determining factor in the implementation of this standard, as well as in the positive effects that may arise from it and the level of satisfaction these effects may lead to.

References


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