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RANKING OF THE FACTORS INFLUENCING THE EFFICIENCY AND EFFECTIVENESS OF THE PROCESS QUALITY MANAGEMENT SYSTEM CERTIFICATION ACCORDING TO THE EXTERNAL AUDITORS' EVALUATION

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Original scientific paper

The paper presents the method of ranking the factors in the study of efficiency and effectiveness of the quality management system certification process which is aligned with the requirements of international standard ISO 9001. During research on the efficiency of the certification of quality management systems we came to the various influencing factors. Therefore, the question was whether to treat each factor equally or whether there are factors that are more important and have a more pronounced effect and greater impact on the certification process. For the study the opinions have been collected of competent experts from the certification institutions or external auditors directly involved in the certification process.

Keywords: *certification, efficiency, external auditors' evaluation, impact factors, quality management system*

Rangiranje utjecajnih faktora na efikasnost i učinkovitost procesa certifikacije sustava upravljanja kvalitetom prema ocjeni vanjskih auditora

Izvorni znanstveni članak

U radu se prikazuje primjena metode rangiranja faktora u istraživanju efikasnosti i učinkovitosti procesa certifikacije sustava upravljanja kvalitetom usklađenim sa zahtjevima međunarodne norme ISO 9001. Tijekom istraživanja o efikasnosti procesa certifikacije sustava upravljanja kvalitetom došlo se do različitih utjecajnih faktora. Zbog toga se postavilo pitanje, može li se svaki faktor ravnopravno tretirati, odnosno postoje li faktori koji su važniji i koji imaju izraženije djelovanje i veći utjecaj na sam proces certifikacije? Za potrebe istraživanja prikupljena su mišljenja kompetentnih stručnjaka iz certifikacijskih ustanova, odnosno vanjskih auditora koji su direktno uključeni u proces certifikacije.

Ključne riječi*: certifikacija, efikasnost, ocjena vanjskih auditora, sustav upravljanja kvalitetom, utjecajni faktori*

1 Introduction

Certification of the organizations' quality management system is the usual outcome of the management system conforming to the requirements of ISO 9001 standard (Fig. 1). The result of the certification process is the organization receiving a certificate from an independent accredited (authorized) organization. The first certifications had started even before the official release of the ISO 9001:1987 standard. The certification was carried out in accordance with the published draft of the standard, which confirms the organizations' need for an independent and objective verification of the quality management system and desire to demonstrate to the market that they are well-structured and organized.

Although there are many advantages of the organization certification, there are still numerous questions connected to it. Significant influence of various factors (management, employees, customers, etc.), the complexity of their relationship and the possibility of various influences, make certification a very demanding process. Companies that modify their quality systems in accordance with the requirements specified by the standard may expect a "benefit" not only from the standard, but also from the certification process [2, 3, 5, 9].

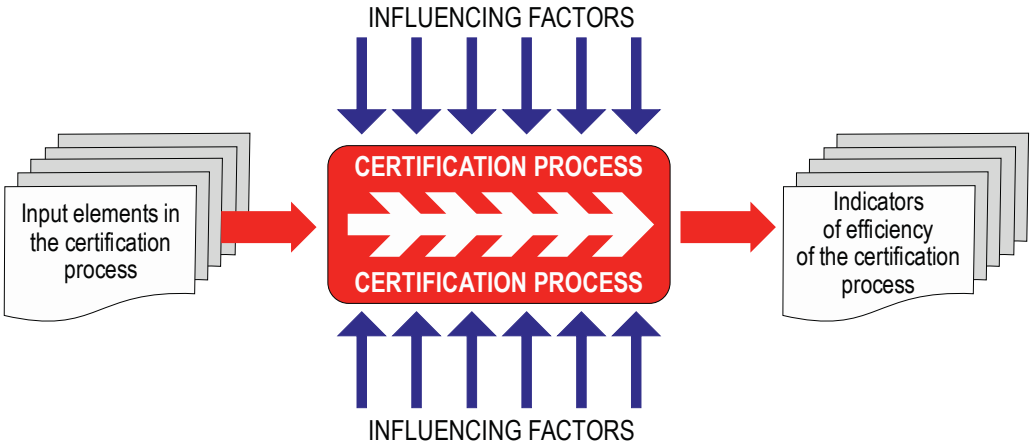

Figure 1 Flow chart of certification process and influencing factors [1]

Extensive research [1] on the metal processing industry has shown a direct impact of the certification process on further improvement of the system and the improvement of the market position of Croatian organizations. As part of the research, ranking of the factors which influence the efficiency and effectiveness of the quality management system itself was also conducted. The ranking was conducted with the specified factors and

15 experienced and competent external auditors who carry out certification procedures voiced their opinion.

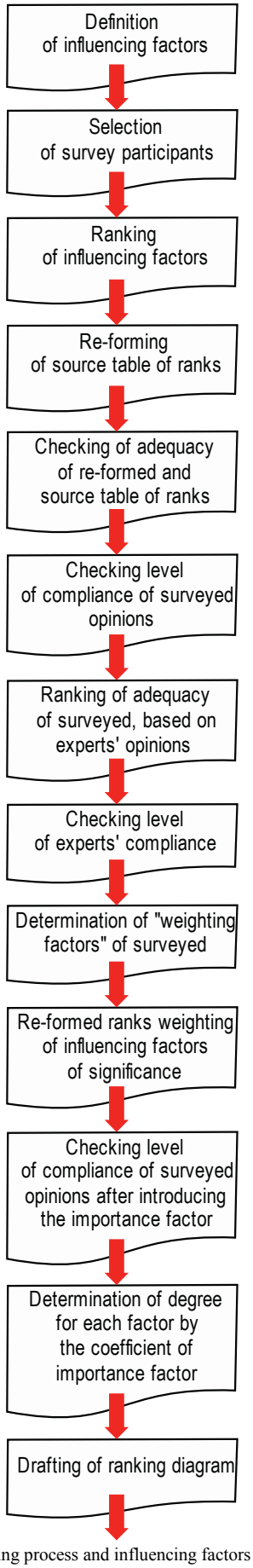

Figure 2 Ranking process and influencing factors analysis [1, 2]

Fifteen external auditors (from different certification companies) conducted the ranking of the following factors:

- F1: Communication before the audit (setting the date, the audit team, the audit plan, scope of the certification, etc.).
- F2: Quality of the opening meeting (completeness of information regarding all aspects of the audit, presentation, the audit objectives, coordination, etc.).
- F3: Auditor's competence.
- F4: Auditor's professional and responsible conduct.
- F5: Employees' competence, knowledge and quality of preparation for the organization's audit.
- F6: Accuracy of determining nonconformities and areas for improvement by the auditor.
- F7: Quality of the final meeting (completeness of information regarding the audit results).
- F8: Communication after the audit (the text of the certificate, the audit report, etc.).
- F9: Quality of surveillance audits (auditors changing, retaining the same criteria, encouraging continual improvement, etc.).

The ranking procedure and analysis was conducted according to the steps shown in Fig. 2. The procedure of a prior ranking is performed by assigning ranks to each identified factor: rank 1 to the most influential and rank 9 to the least influential factor. When appointing ranks of the significance to the mentioned factors, a scale from 1 (the most significant) to 7 (the least significant) was used. Several factors could have the same rank, in other words, several factors could be appointed with the same rank. Since the respondents used the possibility of assigning the same ranks to different factors it was necessary to re-form the ranks. In that case the factors with the same rank received a new rank, equal to the mean value of the position the factors divided among themselves [1, 2].

2 Ranking influencing factors according to external auditors

2.1 Ranking influencing factors and re-forming the original ranks table

The first step in the factors' ranking is creating a table which shows the ranks assigned to individual factors by the external auditors. After that the ranking and ranks re-forming for the external auditors was performed. The re-formed ranks table for all the respondents is shown in Tab. 1. When several factors have the same rank variable value, these are tied ranks. These ranks are assigned the average rank value. The average rank is the arithmetic mean of the ranks, which the factors would have if they were not the tied ranks. The same rank values are shown by the tied ranks.

2.2 Checking the adequacy of the re-formed table

Checking the adequacy of the re-formed table is done by the Spearman's rank correlation coefficient which measures the strength of relationship between the ranked variables i.e. the variables presented by the rank values [4, 7]. The Spearman's rank correlation coefficient can take values of a closed interval, between −1 (the direction of

the first variable value is opposite to the direction of the second variable value) and +1 (the direction of the first variable is the same as the direction of the second variable value). If there is no correlation between the direction of the first variable value and the second variable value, rank correlation coefficient equals zero.

$$r_s = 1 - \frac{6 \cdot \sum_{j=1}^{k} (Q_j^{(1)} - Q_j^{(2)})^2}{k(k^2 - 1)} = 0{,}99167\,, \qquad (1)$$

where
k – number of influencing factors (9),
$Q_j^{(1)}$ - ranks assigned to the factors in the original table according to the total sum of ranks,
$Q_j^{(2)}$ – ranks assigned to the factors in the re-formed table according to the total sum of ranks.

Checking the statistical value of the correlation coefficient r_s is done by testing the hypothesis for the significance of the linear correlation coefficient t_r. The statistical value of the r_s is determined by calculating the t distribution, as follows [4]:

$$t_r = \frac{r_s}{\sqrt{\frac{1 - r_s^2}{k-2}}} = 20{,}155\,, \qquad (2)$$

where
k – the number of influencing factors (9),
r_s – Spearman's rank correlation coefficient (0,99167).

If the calculated t_r value is bigger than the table value t_t correlation coefficient is significant [8]. Since the values calculated showed that $t_r > t_t \Rightarrow 20{,}155 > 2{,}998$ testing the hypothesis for the significance of the linear correlation coefficient t_r confirms the same direction positive correlation. Spearman's rank correlation coefficient r_s = 0,99167 approaches the value of 1 indicating that the table is in compliance with the original table and it can be used in further analysis.

Table 1 Re-formed table ranking influencing factors [1]

No.	External auditors (EA_i)	Influencing factors (j)									Correction factor T_i
		F1	F2	F3	F4	F5	F6	F7	F8	F9	
1.	1	8,5	6,5	3	4	1	2	6,5	8,5	5	12
	2	7	8,5	1,2	1,2	1,2	1,2	8,5	6	1,2	126
	3	4	5	1,33	1,33	8	6	7	9	1,33	24
	4	1,5	3,5	3,5	1,5	6,5	9	5	8	6,5	18
	5	4,5	6,5	1,33	4,5	1,33	1,33	6,5	8,5	8,5	42
	6	7	8	1,5	6	9	1,5	3,5	3,5	5	12
	7	4	5	1,33	1,33	8	6	7	9	1,33	24
	8	4,5	4,5	2	3	8	1	9	6,5	6,5	12
	9	9	7	1	5,5	5,5	4	2,5	8	2,5	12
	10	9	5,5	1	2,5	2,5	4	5,5	7	8	12
	11	1,25	1,25	1,25	1,25	8	6,5	6,5	9	5	66
	12	9	4	1	2	7,5	5,5	5,5	7,5	3	12
	13	7	6	2,5	2,5	1	4	5	9	8	6
	14	3,5	6,5	1	2	9	6,5	3,5	5	8	12
	15	6	4	1	2,5	2,5	5	7,5	9	7,5	12
2.	$\sum_{i=1}^{m} a_{ij}$	87,75	81,75	23,94	41,11	79,03	62,53	89	113,5	77,36	$\sum T_i = 402$
3.	$Q_j^{(2)}$	7	6	1	2	5	3	8	9	4	
4	$\sum \Delta_j = \left\lvert \sum a_{ij} - \overline{\sum a_{ij}} \right\rvert$	14,87	14,87	48,94	31,77	6,15	10,35	16,12	40,62	4,48	
5.	Δ_j^2	221,11	221,11	2395,12	1009,33	37,82	107,12	259,85	1649,98	20,07	

2.3 Testing the level of matching opinions among the surveyed external auditors

The level of matching opinions among the surveyed external auditors is tested by the Kendall coefficient of concordance which is based on the fact that the level of concordance among rank sequences may be measured by deviations of certain rank totals from their respective arithmetic means. The Kendall coefficient of concordance cannot take negative values, because total non-concordance cannot exist among rank sequences. W assumes values from 0 +1 (0 no concordance to +1 full concordance). The Kendall coefficient of concordance [8] formula reads:

$$W = \frac{12 \sum_{j=1}^{k} \Delta j^2}{m^2 \cdot k\left(k^2 - 1\right) - m \sum_{i=1}^{m} T_i} = 0{,}46, \qquad (3)$$

where
k – number of influencing factors (9),

m – number of external auditors (15),

$\sum_{j=1}^{k} \Delta j^2$ – total of deviation square values of all external auditors rank totals,

$\sum_{i=1}^{m} T_i$ – total of correction factors for tied ranks ($T_i = 402$).

Afterwards the value of the correction factor T was calculated (the value for each external auditor is shown in Fig. 1). In order to check the value of the Kendall coefficient of concordance W, the χ^2 – test was performed. Given that $\chi_r^2 > \chi_t^2 \Rightarrow$ 55,20 > 20,090, testing of the hypothesis on concordance of opinions of the responding external auditors shows that rank sequences are interdependent, which means the hypothesis on the presence of the responding external auditors' opinion concordance is accepted.

2.4 Ranking of external auditors competence

Since individual external auditors differ in their work experience, level of education, personality and other traits, which results in different "importance" of the external auditors and different "weight" of grades they give to certain factors of influence, five experts ranked them according to competence. The most competent external auditor was given rank 1, and the external auditor with the lowest competence was given rank 15.

2.5 Testing level of concordance of experts' opinion

The level of the experts' opinion concordance is tested by the Kendall coefficient of concordance. In order to check the value of the Kendall coefficient of concordance W the χ^2 – test shall be applied with the following indicator [7]:

$$\chi_r^2 = h \cdot (m-1) \cdot W = 41{,}30, \tag{4}$$

where
h – number of experts (5),
m – number of external auditors (15),
W – Kendall coefficient of concordance (0,59).

Given that $\chi_r^2 > \chi_t^2 \Rightarrow 41{,}30 > 21{,}666$, testing of the hypothesis of the level of the experts' opinion concordance shows that rank sequences are interdependent, which means that the hypothesis on the presence of the experts' opinion concordance in ranking external auditors' competence is accepted.

2.6 Assigning "weight" or "importance" to external auditors

The external auditor with the lowest rank total shall be assigned the highest importance $Z_4 = 2$, and the EA with the highest rank total shall be assigned the lowest weight $Z_{13} = 1$. Other external auditors' importance is determined by the following formula [2]:

$$Z_i = a + b\sum_{h=1}^{5} a_{ih} \ . \tag{5}$$

2.7 Weighting reshaped factor ranks with the "importance" of external auditors

By weighting of reshaped influence factor ranks with the "importance" of individual external auditors, ranks are allocated certain "weight" and statistically more relevant information is achieved. Each weighted rank is multiplied by individual external auditor's coefficient of importance. The resulting rank value is subtotalled at the level of influence factors.

2.8 Testing the level of opinion concordance of the responding external auditors following introduction of the significance factor Z_i

Level of the responding **external auditors'** opinion concordance is tested by the Kendall coefficient of concordance. For degree of freedom $f = 9$ and probability 0,01 the critical value of χ^2 – test χ_t^2 is 20,090 [1]. Given that $\chi_r^2 > \chi_t^2 \Rightarrow$ 99,228 > 20,090, and in the case when the different "importance" of each external auditor was considered, testing of the hypothesis on concordance of the responding external auditors' opinion shows that rank sequences are interdependent, which means the hypothesis on the presence of opinion concordance of the external auditors is accepted.

2.9 Determining influence level of each factor

The level of influence of each factor on a certain phenomenon is determined by significance coefficient of the influencing factor:

$$M_j' = \frac{\sum_{i=1}^{m} a_{ij} Z_i}{\sum_{i=1}^{m}\sum_{j=1}^{k} a_{ij} Z_i}. \tag{6}$$

Fig. 3 shows a prior rank diagram of factors influencing the efficiency of quality management system certification according to the external auditors' ranking. By analysing the diagram the factors may be divided into three groups:

I) The most influential factors (F3 and F4),
II) Less influential factors (F1, F2, F5, F6, F9) and
III) The least influential factors (F7 i F8).

By a prior ranking of the factors done by the external auditors conducting the certification audit it can be concluded that the most influential factors affecting their efficiency are competence of external auditors (F3) and their professional and responsible conduct during the audit (F4). The factors such as communication before the

audit, the opening meeting, employees' competence and professionalism and the quality of surveillance audit are less influential. Furthermore the closing meeting and communication after the audit are the least influential.

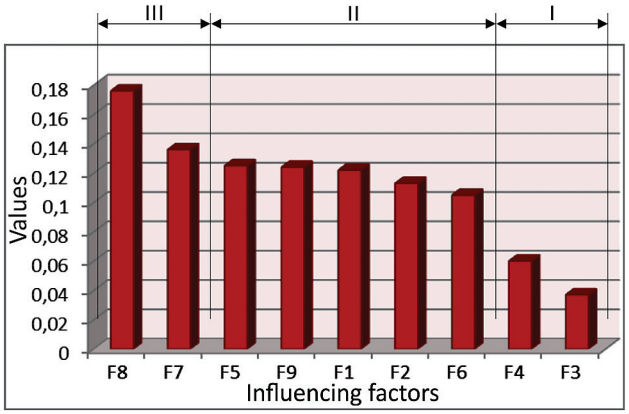

Figure 3 A prior rank diagram of factors influencing efficiency of quality management system audit certification process according to the external auditors' opinion [1]

When the external auditors analysed the most influential factors it was noticeable that they emphasized the place and role of the external auditors in the certification process, as it was expected. For that reason, the second analysis of a prior factors' ranking was performed, where the Quality Management Representatives (QMRs) were asked for their opinion.

3 Conclusion

By ranking of the factors by the external auditors conducting the certification audit it can be concluded that the most influential factors affecting their efficiency are competence of external auditors (F3) and their professional and responsible conduct during the audit (F4). The factors such as communication before the audit, the opening meeting, employees' competence and professionalism and the quality of surveillance audit are less influential. Finally, the closing meeting and communication after the audit are the least influential. Evidently the auditors consider that they provide enough information during the audit and they do not place much importance to the factors connected to the latter activities. Nevertheless, they put an emphasis on their competence and knowledge.

When the external auditors analysed the most influential factors it was noticeable that they emphasized the place and role of the external auditors in the certification process, as it was expected. For that reason, the second analysis of a prior factors' ranking was performed, where the Quality Management Representatives were asked for their opinion and the results were compared.

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