DIFFERENCES OF QUALITY IMPROVEMENT PRACTICE BETWEEN GROUPS OF COMPANIES IN MULTINATIONAL SUPPLY CHAIN

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Abstract: *Quality improvement initiatives failures have triggered scientists, experts, and practitioners for long period of time while this issue becomes even more serious since today competition moves beyond a single firm into the supply chain. The aim of this survey is to find statistically significant differences of quality improvement practice between groups of companies in multinational supply chain. In the first phase, the survey is emailed to all 87 multinational company manufacturing sites and the responses were received from 62 companies (response rate 71.3%). Based on received responses, in the second phase their suppliers worldwide are contacted and 143 supplier companies have replied. There were 153 companies from aerospace (planes) and 47 companies from transportation sector (trains). The total number of received responses in survey was 200. The responses came from 6 continents and 32 countries. In the sample approximately 70% of the plants had more than 500 workers. Differences in quality tools and techniques application were statistically tested. There were found significant differences in quality improvement practice between aerospace and transportation sectors. Aerospace companies have more advanced quality improvement practice. There also were found significant differences in quality improvement practice between multinational company manufacturing sites and their suppliers. It could be noticed that suppliers are very well chosen, since they have slightly higher values of quality improvement practice dimensions. Most frequently used basic quality tools are flow chart, histogram and Pareto diagram; the most frequently used advanced tool is CPM/PERT, and the most frequently used quality technique is brainstorming, followed by benchmarking and FMEA. The results of this survey have implications for business practice since it has proven that special attention has to be put on core business products and suppliers choice.*

Keywords: *quality improvement, supply chain, differences*

INTRODUCTION

Quality improvement refers to increase of efficiency of observed processes or systems in order to obtain appointed quality goals. In other words, quality improvement represents all initiatives with main goal to enhance organizational capabilities in order to reach quality requirements and achieve customer satisfaction. Identification of the problems is the first and the basic step for every application, including continuous quality improvements /1/, while principles of management of quality improvement are related to use of quality tools and methodologies /2/.Most initiatives for quality improvement fails due lack and inadequacy of adequate leadership /3/, in spite that in modern world of continual and unpredicted changes, continuous quality improvements are the imperative that have strong and multidimensional impact on any business environment. Merrill /4/ also identifies top management lack of support, as one of the main obstacles in achievement of desired quality levels. Quality improvement is possible to achieve using tools, techniques, methodologies and standard elements for its improvement. Their adequate application it is possible to achieve desired quality levels, that further leads to continuous quality improvements, which is of utmost important in supply chain management.

Quality improvement initiatives failures have triggered scientists, experts, and practitioners for long period of time /5/,/6/,/7/. In today's dynamic and complex environment, they are mandatory to meet customer expectations and to assure the progress and development of the companies. Problem becomes even more serious since today competition moves beyond a single firm into the supply chain. Contemporary

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companies' efforts to achieve advantage on the market must include effectively managed supplier relationships with carefully chosen suppliers /8/,/9/. In that aim more research of quality management in the supply chain context is needed /10/,/11/,/12/ and this trend poses a major challenge for the future of the field /13/.

The aim of this survey is to find statistically significant differences of quality improvement practice between groups of companies in multinational supply chain.

RESEARCH BACKGROUND

Research was conducted by survey, constructed according previous researches. Survey had 30 questions about quality improvement, with three questions include several sub-questions. For all questions five level Likert scale was applied. Survey was included to various numbers of employees on different managerial levels and organizational entities, with different focal companies-producers, in order to eliminate subjectivity in proposed answers. Survey was distributed as a PDF file via e-mail in 500 production systems for aerospace and transportation industries related to Bombardier.

Relevant literature in this type of research most common is application of the following methods /14/,/15/,/16/,/17/,/18/,/19/,/20/:

- Basic quality tools,
- Managerial quality tools,
- Techniques for quality improvement,
- PDCA methodology,
- Kaizen,
- System Six Sigma,
- Total Quality Management,
- Lean production,
- Corrective measures,
- Preventive measures,
- Internal audits and
- Training.

Apart from above methods, which are most commonly used, it is often utilization of other tools and methods for quality improvement such as TRIZ, Lean Six Sigma methodology, Constraints theory, Value stream mapping, Total Production Maintenance etc.

This paper is focused on use of most common quality improvement techniques in order to obtain valid statistical conclusions. Applied statistical techniques include descriptive statistics, hypothesis testing and analysis of variance.

METHODOLOGY AND RESULTS

SAMPLE CHARACTERISTICS

In the first phase, the survey is emailed to all 87 multinational company manufacturing sites and the responses were received from 62 companies (response rate 71.3%). Based on received responses, in the second phase their suppliers worldwide are contacted and 143 supplier companies have replied. The total number of received responses in survey was 200.

There were in total 153 companies from aerospace (planes) (Pic. 1) and 47 companies from transportation sector (trains) (Pic. 2). The responses came from 6 continents (North America - 55.5%, Europe - 32.0%, Asia - 8.0%, Australia -2.0%, South America - 1.5% and Africa - 1.0%) and 32 countries. In the sample approximately 70% of the plants had more than 500 workers. Also, approximately 68% of the companies in

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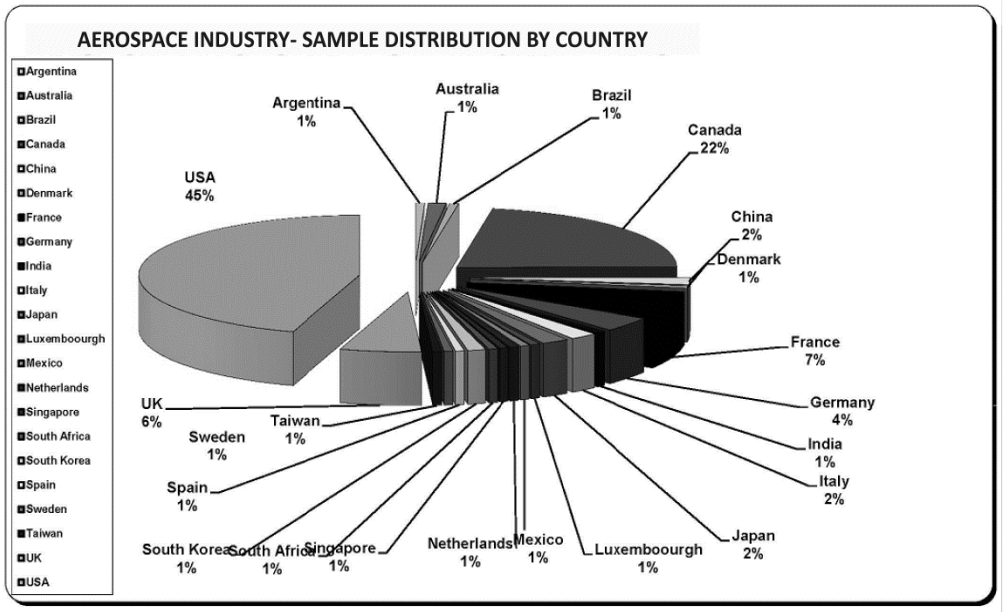
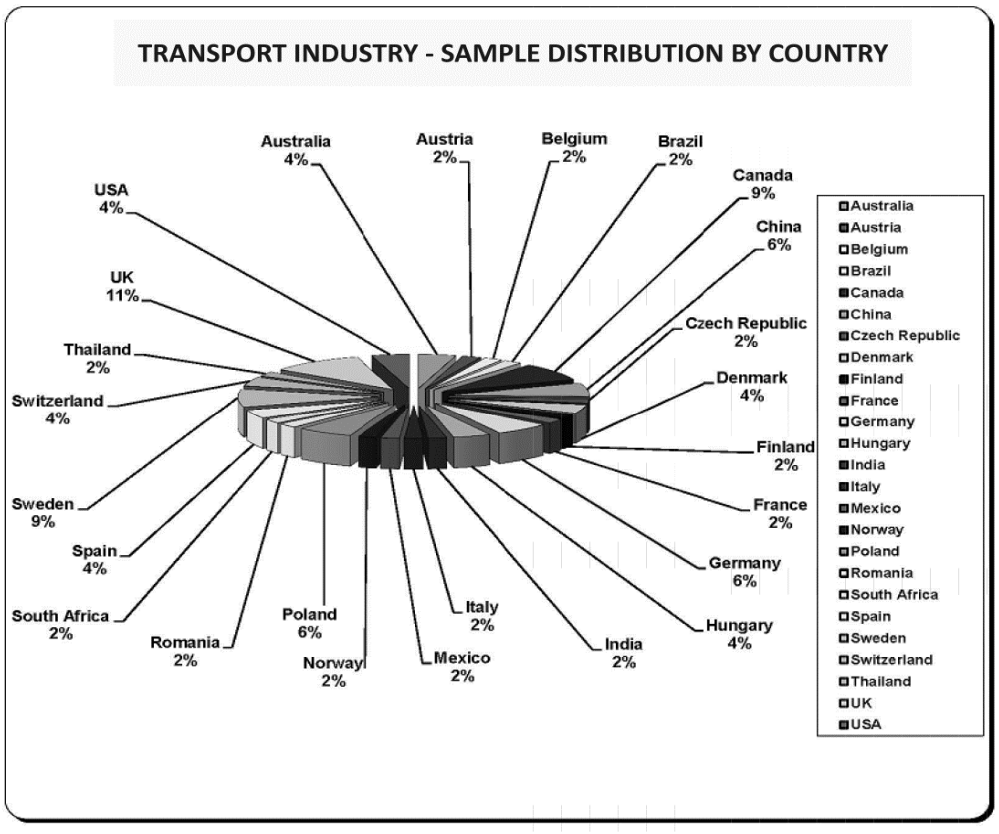
the sample had annual sales up to $100 million, 17% of them between $101 and $500 million, 10% of them between $501 and $1000 million and 5% of them more than $1 billion.



Picture 1. - Sample distribution by country for aerospace industry



Picture 2. - Sample distribution by country for transport industry

STATISTICAL ANALYSIS

System of hypothesis - examinations of differences between aerospace and transport industries in application of tools, methodologies and quality applications

$H_0 : (\mu_1 = \mu_2)$ there isn't difference between aerospace and transport industries regarding used tools,

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methodologies and quality applications

$H_1 : (\mu_1 \neq \mu_2)$ there are differences between aerospace and transport industries regarding used tools, methodologies and quality applications

Sample statistics and testing are presented at Table 1.

Table 1. - Statistical data and hypothesis testing results for tools, methodologies and quality applications

Statistics and testing	Aerospace	Transport
Mean	3.500138	3.08747
Variance	0.252585	0.225007
Observations	153	47
z score	p - value	significance
10.691	0.00	<0.001

Therefore, based on results from Table 1 it can be concluded that highly significant differences exist between aerospace and transport industries regarding use of tools, methodologies and quality applications. Furthermore it is obvious that examined characteristics, i.e. applied methods are far more often and more intensively in use in aerospace industry.

System hypothesis for testing tools, techniques, methodologies and application for quality improvement between focal company-producer and supplier companies.

$H_0 : (\mu_1 = \mu_2)$ there are no differences between focal company-producer regarding application of tools, techniques, methodologies and quality applications

$H_1 : (\mu_1 \neq \mu_2)$ there are differences between focal company-producer regarding application of tools, techniques, methodologies and quality applications

Sample statistics and testing are presented at Table 2.

Table 2. - Statistical data and hypothesis testing results for quality improvement between focal companies and their suppliers

focal-company vs. suppliers	*Suppliers*	*Focal company*
Mean	3.499305	3.194088
Variance	0.239073	0.29568
Observations	137	63

z score	p value	significance
7.174	0.000	<0.001

Test z score is highly greater than theoretical value, therefore null hypothesis is rejected. Therefore it could be concluded that there exist significant differences in application of quality improvement, tools, techniques and methodologies between focal company - producer and supplier companies.

Examination of the differences between application tools, techniques, methodologies and applications in quality improvement based on demographical origins.

System hypothesis for testing tools, techniques, methodologies and application for quality improvement from demographic standpoint.

$H_0 : (\mu_1 = \mu_2 = \ldots = \mu = const)$ there are no significant differences between quality application based on demography of focal company-producer for different locations

$H_1 : (\exists_1 \mu_i \neq \mu = const)$ there exists at least one demographic location where with difference of quality applications in focal company-producer for different locations

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Statistics and resulting ANOVA are presented at Tables 3. and 4.

Table 3. - Descriptive statistical data for applied quality improvement methodology depending of demography

Groups	*Count*	*Sum*	*Average*	*Variance*
North America	109	399.155	3.662	0.070
Europe	64	206.861	3.232	0.208
Asia	16	44.332	2.771	0.768
South America	5	11.753	2.350	0.027
Other	6	18.535	5.916	0.0062

Table 4. - ANOVA table examining influence of demography to applied quality methodology

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*significance*
Between Groups	22.519	4	4.504	27.132	0	<0.001
Within Groups	32.347	195	0.166			
Total	54.866	199				

Therefore it can be concluded that there are significant differences between tools, techniques, methodologies and application for quality improvement depending on demography, i.e. continent where factory is located.

CONCLUSION AND IMPLICATIONS

There were found significant differences in quality improvement practice between aerospace and transportation sectors. Aerospace companies have more advanced quality improvement practice. There also were found significant differences in quality improvement practice between focal company manufacturing sites and their suppliers. It could be noticed that suppliers are very well chosen, since they have slightly higher values of quality improvement practice dimensions. There were also significant differences between continents regarding quality improvement practice.

Most frequently used basic quality tools are flow chart, hystogram and Pareto diagram; the most frequently used advanced tool is CPM/PERT, and the most frequently used quality technique is brainstorming, followed by benchmarking and FMEA.

The results of this survey have implications for business practice since it has proven that special attention has to be put on core business products and suppliers choice.

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