

# Differences in Kaizen Implementation between Countries and Industry Types in Multinational Supply Chain

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*Previous research shows that Kaizen's benefits are multiple and evident, but its practices in the supply chain have been sufficiently examined now. Conversely, we are witnessing numerous issues in contemporary global supply networks. In this survey, after conducting a literature review, three research questions regarding Kaizen modes of usage were formulated and tested on the sample of 195 enterprises that are part of the global supply chain, located in 31 countries, and active in two different types of industries – aircraft, and transportation. A combined approach containing descriptive statistics, reliability, factor analysis, and statistical hypothesis testing by Kruskal-Wallis one-way ANOVA and Mann-Whitney U tests were used. Results show significant differences between Kaizen practices applied in countries such as Italy, the United Kingdom, Canada, the USA, Japan, and China, where national and corporate cultures differ. Kaizen implementation significantly differs between companies operating in the aircraft and transportation sectors, which is unsurprising since aircraft industry has a higher formalization level. The goal to determine the differences in Kaizen practices around the globe was fulfilled since statistically significant differences indicate the importance of the contextual factors and connect adverse and Kaizen events.*

**Keywords:** Kaizen, Statistic, Countries, Multinational, Aircraft industry, Transportation industry

## 1. INTRODUCTION

It is evident that when organizations collaborate in networks of businesses rather than purely independent entities, there are numerous competitive benefits [1]. The end consumer's needs are prioritized over supply chains, but over recent years, several problems in supply chain management have emerged [1,2].

During the lockdowns all over the world caused by COVID-19, supply chain issues were prevalent due to changes in demand, numerous workforce constraints, and structural issues, while Russia and Ukraine conflict and the further lockdowns in China have aggravated problems, affecting supply in all industries. Focus on costs in the center is no longer sustainable, but more attention is paid to risks leading to chain disruption. Production, operations, and quality management literature now have intensively examined the effects of a firm's supplier network structure and complexity on its financial, environmental, and innovation performance. However, knowledge of how to solve a multinational enterprise's global supply chain risks and complexities is limited [1].

Due to the fact that sustainable supplier selection is already a critical problem in sustainable supply chain management, appropriate decision-making nowadays is the first prerequisite for appropriate supply chain

organization [2,3].

Supplier resilience and location are also critical in reducing the vulnerability of the focal business and the supply chain [2,4]. Only efficient supply chain built from reliable suppliers with high levels of resilience and sustainability can recover quickly from supply disruptions, caused by the dynamic and hostile environment outside the chain [5].

The Japanese words "kai", which is translated as continuous, and "zen", which means improvement or wisdom, are the roots of the Kaizen [6]. It is used worldwide as a means of gradual and continual improvement by improving certain events and setting and achieving higher and higher standards in processes made up of given circumstances. Those initiatives often need to show high sustainability or success [6,7]. Practitioners, as well as scholars, stressed the significance of Kaizen to succeeding in a cutthroat environment. Despite extensive research on small, continuous improvement benefits, more needs to be written about the factors required to implement Kaizen Event [6,7] effectively. Even when it is in focus, the case study or smaller samples (below 65) usually are employed [6]. Kaizen-type improvements have great potential to improve performance and resilience for supply chain companies and the entire supply chain. But, in the matter of Kaizen implementation in the supply chain context, numerous open questions remain, as in the following literature review.

## 2. LITERATURE REVIEW

In the last decades, significant growth of supply networks into numerous international locations is evident.

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It is particularly pronounced in the automobile, computer, transport, aerospace, and apparel industries [8,9]. This increase in internationalization and the additional management difficulties it brings have piqued the interest of both practitioners and academics in global business logistics management [9–11].

Today's global production networks and value chains' success and survival necessitate constant evolution and change [12]. Quality improvement efforts play a critical role in this evolution, and they are frequently revolutionary processes that lead to success. Unfortunately, many instances of poor quality improvement initiatives failed to produce the desired results [13]. One of the secrets to the success of Japanese goods abroad is part of their quality improvement programs spread to all organizational levels and focused on Kaizen. However, it is also evident that Japanese companies have more organic structures and specific corporate cultures than other countries [13].

On the other hand, customs of the region, different linguistic systems, and cultural practices as a whole impact how effectively every entity in the network conducts business. Also, logistics resources, as well as insufficient worker skills, supplier availability, supplier quality tools, and technology, present obstacles that take work to overcome [9,14]. All these challenges limit the extent to which a global supply network can provide a competitive edge [15]. Businesses must evaluate their own logistics chain and operations' possible traits and find places for improvement in the cycle, which starts from raw material to end-of-life regarding each product and its components [8].

In that sense, several previous studies have found that Kaizen's continued operation benefits the development and maintenance of manufacturing businesses' competitive advantages and is especially important in the international supply chain context [16]. The results of the research [13] demonstrated that the use of Kaizen improves performance metrics, particularly in the field of quality, and that it has a positive correlation with factors that are crucial for the success of the supply network, including organizational objectives, formalization levels, system rewards, resolution of conflicts, and employee growth. Authors in [7] find a Kaizen culture essential for organizations to optimize their operational performance on the sample of electrical and electronic production firms in Malaysia. Further, the factors contributing to the practical completion of Kaizen events are identified. It is suggested that work-study persons have the strategies and skills to successfully collaborate with other co-workers to complete a Kaizen project [17]. Authors in [18] find that Kaizen is used more frequently in the supply chain when the level of formalization in an organization is high, according to statistical evidence from structural equations modeling, and also provided a few additional crucial suggestions for the application of Kaizen. Other authors contribute to the supply chain management literature by suggesting an integration model for supply chain quality management and Industry 3.5 [19].

Studies on improving quality practices at production facilities of global corporations and their suppliers have

also been conducted. They have found significant differences in quality improvement practices between multinational companies' manufacturing sites and suppliers [21]. Research is rare regarding the spatial spread of the companies in the chain, and some of those prove that there are statistically significant differences in dimensions of organizational culture and applied quality management programs depending on the company's geographical location [20].

It is clear that variations in Kaizen application across nations and business sectors in global supply chains have yet to be studied up to this time.

Accordingly, this paper focuses on that not sufficiently surveyed topic in the following manner. After an introduction and literature review, the next section describes the methodology applied to the large sample with the aim of testing the differences in a multinational supply network where members belong to different countries and industries. The results are later discussed regarding what can lead to differences and conclusions, and future research avenues are afterward given. The disadvantage of a small sample size, noted in previous research by a survey [6], will also be overcome in this paper.

### 3. METHODOLOGY

This research focused on members of a multinational corporation that operates globally. The short questionnaire has been designed and used as the research instrument. Exactly 500 companies in the chain of businesses received the questionnaire (via email), which was spread worldwide in 32 countries and on all six continents.

Answers have been obtained from 195 companies participating in the chain, which are settled in 31 countries (Argentina, Australia, Austria, Belgium, Brazil, Canada, China, the Czech Republic, Denmark, Finland, France, Germany, Hungary, India, Italy, Japan, Luxemburg, Mexico, the Netherlands, Norway, Poland, Romania, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, the United Kingdom, and the United States of America) and which operate in two different types of industries – aircraft (153 companies) and transportation (42 companies).

Production program within the aircraft industry covers business aircraft, commercial aircraft, amphibious aircraft, and specialized solutions for aircraft, while in transportation industry covers rail vehicles, drive systems and controls, rotating systems, transport systems, and rail control solutions. Most of the businesses in the survey were middle and large-sized firms involved in the system of the international corporation. The resulting sample of 195 questionnaires fully corresponds to the population according to the criteria of the number of people employed, annual sales, property value, and the distribution of industries.

Participants answered the three following questions about implementing Kaizen in their company by using the Likert scale from 1 to 5 (where the scale corresponded as follows (1) Strongly disagree; (2) Disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree):

Q1: In our company, Kaizen refers to the philosophy that focuses on continuous, incremental improvements of all our processes and involves all our employees regularly.

Q2: In our company, as per Kaizen philosophy, we standardize, measure, and improve our processes repeatedly and as a part of the continual cycle.

Q3: In our company, we sometimes apply Kaizen Event - a structured, team-based, problem-solving activity in an accelerated manner that focuses on a specific improvement area.

Questions in the instrument are chosen in accordance with the attitudes of Lagrosen and Senapati, as explained in their works [22-23].

After preliminary analyses of two answers obtained from each participating company, which have shown a very high correlation, one person answered the questionnaire from each company. Answers have been obtained from 61 quality managers, 20 production managers, 7 general managers, 49 managers for quality improvement/Kaizen/Six sigma, and 58 other positions in the quality management field. There were 55 persons with seniority at work and experience over ten years, 59 persons who had been employed for between five and ten years, 41 individuals with three to five years of expertise, and other poll respondents who had less expertise.

## 4. RESULTS

### 4.1 Descriptive statistics

Table 1 displays the descriptive statistics findings on the whole data set in relation to three posted queries. It includes sizes of samples (xN), ranges, minimum and maximum values, mean values and their standard errors, median values, standard deviation, and variance.

**Table 1. Descriptive statistics**

	Q1	Q2	Q3
N	195	195	195
Range	4.000	4.000	4.000
Minimum	1.000	1.000	1.000
Maximum	5.000	5.000	5.000
Mean	4.2769	4.0256	3.6205
Std. Error	0.0556	0.0606	0.0646
Median	4.000	4.000	4.000
Std. Deviation	0.7767	0.8461	0.9022
Variance	0.603	0.716	0.814

There is the highest mean value on Kaizen focus on continuous, incremental improvements of all our processes (4.27) with the lowest variation and involves all our employees regularly and the lowest one about Kaizen Event as a structured, team-based, problem-solving activity which in an accelerated manner focuses on a certain area of improvement (3.62) with the highest variation.

It is natural to analyze all interdependent variables together, as an entity as a whole, and without taking one by one out of context. Factor analysis, as one of the multivariate statistical methods, primarily defines the underlying structure in a data matrix. According to that aim in Tables 2 and 3, the results of the employed factor analysis are given.

According to obtained results, it is evident that chosen three dimensions appropriately describe the Kaizen practice as a construct. Table 2 shows that question 1 contains the largest part of the variance - 77.18%, while the other two questions count the remaining 22.82%.

**Table 2. Exploratory Factor Analysis for Kaizen Methodology**

Factor		Q1	Q2	Q3
Initial Eigenvalues	Total	2.315	0.470	0.214
	Variance %	77.180	15.682	7.139
	Cumulative %	77.180	92.861	100.00
Extracting Sums of Squared Loadings	Total	2.315		
	Variance %	77.180		
	Cumulative %	77.180		

**Table 3. Factor Loading on variables for Kaizen Methodology**

Variable	Q1	Q2	Q3
Factor Loading	0.836	0.929	0.868

All Kaizen methodology variables have sufficiently high factor loadings, which have values over 0.8 [22], as shown in Table 3.

There is the highest value in standardizing, measuring, and improving processes repeatedly and as a part of continual cycle.

Finally, following data processing by factor analysis, one factor which contains three proposed dimensions for Kaizen description was obtained for future examination.

The reliability of each scale of the researched variables will be assessed by calculating the Cronbach alpha coefficient, which indicates the amount of random error present in the scale used for measurement [24,25].

Tables 4 and 5 show given results of reliability testing. According to the results obtained, the measurement scale is reliable with an absence of measurement errors.

**Table 4. Cronbach's alpha value for Kaizen methodology**

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N
0.850	0.851	3

The obtained Cronbach's alpha value of 0.850 meets the generally accepted criteria of reliability and internal consistency ( $\alpha \geq 0.700$ ) [24]. It shows that Kaizen as a construct could be reliably described with three proposed dimensions.

The scale's reliability equals 0.850, which is adequate, and there is no need for further improvement by removing further variables, as in Table 5. It is evident that deleting certain variables would not enable significantly better. Still, it even will give worse results regarding the reliability of examined scale (in the cases of the second and the third question).

**Table 5. Reliability analysis for Kaizen methodology**

	Q1	Q2	Q3
Scale Mean if Item Deleted	7.630	7.875	8.275
Scale Variance if Item Deleted	2.636	2.150	2.210
Corrected Item - Total Correlation	0.649	0.820	0.703
Squared Multiple Correlation	0.470	0.674	0.561
Cronbach's Alpha if Item Deleted	0.855	0.692	0.811

**4.2 Tests of Normality**

To test for differences with an adequate test, tests of the normality of the data have to be done first. Two well-known normality tests were performed: the Kolmogorov-Smirnov test and the Shapiro-Wilk test. For all three questions, according to both tests, the degree of freedom (df) is 195, while the significance level (p) is 0.00, which indicates that the data are not distributed according to normal distribution [25].

In Table 6, both normality checks are provided.

**Table 6. Test of Normality**

Tests/Question		Q1	Q2	Q3
Kolmogorov-Smirnov <sup>a</sup>	Statistics	0.255	0.278	0.289
	df	195	195	195
	Sig.	0.000	0.000	0.000
Shapiro-Wilk	Statistics	0.767	0.827	0.864
	df	195	195	195
	Sig.	0.000	0.000	0.000

a. Lilliefors Significance Correction

**4.3 Hypothesis Testing**

This section is divided into two sections, each of which tests a different hypothesis about how the different industry sectors and nations in the subjected multinational supplier network execute Kaizen.

The first part contains comparison of data that describes Kaizen practice between 31 countries participating in the global chain, while the second one contains Kaizen practice description data comparison between two industry types.

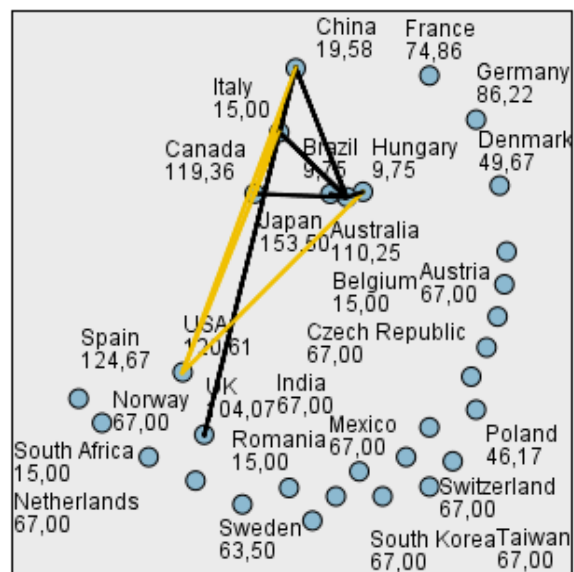
Namely, both tests previously conducted regarding normality pointed out that, since the data is not normally distributed, nonparametric tests needed to be performed.

For the first test, comparing these three questions according to categories of countries, a Kruskal-Wallis one-way ANOVA test was chosen to be performed. The significance level was 0.05, and the confidence interval

was 95% [23]. The Bonferroni correction for multiple tests has adjusted the The scale's reliability equals 0.850, which is adequate, and there is no need for further improvement by removing further variables, as in Table 5. It is evident that deleting certain variables would not enable significantly better. Still, it even will give worse results regarding the reliability of examined scale (in the cases of the second and the third question). significance values in the analysis. The Kruskal-Wallis one-way ANOVA test has been chosen because it uses ranks instead of 'raw' data, uses more information than the median test, and is a 'stronger' test.

The test results showing only statistically significant differences regarding three posted questions between countries (p<0.05) are presented in Table 7. No significant differences between other countries were found (non-significant differences are not shown in Table 7).

Figures 1-3 show pairwise comparisons between countries for Q1, Q2, and Q3, respectively.



**Figure 1. Pairwise comparisons between countries for Q1**

According to Table 7 and Figures 1-3, it is evident that the biggest differences are found in Kaizen practices in China vs. USA, Japan, and Canada since there is an evident adjusted significance value which equals 0.001. Namely, there is the lowest adjusted significance value regarding a question about standardizing, measuring, and improving processes between China and USA and between China vs. Japan and Canada regarding Kaizen Event as a structured, team-based, problem-solving activity in an accelerated manner that focuses on a specific improvement area.

It is followed by differences found between China and the USA regarding continuous, incremental improvements of all our processes and involving all our employees on regular basis and Kaizen as continuous, incremental improvements of all processes by all employees on regular basis, where adjusted significance value equals 0.002.

Kaizen standardizing, measuring, and improving processes in China and Japan have shown significant differences, with the highest adjusted significance value (0.019), meaning there is the significant difference with the lowest power.

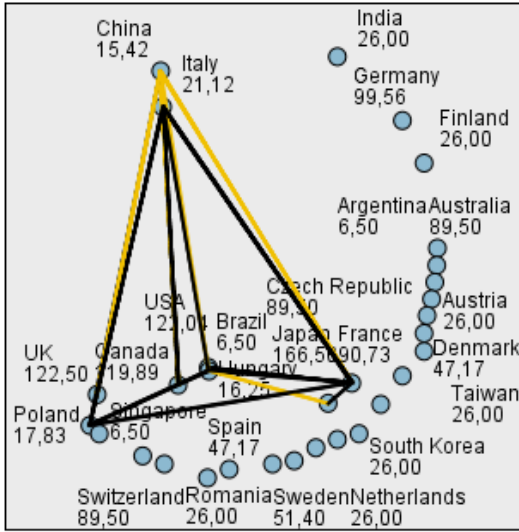


Figure 2. Pairwise comparisons between countries for Q2

The second test was performed using the Mann-Whitney u test. When an independent-sample t-test is not suitable due to an assumption about the distribution of a population, the Mann-Whitney U Test is typically used. It determines if two samples are likely to belong to the same main population. The significance level was 0.05, and the confidence interval was 95%. The tests' results are given in Table 8 and Figures 4-6 for the questions Q1, Q2, and Q3, respectively.

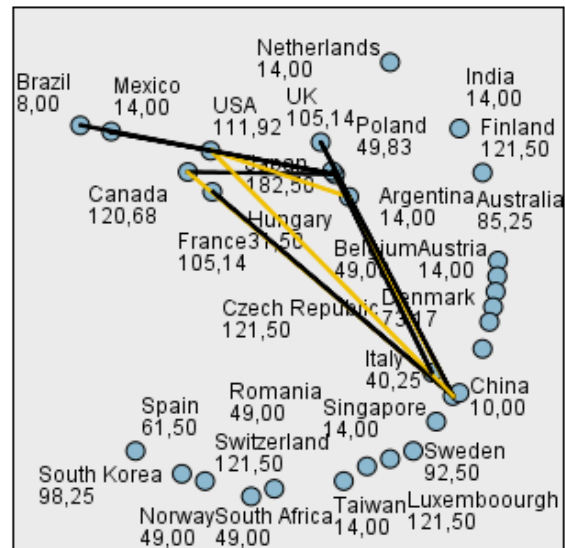


Figure 3. Pairwise comparisons between countries for Q3

The U-value measures how frequently data from one group appear before those from the other group in the ranking, while Wilcoxon W statistics gives the sum of ranks. It is evident that Kaizen practice in the field of all three questions significantly differs between the aircraft and rail transport industry since the p-value associated with asymptotic significance (2-tailed) equals 0.000.

Table 7. Results of the Kruskal-Wallis one-way ANOVA test

Q1: In our company, Kaizen refers to a philosophy that focuses on continuous, incremental improvements of all our processes and involves all our employees on regular basis.					
Sample 1 - Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
Italy – Canada	104.355	26.938	3.874	0.000	0.050
Italy – USA	-105.606	26.335	-4.010	0.000	0.028
China – Canada	99.772	22.512	4.432	0.000	0.004
China – USA	-101.022	21.787	-4.637	0.000	0.002
Q2: In our company, as per Kaizen philosophy, we standardize, measure, and improve our processes repeatedly and as a part of a continual cycle.					
Sample 1 - Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
China – Canada	104.478	22.861	4.570	0.000	0.002
China – USA	-106.619	22.125	-4.819	0.000	0.001
China – UK	-107.083	25.393	-4.217	0.000	0.012
China – Japan	-151.083	36.798	-4.106	0.000	0.019
Q3: In our company, we sometimes apply Kaizen Event – a structured, team-based, problem-solving activity in an accelerated manner that focuses on a specific improvement area.					
Sample 1 - Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.
China – Japan	-172.500	37.034	-4.658	0.000	0.001
China – Canada	110.684	23.007	4.811	0.000	0.001
China – USA	-101.915	22.266	-4.577	0.000	0.002

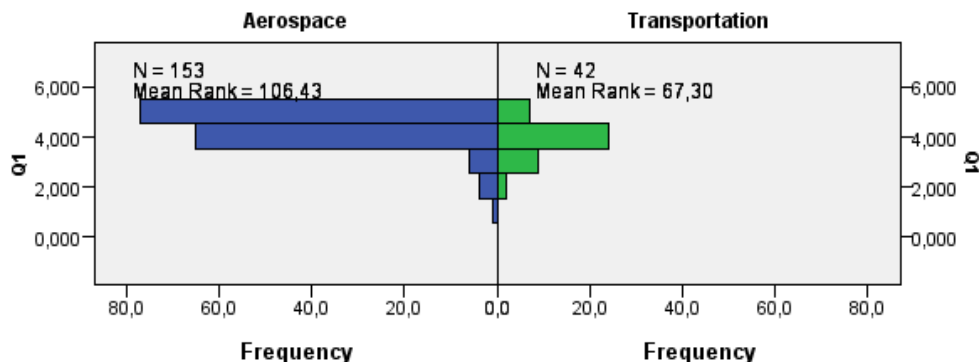


Figure 4. Results of Mann-Whitney U test for Q1

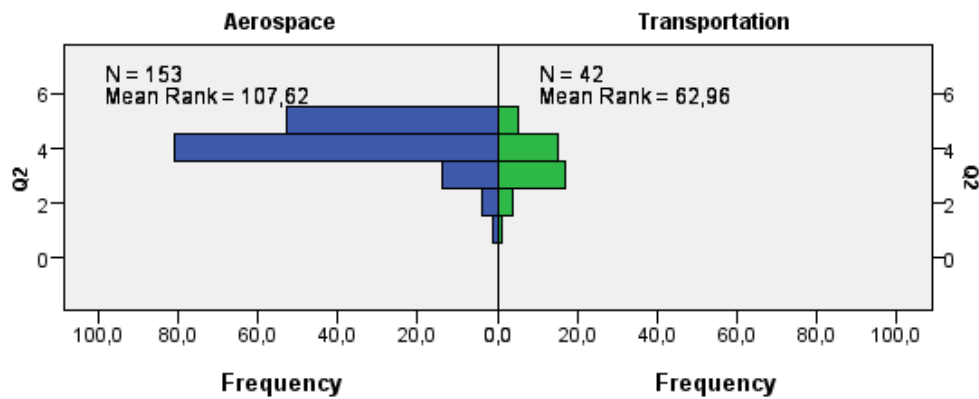


Figure 5. Results of Mann-Whitney U test for Q2

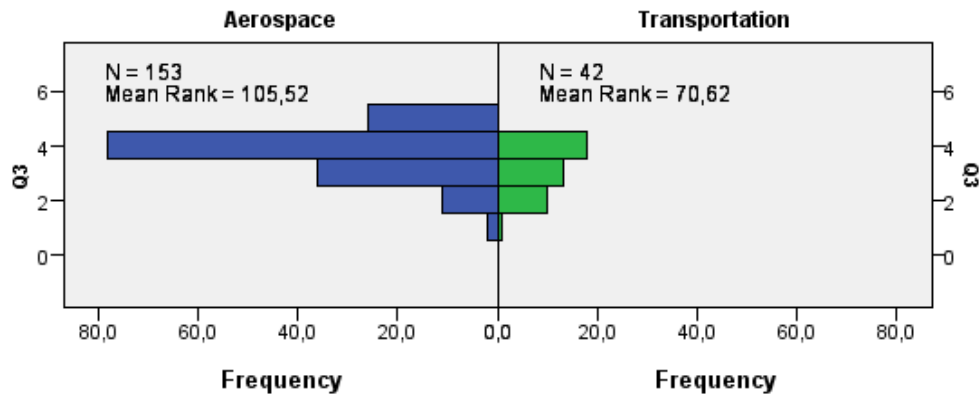


Figure 6. Results of Mann-Whitney U test for Q3

Table 8. Results of the Mann-Whitney U test

	Q1	Q2	Q3
Total N	195	195	195
Mann-Whitney U	1,923.50	1,741.50	2,063.00
Wilcoxon W	2,826.50	2,644.50	2,966.00
Test Statistic	1,923.50	1,741.50	2,063.00
Standard Error	294.178	298.741	300.651
Standard Test Statistics	-4.383	-4.926	-3.825
Asymptotic Sig. (2-sided test)	0.000	0.000	0.000

## 5. CONCLUSION

Resilient supply networks are prepared for adverse events, capable of responding quickly and effectively, and very frequently able to return to their pre-event condition or perform better than before [26,27]. Adopting and applying Kaizen events is sustainable and beneficial, but a long-run way usually is complex since the concept is complex and context-dependent [20, 21,28]. This paper aimed to connect Kaizen events and risks caused by adverse events to highlight various practices worldwide by comparing Kaizen implementation in the supply chain between 31 nations worldwide and the aviation and transportation sectors.

Factor and reliability analysis revealed that the collected data for all three questions by which the Kaizen was described have high reliability and can be grouped into one factor. Furthermore, conducted Kruskal-Wallis one-way ANOVA test for comparison between countries showed that, for the first question, there is statistical significance between Italy and Canada ( $p = 0.050$ ), Italy and the USA ( $p = 0.028$ ), China and

Canada ( $p = 0.004$ ), and China and USA ( $p = 0.002$ ). When it comes to the second question, the test showed that there is a significant difference between answers from the following countries: China and Canada ( $p = 0.002$ ), China and USA ( $p = 0.001$ ), China and UK ( $p = 0.012$ ), China and Japan ( $p = 0.019$ ). Finally, the answers to the third question showed a statistical difference between China and Japan ( $p = 0.001$ ), China and Canada ( $p = 0.001$ ), and China and the USA ( $p = 0.002$ ). No significant difference was found in other countries' comparisons ( $p > 0.005$ ).

When it gets to comparing the Kaizen practice between industries represented in the observed global production network - aircraft and transportation, the Mann-Whitney U test showed that there is a significant difference in Kaizen implementation between these two industries regarding all three questions by which the Kaizen is described ( $p = 0.000$  for Q1, Q2, and Q3).

Our findings support the claim that national and corporate cultures impact the application of quality methods, as stated in [18,20]. Results presented in [20] show significant differences in corporate culture parameters and quality growth procedures depending on the continent where companies are incorporated. Herein, in accordance with that fact, significant differences are found between companies based in large countries on different continents. The principles and techniques that produce outstanding results in one setting could cause problems in another. This is an additional reason for more intensive research on organizational cultures, which are highly influenced by differences in national cultures. The concept of corporate culture covers all employees' formal and informal beliefs and behaviors. It

originates from the USA, while Kaizen also covers employees at all levels to work together proactively to achieve regular, incremental improvements, it was created in Japan, so it is logical that common assumptions, values, beliefs, and principles differ between countries and industry types. That methodology, such as Kaizen, is applied differently according to those differences. For management to be able to manage organizational culture in general, it is necessary for managers first to become aware of the importance of corporate culture, study the existing organizational culture, its strengths, and possible subcultures, and, in accordance with its evolutionary path, possibly correct it using all his examples, symbolic content, and reward systems. Our results are further supported by research [29,30] that has found differences in Kaizen application between Chinese and Japanese cultures, which are similar but with higher collectivism in Japan [30], and those differences are mainly evident in rewards and appraisal systems there. Researching corporate culture in Italian manufacturing firms takes a lot of work. Still, the research compares organizational culture modes between Canada and one Asian country – South Korea. Namely, authors in [31] demonstrate that organizational climate and leadership, two other organizational characteristics of a company that are tightly linked to culture, have substantial relationships with national cultures and industry and context-specific factors.

Additionally, authors in [18] pointed out that the degree of formalization, the quality of the reward system, and the organization's emphasis on objectives and associated outcomes as a dimension of culture favorably impact Kaizen, and those facts also support the results of this survey. The outcomes of the analysis comparing the two types of industry were also expected, which could be explained by the fact that aviation industry has stricter and more numerous safety, reliability, and quality standards [32] compared to the transportation industry. Organizational structure types there also differ significantly.

A more thorough examination of Kaizen implementation in various sectors and countries, as well as its national cultural models, should be included in a future study, which can result in creating a structural model consisting of cultural influence, Kaizen and performance, as well as an influence of organizational structure types or at least analysis of its organic components. Further increasing the size of samples is also advised.

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**РАЗЛИКЕ У ПРИМЕНИ КАИЗЕНА ИЗМЕЂУ  
ЗЕМАЉА И ТИПОВА ИНДУСТРИЈЕ У  
МУЛТИНАЦИОНАЛНОМ ЛАНЦУ  
СНАБДЕВАЊА**

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Претходна истраживања показују да су предности Каизен-а вишеструке и евидентне, али примена Каизена у ланцима снабдевања до данас није довољно истражена. С друге стране, сведоци смо бројних проблема у савременим глобалним мрежама снабдевања. У овом раду су након приказа претходних истраживања, формулисана и тестирана три истраживачка питања везано за начине имплементације Каизен-а на узорку од 195 предузећа, која су део глобалног ланца снабдевања, лоцирана у 31 земљи и активна у две различите врсте индустрије – авионима и транспорт. Коришћен је комбиновани приступ који садржи дескриптивну статистику, анализу поузданости и факторску анализу, као и тестирање статистичких хипотеза помоћу Крускал-Њалис једносмерног АНОВА теста и Манн-Њхитнеу У теста. Резултати показују значајне разлике у примени Каизен-ау земљама попут Италије, Велике Британије, Канаде, САД, Јапана и Кине, где се разликују и националне и корпоративне културе. Примена Каизен-а се



значајно разликује и између компанија које послују у авио и транспортном сектору, што није изненађујуће с обзиром на чињеницу да авио индустрија има виши ниво формализације. Циљ да

се утврде разлике у Каизен пракси широм света је испуњен, јер статистички значајне разлике указују на значај контекстуалних фактора и повезују нежељене и Каизен догађаје.