

LINKING ORGANIZATIONAL CULTURE, QUALITY AND AGILITY TO BUSINESS PERFORMANCE: A CROSS-COUNTRY CLUSTER ANALYSIS OF A TRANSPORTATION SUPPLY CHAIN

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ABSTRACT

This paper develops a configurational, cross-country taxonomy of organizational culture and quality management practices in a global transportation supply chain. Data were collected from 47 companies across 25 countries within the supply chain of a multinational railway transport manufacturer. Four composite indices - Human Capital, Agility, Communication and Formalization, and Quality, were measured through a structured Likert-scale questionnaire and its reliability is validated using Cronbach's alpha. Hierarchical cluster analysis is done by Ward's method and has identified four distinct organizational clusters, statistically validated by one-way ANOVA. The Mann-Whitney U-test was then applied to compare the resulting clusters in terms of business performance. Results show that the cluster combining strong agility, developed human capital and high-quality practices significantly outperform clusters with weak agility or underdeveloped quality systems, while a cluster characterized by mature, highly formalized quality and communication practices achieves comparable performance. The study confirms that two distinct organizational configurations can lead to top-tier business performance and offers practical implications for multinational manufacturers managing geographically dispersed suppliers.

Keywords: Organizational culture, Supply chain, Cluster analysis, Quality management, Business performance

INTRODUCTION

The transportation supply chain operates as a globally distributed system where all providers from culturally diverse environments coordinate to deliver complex products (Czerniachowicz, 2017), and operational excellence depends not only on technology and process efficiency (Tortorella et al., 2021), but increasingly on aligning organizational culture, human capital practices, communication systems and quality methodologies across geographically dispersed organizations (Spasojević-Brkić, 2013; Tomic et al., 2017). Organizational culture is identified as a critical antecedent of performance, agility and competitiveness (Carvalho et al., 2017, 2023; Felipe Llanos et al., 2017; Tomic et al., 2017). However, empirical studies examining how these dimensions co-occur across countries within a supply chain remain limited, particularly in the railway transportation industry, where lead times are long and safety requirements are stringent (Gholamizadeh et al., 2022; Hajiaghahi-Keshteli et al., 2014). This paper aims to address this gap by developing an empirically grounded taxonomy of organizational profiles within the transportation supply chain of a multinational railway manufacturer. Drawing on data from 47 companies across 25 countries, 4 composite indices are constructed as inputs in hierarchical cluster analysis and later compared in terms of business performance to test if organizations integrating a strong quality culture with developed human capital practices achieve superior business performance. After introduction, section 2 reviews prior research, section 3 outlines methodology, section 4

presents cluster analysis, section 5 gives performance comparisons, and the paper concludes with findings, implications, and limitations.

PREVIOUS RESEARCH

The relationship between organizational culture and operational performance has attracted considerable academic attention over the past two decades. Foundational work by Naor et al. (2008) demonstrated, on a sample of 189 manufacturing plants across nine countries, that organizational culture is a significant antecedent of infrastructure quality management practices, which in turn drive manufacturing performance more strongly than core quality techniques alone. Naor et al. (2010) further showed that organizational culture can attenuate the influence of national culture on operational strategy, suggesting that strong corporate cultures partially "neutralize" cross-country differences within supply chains. Hult et al. (2007) argued that a culture of competitiveness and continuous knowledge development is a determinant of strategic supply chain performance. Kaynak and Hartley (2008) extended quality management to the supply chain level and confirmed positive operational and financial effects. Sila et al. (2006) provided early empirical evidence that quality practices are unevenly distributed across supply chain partners and that this heterogeneity affects overall chain performance.

Recent studies (Spasojević Brkić, 2013; Tomic et al., 2017) confirmed, in a multinational transportation supply chain context, the joint effect of quality tools, organizational culture and human capital practices on business performance. Building on this stream, Tomic & Spasojević Brkić (2018) further demonstrated that ISO 9001 improvement requirements in multinational supply chains directly shape customer satisfaction outcomes, reinforcing the link between standardized quality practices and downstream business performance. Supply chain agility has emerged as a parallel research stream. Braunscheidel and Suresh (2009) identified internal organizational antecedents, such as learning orientation and integration, of supply chain agility used for risk mitigation, while Chan et al. (2017) combined agility and flexibility to improve performance results. The recent meta-analysis by Alfalla-Luque et al. (2023), based on 63 empirical studies and 14,469 firms, established a large and positive correlation between supply chain agility and performance, highlighting persistent heterogeneity across industries and economic regions. Geyi et al. (2020) further demonstrated that agile capabilities are necessary, though not sufficient, conditions for sustainable supply chain performance, while Kim and Chai (2017) emphasized the role of supplier innovativeness and information sharing as agility enablers. The framework has recently been extended to digital and smart supply chains by Sharma et al. (2024).

The configurational perspective, on which this paper builds, had less empirical attention. Cao et al. (2015) applied a contingency and configuration approach and identified organizational culture profiles: Hierarchical, Flexible, Flatness, and Across-the-Board, with significantly different supply chain integration outcomes. Zanon et al. (2021) showed using grey clustering combined with fuzzy cognitive maps, that supply chain performance depends on coherent cultural configurations. Despite these advances, empirical configurational studies that simultaneously examine human capital, agility, communication and formalization, and quality across countries within a transportation supply chain remain scarce. The present paper addresses this gap.

METHODOLOGY

Data were collected from 47 companies, as units of analysis, across 25 countries worldwide, within the supply chain of a multinational railway transport manufacturer, where structured questionnaires were distributed to employees of the transportation supply chain. The questionnaire is designed to be answered by the Likert five-point scale (1 represents 'strongly disagree', 5 reflects 'strongly agree'). The general structure of the questionnaire described in detail in Spasojević Brkić et al. (2013) and Tomic et al. (2017) herein is organized into 4 main groups, which obtain key features (indexes) for the analysis. The Human Capital Index measures employee care levels, reward systems, expectations of employees in terms of their professional development and advancement. The Agility Index evaluates responsiveness when external factors influence internal processes, speeding up operations for achieving competitiveness, cycle-time reduction, structured approval system for innovations, and decision-making processes. The Communication and Formalization Index evaluates communication effectiveness, information availability, its link to motivation, formal and informal

channels, importance of formalization and documentation in organizations. The Quality Index shows the levels of utilization of quality improvement methods such as Plan-Do-Check-Act (PDCA), Kaizen and Six Sigma. The following part of the paper is focused on cluster analysis, which is applied to group similar countries within the transportation supply chain based on these indexes and later on the generated clusters and compared in order to examine links between cluster characteristics and business performance.

The reliability of the 4 conducted indexes is determined by the Cronbach Alpha coefficient, where the obtained scores for each index of the analysis are presented in Table 1. According to Adeniran (2025) and Taber (2018), the preferable values of the Cronbach Alpha are between 0.70 and 0.95, which means that all Cronbach's alpha values (Table 1) are within the acceptable range. The Quality Index achieved the highest score for reliability (0.908), followed by the Human Capital Index (0.854) and the Agility Index (0.812). The Communication and Formalization index obtained lower, but acceptable values for further analysis, 0.724. The results of the One-way ANOVA analysis (Table 1) indicate that there are statistically significant differences between the 4 clusters for all analysed Indexes ($p < 0.01$). The largest differences were identified for the Agility Index ($F = 33.396$). The Human Capital Index has the lowest F values, indicating smaller differences between clusters. Table 2 shows the number of countries grouped in each cluster. Cluster 4 is the largest (32%), followed by Cluster 3 (28%), Cluster 2 (24%), while Cluster 1 is the smallest cluster (16%), half the size of Cluster 4.

Table 1: Cronbach's alpha values and One-way ANOVA results

Index	Cronbach's alpha value	F value	p-value
Human Capital	0.854	8.686	0.001
Agility	0.812	33.396	0.000
Communication and Formalization	0.724	11.783	0.000
Quality	0.908	14.443	0.000

Table 2: Frequency of Clusters in Ward Method

		Frequency	Percent	Cumulative Percent
Valid	1	4	16.0	16.0
	2	6	24.0	40.0
	3	7	28.0	68.0
	4	8	32.0	100.0

Figure 1 depicts dendrogram and clusters formed based on similarities across evaluation indexes. Cluster 1 groups Canada, USA, France and Germany. Cluster 2 groups Mexico, Brazil, Czech Republic, Norway and Poland. Cluster 3 groups Denmark, Italy, Hungary, China, Romania, South Africa and Thailand. Cluster 4 groups Sweden, Switzerland, UK, Austria, Finland, Spain, Australia and India.

The descriptive statistics values in Table 3 are used in order to examine the clusters' performances based on the proposed indexes of the analysis. Cluster 2 is identified as 'Poor' performance Cluster, given that it achieved the drastically lowest values in terms of organizations' agility (1.81), while achieving moderate value in terms of human capital (2.34), that is slightly higher than Cluster 3. Cluster 4 is identified as the overall best performing cluster, defined as 'Excellent' performance cluster, as it achieved the highest overall values in the Agility (3.68) and Human Capital (3.22) Indexes, second highest values for the Quality Index (3.46), and slightly lower values for the Communication and Formalization Index (3.11) compared to Cluster 1. Cluster 1 is defined as the 'Very Good', but smaller in terms of size, performance cluster. It achieved overall highest values for the Communication and Formalization and Quality Indexes, with the mean values of 3.36 and 3.99, but had low values for Agility Index (2.20), while achieving moderate mean values in terms of Human Capital Index (2.58). Cluster 3 is the 'Moderate' performance cluster, given its high value for Agility Index, that is drastically higher than Cluster 2 values, but still achieved lower overall values for the other 3 Indexes. Cluster 2 and 3 achieved similar scores in Human Capital Index.

In order to test the hypothesis regarding the potential relationship between cluster performance in terms of generated indexes, and the new area of analysis, as proposed, business performance of the organizations, further statistical analysis is conducted, for assessing the clusters' effectiveness in the aspects of their market and

financial achievements, operations and process progress and improvements, employees commitment, plans and possibilities for investments and customer related aspects (Spasojević-Brkić, 2013; Tomic et al., 2017). Descriptive statistics of business performance across the four clusters (Table 4) provides values for the number of the non-missing values as valid N, mean, median, minimum and maximum, range, standard deviation (SD), and coefficient of variation (CV). Cluster 4 contains the largest number of obtained values (240), followed by Cluster 3 (210), while Cluster 2 and Cluster 1 have fewer, 150 and 120. Highest mean values are achieved by Cluster 1, followed by Cluster 4, while Cluster 2 and 3 show lower values. All CV values for the identified clusters are below 30%, indicating moderate dispersion of the responses.

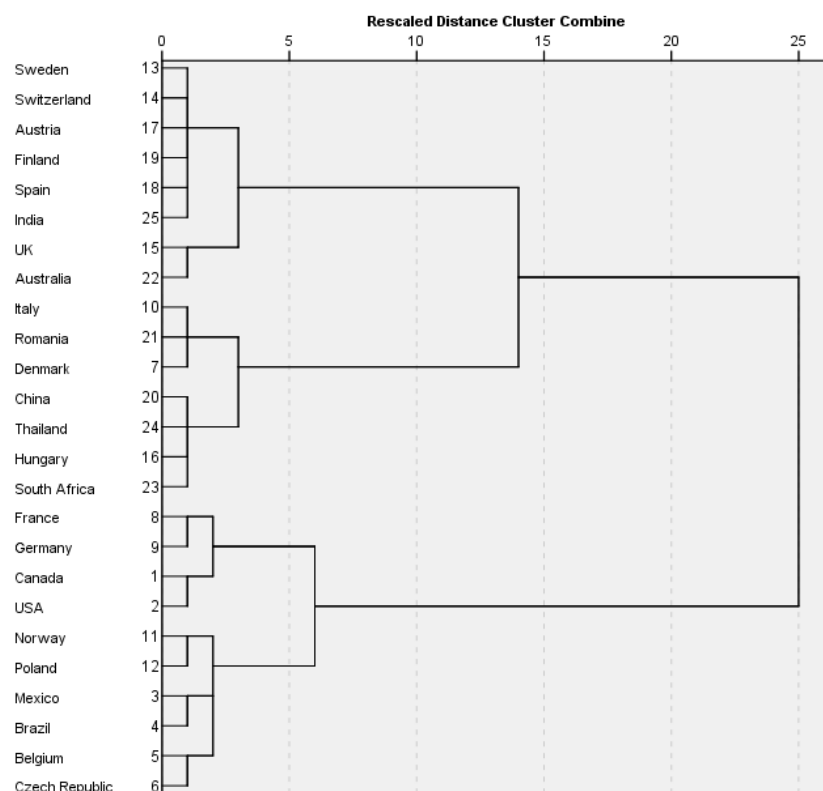


Figure 1: Dendrogram using Ward Linkage

Table 3: Mean values of clusters – Ward Method

Ward Method		Agility Index	Communication and Formalization Index	Human Capital Index	Quality Index
1	Mean	2.2000	3.3583	2.5729	3.9954
	SD	0.2828	0.1658	0.4557	0.2584
2	Mean	1.8111	2.8667	2.3444	3.0185
	SD	0.3513	0.2338	0.4925	0.3401
3	Mean	3.1619	2.3595	2.3095	2.7910
	SD	0.4821	0.3641	0.3276	0.2576
4	Mean	3.6825	3.1088	3.2206	3.4632
	SD	0.3306	0.3313	0.3261	0.3678
Total	Mean	2.8504	2.8808	2.6516	3.2534
	SD	0.8517	0.4633	0.5486	0.5206

In order to assess the normality of data distribution, the Kolmogorov-Smirnov test is applied (Table 4). In all cases, the p-values are below 0.01 indicating the rejection of the null hypothesis and concluding that the data do not follow the normal distribution and it is justified to use further non-parametric tests. The goal of the paper is to examine and determine if the organizations that integrate a high-quality culture with strong human capital achieve superior financial/business performance results.

The Mann Whitney U-test results in Table 5 present comparisons between Cluster 4 and Clusters 1, 2, and 3. Significant differences are identified between Cluster 4 and Clusters 2& 3 ($p < 0.05$), indicating higher business

performance in Cluster 4. No significant difference is observed between Cluster 4 and Cluster 1 ($p > 0.05$), suggesting similar performance levels even though higher rank sum values are reported in the case of Cluster 4.

Table 4: The results of descriptive statistical analysis and Kolmogorov-Smirnov test clusters

Variable	Descriptive statistical analysis								Kolmogorov-Smirnov test	
	Valid N	Mean	Median	Min	Max	Range	SD	CV (%)	d	p
Cluster 1	120	3.1965	3.00	1.00	5.00	4.00	0.75	23.33	0.1789	<0.01
Cluster 2	150	2.8178	3.00	1.00	5.00	4.00	0.73	26.10	0.2821	<0.01
Cluster 3	210	2.6905	3.00	1.00	5.00	4.00	0.71	26.59	0.2612	<0.01
Cluster 4	240	3.0579	3.00	1.00	5.00	4.00	0.74	24.34	0.2268	<0.01

Table 5: The results of the Mann Whitney U-test - Clusters

Rank Sum Cluster 4	Rank Sum		U	Z*	p-value
41614.00	Cluster 1	23366.00	28126.50	-1.94	0.052807
47141.50	Cluster 2	25367.00	10578.50	3.97	0.000073
62112.50	Cluster 3	39362.50	11760.50	6.27	0.000000

DISCUSSION AND CONCLUSION

The four-cluster solution obtained through Ward's method reveals that companies within the transportation supply chain do not converge towards a single managerial template, despite operating under shared corporate standards. Instead, four distinct configurations emerge, each combining the four indices in a different way and producing markedly different business performance outcomes. Cluster 4 ("Excellent"), grouping predominantly Western and Northern European countries together with Australia and India, achieves the highest mean values for Agility (3.68) and Human Capital (3.22), together with high values for Quality (3.46). This balanced profile is consistent with the literature suggesting that operational excellence emerges from the simultaneous cultivation of employee-centered practices and structured improvement methodologies, rather than from any single dimension in isolation. Cluster 1 ("Very Good"), comprising Canada, USA, France and Germany, shows the opposite logic since it scores highest on Quality (3.99) and Communication and Formalization (3.36), but considerably lower on Agility (2.20). This profile reflects mature, formalized organizations in which standardized quality systems are deeply embedded but responsiveness to change is constrained by hierarchical decision-making. Cluster 3 ("Moderate") displays a high Agility score (3.16) combined with the lowest values for Quality and Communication and Formalization, indicating responsiveness without the structural support of formalized quality systems. Cluster 2 ("Poor"), which includes several emerging-market and selected European countries, shows the lowest Agility (1.81) and weak performance across all dimensions, suggesting underdeveloped managerial infrastructures.

The Mann-Whitney U-test results provide partial support for the central hypothesis. Cluster 4 statistically outperforms Cluster 2 and Cluster 3 in business performance, confirming that the integration of agility, quality and human capital is associated with superior outcomes. However, no statistically significant difference is found between Cluster 4 and Cluster 1, implying that strong quality culture combined with developed communication systems can compensate for lower agility and deliver comparable business results. This nuance refines the prevailing view in the literature that there is more than one viable pathway to high performance in transportation supply chains. It means that a balanced "agile-quality" model and a "formalized-quality" model both prove effective, while configurations weak in quality or agility consistently underperform.

These findings have practical implications for multinational manufacturers managing geographically dispersed suppliers. Rather than imposing a uniform managerial template, headquarters should diagnose the cultural-organizational profile of each region and develop differentiated improvement programs by reinforcing agility and human capital in formalized environments, and strengthening quality systems and communication where agility already exists.

This paper develops an empirically grounded taxonomy of organizational culture and quality management practices within a global transportation supply chain consisting of 47 companies across 25 countries and there four distinct clusters were identified through Ward's hierarchical clustering and validated by one-way ANOVA, which confirmed statistically significant differences between clusters across all four indices. The comparative analysis of business performance, conducted via the Mann-Whitney U-test, shows that the cluster combining high agility, developed human capital and strong quality practices (Cluster 4) significantly outperforms clusters characterized by weak agility or underdeveloped quality systems (Clusters 2&3), while the cluster dominated by mature, highly formalized quality and communication systems (Cluster 1) achieves business performance statistically comparable to Cluster 4. The proposed hypothesis that organizations integrating a high-quality culture with strong human capital achieve superior business performance is confirmed, with the additional finding that two distinct organizational configurations can lead to top-tier performance. The main contribution of the paper lies in offering a configurational rather than variable-centered view of operational excellence in transportation supply chains, and in demonstrating that managerial practices cluster along recognizable national-regional patterns. From a practical side, the results suggest that multinational chains should adopt differentiated, profile-specific improvement strategies for suppliers rather than uniform global programs. The study has limitations regarding generalizability and response bias. Future research should extend sample, incorporate longitudinal data to capture dynamics, and examine moderating effects of national culture.

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