

Applying Concept Mapping to Explore Temperature Abuse Factors in the Processes of Cold Chain Logistics Centers

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Abstract : As societal and family structures, consumer dietary habits, and awareness about food safety and quality continue to evolve in most developed countries, the demand for refrigerated and frozen foods has been growing, and the issues related to their preservation have gained increasing attention. A well-established cold chain logistics system is essential to avoid any temperature abuse; therefore, assessing potential disruptions in the operational processes of cold chain logistics centers becomes pivotal. This study preliminarily employs HACCP to find disruption factors in cold chain logistics centers that may cause temperature abuse. Then, concept mapping is applied: selected experts engage in brainstorming sessions to identify any further factors. The panel consists of ten experts, including four from logistics and home delivery, two from retail distribution, one from the food industry, two from low-temperature logistics centers, and one from the freight industry. Disruptions include equipment-related aspects, human factors, management aspects, and process-related considerations. The areas of observation encompass freezer rooms, refrigerated storage areas, loading docks, sorting areas, and vehicle parking zones. The experts also categorize the disruption factors based on perceived similarities and build a similarity matrix. Each factor is evaluated for its impact, frequency, and investment importance. Next, multiple scale analysis, cluster analysis, and other methods are used to analyze these factors. Simultaneously, key disruption factors are identified based on their impact and frequency, and, subsequently, the factors that companies prioritize and are willing to invest in are determined by assessing investors' risk aversion behavior. Finally, Cumulative Prospect Theory (CPT) is applied to verify the risk patterns. 66 disruption factors are found and categorized into six clusters: (1) "Inappropriate Use and Maintenance of Hardware and Software Facilities", (2) "Inadequate Management and Operational Negligence", (3) "Product Characteristics Affecting Quality and Inappropriate Packaging", (4) "Poor Control of Operation Timing and Missing Distribution Processing", (5) "Inadequate Planning for Peak Periods and Poor Process Planning", and (6) "Insufficient Cold Chain Awareness and Inadequate Training of Personnel". This study also identifies five critical factors in the operational processes of cold chain logistics centers: "Lack of Personnel's Awareness Regarding Cold Chain Quality", "Personnel Not Following Standard Operating Procedures", "Personnel's Operational Negligence", "Management's Inadequacy", and "Lack of Personnel's Knowledge About Cold Chain". The findings show that cold chain operators prioritize prevention and improvement efforts in the "Inappropriate Use and Maintenance of Hardware and Software Facilities" cluster, particularly focusing on the factors of "Temperature Setting Errors" and "Management's Inadequacy". However, through the application of CPT theory, this study reveals that companies are not usually willing to invest in the improvement of factors related to the "Inappropriate Use and Maintenance of Hardware and Software Facilities" cluster due to its low occurrence likelihood, but they acknowledge the severity of the consequences if it does occur. Hence, the main implication is that the key disruption factors in cold chain logistics centers' processes are associated with personnel issues; therefore, comprehensive training, periodic audits, and the establishment of reasonable incentives and penalties for both new employees and managers may significantly reduce disruption issues.

Keywords : concept mapping, cold chain, HACCP, cumulative prospect theory

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