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An NGT-DEMATEL-PROMETHEE Methodical Analysis of the Parameters Influencing the Promotion of Safety Conformity in Bottling Process Plants

Shedrach Aliakwe MARTINS[1] Sunday Ayoola OKE[1*] Adeyemi Adebayo OGUNDARE[1] Joseph Ifeolu ORISALEYE[2] Samuel Bolaji ADERIBIGBE[1] John RAJAN[3] Swaminathan JOSE[4]

[1] Department of Mechanical Engineering, University of Lagos, Lagos, Nigeria
[2] Department of Engineering, Birmingham City University, Birmingham, United Kingdom
[3] School of Mechanical Engineering, Vellore Institute of Technology, Chennai, India
[4] School of Mechanical Engineering, Vellore Institute of Technology, Vellore, India

Keywords

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Abstract

In bottling process plants, safety conformity effectively addresses hazard control, workers well being and product integrity, promising the protection of the bottling plants from risks and building trust in them. Currently, insufficient attention from comparing safety managers hinders safety conformity development. To address this, the present study aims to explore how the combination of NGT (nominal group technique), DEMATEL (Decision Making Trial and Evaluation Laboratory) and PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) is used to concurrently evaluate the interrelationship and prioritize parameters according to their importance. The study analyzed five relevant segmental classifications of the plant, identified 29 parameters affecting the promotion of safety conformity and constructed an outranking flow model based on aggregate preference function on the leaving-entering flow matrix. The alternate comparison scheme was used to identify the key parameters associated with each of the five segments, namely, warehouse, manufacturing corridors, quality assurance, fleet of vehicles and contractors. Subsequently, the highest-to-lowest ranking of parameters according to the respective aforementioned segments are forklift drivers (aggregate 7; P, P-1, R, I → 7,0,0,0), sighters (aggregate 6; P, P-1, R, I → 6,0,0,0), syrup mixers (aggregate 5; P, P-1, R, I → 5,0,0,0), welders (aggregate 2; P, P-1, R, I → 2,0,0,0) and security (aggregate 4; P, P-1, R, I → 4,0,0,0) in segments 1 to 5, respectively. The study reveals the safety conformity influential parameters with which the most of effective changes and complaints with regulations could be attained. The study results provided guidance and understanding to locate the most influential parameters with high interactions with others, and a platform to drastically enhance safety conformity.

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Author ID (ORCID Number)

0000-0002-0070-8557	Shedrach Aliakwe MARTINS
0000-0002-0914-8146	Sunday Ayoola OKE
0000-0003-3523-8214	Adeyemi Adebayo OGUNDARE
0000-0002-8793-3043	Joseph Ifeolu ORISALEYE
0009-0000-6922-9987	Samuel Bolaji ADERIBIGBE
0000-0001-8892-3130	John RAJAN
0000-0002-9151-0000	Swaminathan JOSE

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1. INTRODUCTION

Safety conformity is critical in bottling process plants, promoting injury prevention and mitigation of risks such as shear hazards, crush, entanglement and nib associated with machining operations (Martins & Oke, 2020a). It persuades workers to give up unsafe behaviours, avoid accidents and injuries (Behara & Hassan,

*Corresponding Author, e-mail: sa_oke@yahoo.com

2019). However, limited studies exist on safety conformity within the bottling process plants (Martins & Oke, 2021). This study evaluates the safety conformity of a bottling plant, to concurrently examine and prioritize relationships among parameters. It uses nominal group technique (NGT), Decision Making Trial and Evaluation Laboratory (DEMATEL) and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) method (Jackson et al., 2025; Maduekwe & Oke, 2021; Nurmalassari et al., 2025). A detailed study of a bottling process plant located in the south-western Nigeria was made. The plant was segmented into five aspects, based on literature review and field experience. These are the warehouse, manufacturing corridor, quality assurance fleet of vehicles and contractors. The holistic analytical approach to safety conformity, adopted in this work considered both manufacturing and non-manufacturing related segments within the plant to present a novel approach previously unreported. In the first phase of this work, the NGT was hybridized with the DEMATEL, which was tested with group consensus data. The second phase involves further transforming the method by adding the PROMETHEE method. NGT was used to create ideas and reach a consensus decision, DEMATEL aided to establish causal interdependencies among safety parameters while PROMETHEE obtained the global priority weights in pairwise alternative comparison and aggregates the results to establish ranks in an outranking scheme. A comprehensive evaluation was pursued by examining two variants of PROMETHEE, namely PROMETHEE I and II for partial and full ranking, respectively. Coincidence analysis was made on the ranking options of PROMETHEE I and II.

2. LITERATURE REVIEW

2.1. DEMATEL Method

DEMATEL has been applied in several areas, including Farmland project (Li, J. et al., 2025), logistics (Chakraborty et al., 2025), IT implementation (Kaur & Chauhan, 2025), knowledge management (Chatzifoti et al., 2025), uncertainty environment (Appasamy, 2026), small and medium enterprises (Ferreira & Ferreira, 2025), hospitals (Gokalp & Eti, 2025), supply chains (Ozturk, 2025), economic development (Bas et al., 2025), food systems (Markosyan et al., 2024), waste water treatment (Yalcin, 2025), building energy (Tang et al., 2025), logistics (Rahimi et al., 2025) and aerospace (Nurmalassari et al., 2025). In Li, J. et al. (2025), a triple method of DEMATEL, interpretive structural model and Bayesian network model were integrated to achieve accurate budget planning in a farmland. Chakraborty et al. (2025) introduced the R'DEMATEL method to establish the interaction of the barriers in a horizontal collaboration among companies. Kaur and Chauhan (2025) analyzed the principal parameters that drive emotional intelligence in experts working within the information technology domain using fuzzy-DEMATEL method coupled with factor analysis. Chatzifoti et al. (2025) applied DEMATEL to the tourism accommodation industry with specific emphasis on how to implement knowledge management.

The review shows that DEMATEL has been widely applied both in manufacturing and service systems. However, it also highlights that more structured approaches, which could integrate other methods to the

DEMATEL frameworks are needed to improve the understanding and diffusion of DEMATEL method within the manufacturing domain. Moreover, DEMATEL method has been combined with other methods. With several studies affirming the effectiveness of the DEMATEL method in diverse settings, the potential to successfully use it within the safety conformity domain is therefore established. Therefore, the present study addresses this gap and attempts to establish the association among the substantial parameters of the safety process using DEMATEL as a method within an integrated framework.

2.2. Nominal Group Technique

NGT has been applied in various areas and sectors of economy. These include applications in healthcare (Black et al., 2025; Elwyn et al., 2025; Gege et al., 2025; Guruz & Tanriover, 2025; Heward et al., 2025; Jackson et al., 2025; Neto et al., 2025; Teixeira et al., 2025; Vardaman et al., 2025; Yepes-Cortés et al., 2025). Other application areas include intelligent robot services (Cui et al., 2025), public service administration (Abdul Aziz & Ali, 2025). In the healthcare sector, the NGT has an overwhelming influence in prioritizing health services such as language disorder intervention, care discharge management, emergency medical services, and nursing education. In this area, the theme of research has been to prioritize important factors that will greatly influence decision making in healthcare. Moreover, other application areas such as in intelligent robot services and public service management, have maintained prioritisation as a theme. The above perspectives on NGT highlight the strong decision making potential of NGT and its necessity for application in safety conformity services, which has been ignored till date. Therefore, given this gap, for the bottling plant, the NGT should be introduced into safety conformity assessment decisions.

3. METHODOLOGY

3.1. The Bottling Process Plant

Bottling process plant is studied in the present work and not other processes because of the urgent need to recognize and ascertain product quality, reduce waste and optimize process efficiency (Figure 1). Moreover, product quality in the beverage industry may be ascertained through feedbacks from customers, strict adherence to local standards. Such include the Soft Drinks Regulations, 2021, of the National Agency for Food and Drug Administration and Control (NAFDAC). The Extraordinary publication in the Federal Republic of Nigeria (Official) Gazette regulates the safety of soft drinks in Nigeria. Another local standard on soft drinks system safety is regulated by the Standards Organization of Nigeria (SON). The SON establishes standards on industrial processes, machinery and protective equipment. Locally in Nigeria, the Federal Ministry of Labour and Productivity is responsible for safety administration in plant, including soft drinks bottling processes. To perform their duties, the ministry establishes norms, and enforces them to protect employees against occupational hazards. Furthermore, the Factory Act of Nigeria is enforced as a legislative act on safety of workers in factories located in Nigeria.

The act compels factory owners to ascertain that they train their workers and offer safe working conditions (Li, H. et al., 2025). Product quality is assured also by certifications, rigorous quality control checks and process safety audits. Moreover, to reduce waste in the bottling process plants, the process engineer needs to target waste generated in bottling process, excess materials and product defects. Furthermore, the bottling process plant is studied to optimize efficiency by enhancing the safety practices in the plant. This interacts with the implementation of total productive maintenance, inventory management enhancement, production planning optimization and distribution enhancement.

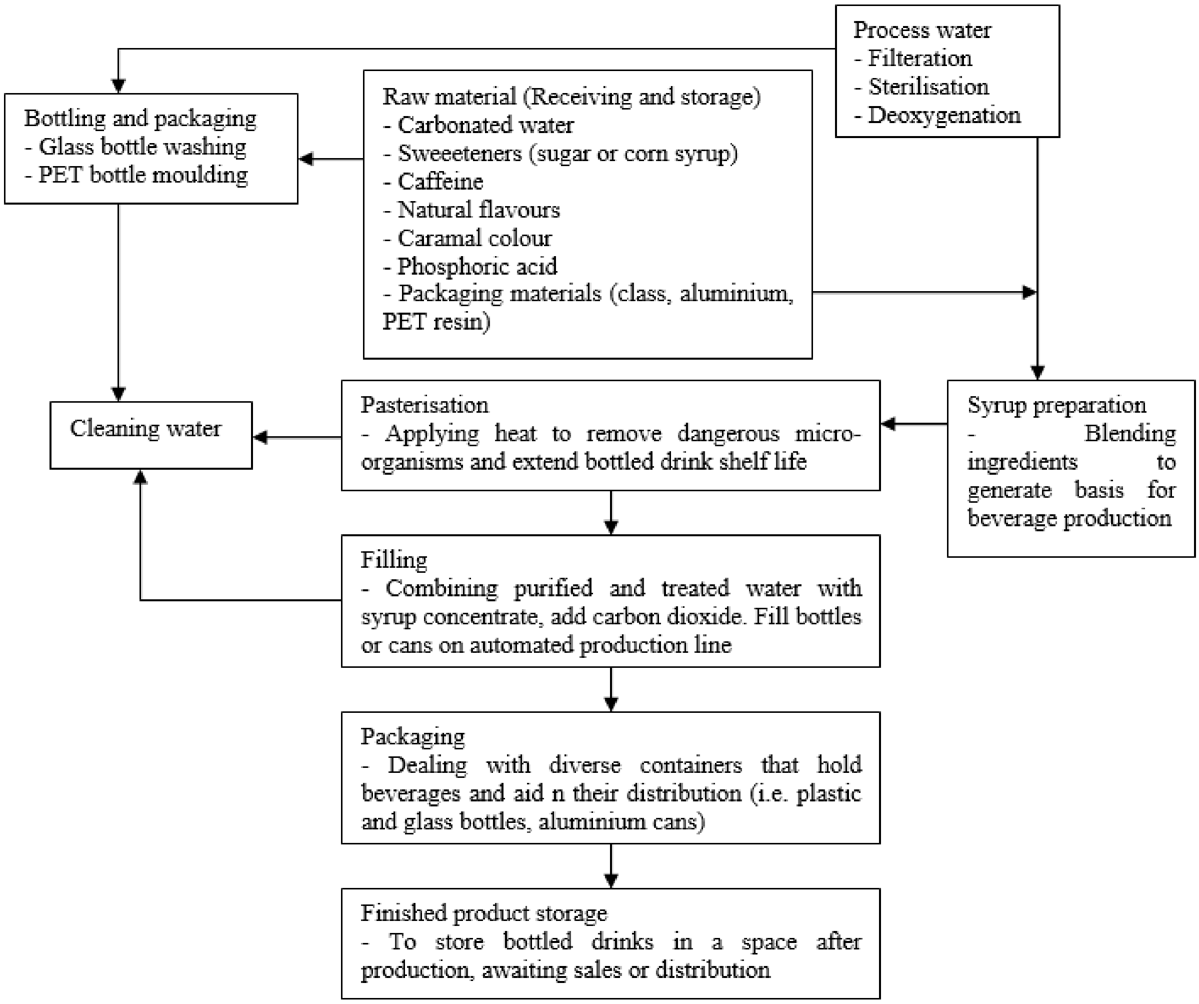

Figure 1. *Bottling process plant*

3.2. The Choice of PROMETHEE Method to Analyse Safety Conformity

In this work, the PROMETHEE method, consisting of PROMETHEE I and PROMETHEE II was chosen to analyse the safety conformity process because it is suited for multicriteria decision making. Contemplating safety conformity as a multicriteria problem is necessary because it recognizes that safety conformity decisions involve several parameters that surpass viewing them only as hazards or costs. For instance, organizational, individual and environmental factors are the main drivers of safety decisions. Organizational factors may include communication of ideas and policies from the management to workers, safety culture installed by the management in the system and leadership commitments. These organizational factors may be quantified using surrogates and formulated as a multicriteria problem. Instead of using a single objective such as cost to evaluate the safety conformity performance, several values and priorities should be considered.

3.3. Data Collection ProcessandMethods

There are two aspects of this section of research: The data collection and the methods applied to the process. Data on conformity to safety are collected and stored to permit the drawing of information from the analysis of the data. Through evaluation, selection and ranking of safety conformity data, understanding the present state of safety conformity will be made for the bottling process industry. In this research, data has been collected from a major bottling plant operating in the southwestern part of Nigeria.

To achieve data collection, the following steps are followed;

Step 1: Locate the bottling plant and divide it into segments and sub-segments. The principal operations of the bottling plant are centered on the bottling room. This is separated from other plant units by self-closing doors, walls and ceilings. Other areas are water processing rooms, bottle washing and sanitation spaces. Others are collection points, storage tanks, fillers, and cappers. Other work areas related to processing, packaging, handling and transportation of bottled drinks. Other essential non-technical operations but support functions include canteen services by contractors.

Step 2: Planning the collection of safety conformity data: This is how the data will be obtained. In particular, for each workstation, the key safety features are identified. For instance, in the bottling floor, the concern is the wearing of personal protective equipment. The present researcher visits the plant at designated periods to observe whether the personal protective equipment are worn and by how many of the workers at the time of sighting them.

Step 3: Choosing the approach to data collection. Here, forms are developed and the marking of the forms is done at hourly periods to assess the staff on how they conform to safety practices at the various workstations.

Step 4: Gathering the conformity data. This involves the collation of the conformity data and the analysis of the frequency of using the personal protective equipment.

Step 5: Analysis of the conformity data. This is made using the multicriteria methods of NGT, DEMATEL and PROMETHEE.

Figure 2 illustrates the combined method used in the present study, which is NGT-DEMATEL-PROMETHEE method. It involves the combination of three different methods, which are the NGT, the DEMATEL method and the PROMETHEE method. First, the NGT method is combined with the DEMATEL method and subsequently, the combined methods have the PROMETHEE method appended to it. It implies that the proposed method undergo two different transitions. First, the NGT method transits to NGT-DEMATEL method while the NGT-DEMATEL method transits to NGT-DEMATEL-PROMETHEE method. For the first transition, which is from NGT to NGT-DEMATEL method, the strength of the NGT and DEMATEL methods are integrated to offer a largely broad examination of safety conformity. It assists the researcher to establish and rank parameters, through equal contributions of all participants, irrespective of their positions in the organization. This is achieved by creating an array of ideas and showcasing a perception of decision making.

However, the DEMATEL method assists in examining complicated associations, and establishes cause-and-effect trend. It assists to conceptualize the parametric associations in a straight forward mapping scheme. At the second transition, where the PROMETHEE method is added to the combination of NGT and DEMATEL method, the PROMETHEE method strengthens of the other two methods. The new method is a user-friendly outranking method which exhibits flexible handling of the diverse preference functions. It has openness in decision making on the safety conformity problem. Moreover, it is important to justify the transitions of the proposed method, which changed from NGT to NGT-DEMATEL method during the first transition and further to NGT-DEMATEL-PROMETHEE method in the second transition. The justification for the first transition is the drive by the requirement for a refined comprehension of the compound decision making schemes. Specifically, the interdependences of the parameter are of the prime concern to the decision makers. Thus, in the NGT-DEMATEL method, the broad analysis leads to a largely effective decision making policies. Furthermore, the justification for the second transition is to provide an organized and straight forward method in ordering safety conformity parameters which contains conflicting multiple characteristics. The safety conformity situation is such that decision makers are compelled to compare parameters and establish a preferred order in a complicated and unstructured problem scenario. In that instance, the PROMETHEE method in the second transition brings about this strength into the NGT-DEMATEL-PROMETHEE method.

3.4. Principal Parameters Used During the Operational Study

In this work, novel interrelationship management of safety conformity parameters are discussed for the carbonated beverage bottling plant where precision and expertise coupled with a safe environment, are required in production. However, choosing representative parameters that influence the working operations during the operational studies is crucial. These parameters are discussed here for direct and indirect beverage production activities. Thus, the essential parameters considered in Martins and Oke (2020a; 2020b) and Martins et al. (2021) were adopted in the present study. In all, five segment were considered, notably, warehouse, manufacturing corridor, quality assurance, fleet workshops, and contractors. The detailed explanations of these segments are as follows: Segment 1 is the warehouse that contains 8 inputs: Forklift drivers, sorters, rescuers, chip neck removers, sugar handlers, haulage drivers, haulage truck mates and extra bottle removers. The convener of the NGT meeting explained the function of each of the sub units. The forklift drivers are those that drive the forklifts for the carriage of crates and heavy items. These items are challenging for manual lifting. It includes raw materials and finished goods. The movement of the forklift drivers is often within the factory. Sorters are these responsible for arranging and separating different bottle brands. Often, customers may mix different brands of bottles in a crate. Washing and feeding these brands with the same content is not appropriate. Hence, sorters are responsible for correcting this anormally. Rescuers are those that watch the moving bottles on the conveyor belt and ensure that they flow well without interrupting the flow. They achieve this without disturbing other bottles from standing upright in the flow. They ensure that there is no obstruction. If they discover potential obstruction of the bottles in their flow, they intervene by arranging them. Sugar handlers see to the carriage of sugar bags, which is one of the raw materials. Haulage drivers are those that drive the trucks that bring in empty bottles to the plant. They also bring in raw materials and transport the product from the warehouse to the consumers. Haulage truck mates are those that assist in the loading and off loading of haulage trucks. Chip neck removers observe the necks of the bottles, discover those whose necks are cracked or broken and remove them from the flow. Extra bottle removers are meant to discover excess bottles along the line and remove them from the flow of bottles. These descriptions are for segment 1. However, segment 2 has the following components and descriptions.

Segment 2 is the manufacturing corridor, and has the following items, inputs or operators: sighters are those who watch over the process. Next is the filler operator who operates the syrup filling machines. Palletizers and depalletizers are those who remove bottles from the wooden carriages that carries creates. They also put the products on the wooden carriages. Washer operators are those who operate the bottle washing machine. The functions of the Chip neck removers as explained under the warehouse segment. Technical operators (utilities) are those that work on maintenance activities on the different machines within the plant. Packer and unpacker operators are those who operate the packing machine and also the unpacking activities. Segment 3 is the quality assurance which has the following members: sugar mixers, who carry sugar bags from points to points, within the quality control unit. They move the sugar bags from the warehouse to the mixing locations. They also carry sugar bags from any point in the plant where the forklifts have dropped them. Syrup mixers are those with oversight functions on the mixing of syrup. They introduce a mixing ratio between water concentrates and sugar. Laboratory technicians are quality control personnel who works in the laboratory to measure the properties of the bottled drinks as well as their quality characteristics. These are taste and filling height as well as colour and smell. Water technicians are those working on water. The Etp are technicians that engage in other electrical works. Others are the category that encompasses industrial attachment students and other support staff and technicians. Segment 4 is the fleet workshops which has three members: forklift technicians are those that maintain the forklift. Welders are those who engage in welding works. Battery chargers/technicians are those that works on the batteries, especially the batteries of the forklifts. They change the batteries. The last is segment 5, which comprises of contractors, resident in the company or working from outside. Under segment 5, these are five participants: securities, which are those that attend to the security of the factory premises. Kitchens are people who work in the kitchen (contractors I, II and III). These contractors handle different aspects of materials required for the operation. Contractor I is tailors that cut and sew uniforms for the factory workers. Contractor II is responsible for the supplies of safety boots. Contractor III is the chemical supplier for the plant.

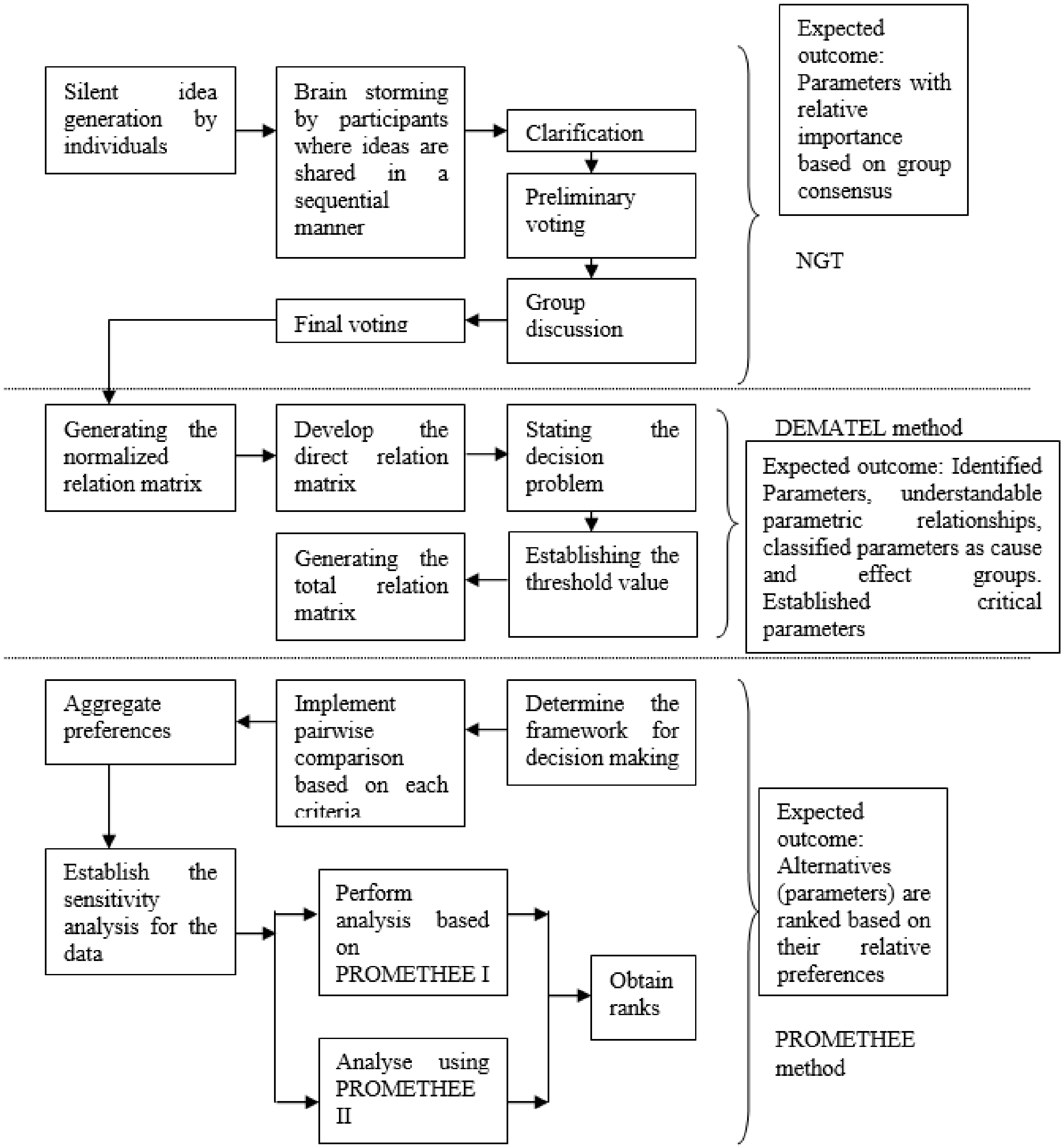

Figure 2. *Research methodology for the NGT-DEMATEL-PROMETHEE method*

The discussion in this section of the paper encourages the adoption of the NGT-DEMATEL method in a soft drinks bottling plant and using the method to evaluate the safety conformity of the various sub segments, which are termed parameter in this work. Moreover, effectiveness of the safety programme and the need to establish areas of improvement push the present investigations to seek a method that would show the interactions among the parameters of the bottling process plant. In this section, the NGT and how it was applied is discussed.

3.5. NGT-DEMATEL-PROMETHEE Procedure

In the previous subsection, the methodology of the NGT- DEMATEL method has been given. However, for a complete procedure of the NGT-DEMATEL-PROMETHEE method, the PROMETHEE technique has tobe appended to the NGT-DEMATEL method. This activity commences with the introduction of the normalization procedure into the study, Equations (1) and (2) are the normalization indices, covering beneficial and non-beneficial aspects for the NGT-DEMATEL-PROMETHEE method.

for Beneficial Criteria,

$$R_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} \tag{1}$$

for Non-Beneficial Criteria

$$R_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} \tag{2}$$

where $i = 1, 2, 3, \ldots, m$; $j = 1, 2, 3, \ldots, n$.

R_{ij} is the normalized performance value of a particular safety alternative i (i.e. specific forklift drivers, truck mates, or bottle sorters) with respect to the safety criterion of safety conformity.

X_{ij} is the row performance score of alternative i when considering criterion j.

min (X_{ij}) is the minimum value of a criterion among all the alternatives that are assessed.

max (X_{ij}) is the maximum value of a criterion among all the alternatives being assessed.

In this work, the terms parameters, alternatives or criteria are used interchangeably. Moreover, while processing the PROMETHEE method's application to safety conformity parametric ranking, there is a stage of the analysis that requires determining whether the parameter is a beneficial criterion on a non-beneficial criterion. Furthermore, by assessing safety conformity based on these two criteria guarantees positive and proactive viewpoints to safety at the bottling process plant. This, in turn, stimulates the mitigation of risks in a financially sound manner and alsolead to enhanced bottling process outputs with improved safety. Further explanation is given on the mitigation of risks in the bottling process where financial soundness is a key issue. Consider the forklift driver that unloads the forklift in a bottling plant in the wet environment. During the raining season such as June and July of every year, forklift driver must work, load and unload the forklift to fulfill the planned product delivery schedule. These loading and unloading activities may take place in the rain where the driver regularly drives in and out of the warehouse. Interestingly, beneficial criteria depends on the aspect of impact and the kind of benefits that they represent. For example, the mitigation of risks by the forklift drivers in the rain has financial impacts on the bottling plant. Implementing the suggestions to mitigate the hazard could be viewed as an organizational impact. It will influence the safety culture of the manufacturing plant. Usually, pedestrians move in the assigned areas where they need to carry out their different jobs. The exclusion zones between forklifts and the pedestrian is roughly 3 meters. Given that forklift drivers may speed to a maximum of 10 metres per hour, forklifts slides in some areas due to water build-up. Thus, mitigating risk by eliminating the hazard (i.e. risk avoidance) may be the most profitable decision. Better draining of the water could be made. Changing the tyres of the forklifts requires new tyres. Alternatively, change the surface of the warehouse floor to a more resistant surface, which can avoid slips. To achieve this, suitable concrete may be used. This achieves the beneficial criterion and enhances organizational value. Furthermore, non-beneficial criterion is one which imposes a negative impact on the bottling plant. Viewing criteria in PROMETHEE analysis for the bottling plant may be useful in establishing the weaknesses of the plant concerning safety. It could also help to enhance the safety performance of the bottling plant.

Step 6: Calculate the Evaluative Differences of i^{th} Alternative w.r.t other alternatives

Step 7: Calculate the Preference Functions, Pj (a,b)

$$P_j (a, b) = 0 \text{ if } Raj \leq Rbj :D(Ma - Mb)\leq 0 \quad (3)$$

$$P_j (a, b) = (R_{aj} - Rbj) \text{ if } Raj > Rbj : D(Ma-Mb)>0 \quad (4)$$

Step 8: Calculate the Aggregated Preference Function, π (a,b)

$$\pi (a,b) = n\sum j=1 [wjPj(a,b)]/n\sum j=1wj \quad (5)$$

Step 9: Determine the Leaving and the Entering Outranking Flows: $\phi^+(a)$, $\phi^-(a)$

$$= 1/(m-1)^m\sum_{b=1} \pi (a,b);\ a\neq b \text{ where m is the number of alternatives} \quad (6)$$

$$= 1/(m-1)^m\sum_{b=1} \pi (b,a);\ a\neq b \text{ where m is the number of alternatives} \quad (7)$$

3.6. NGT-DEMATEL-PROMETHEE Application

There are three accounts on which the NGT was developed. While some scholars declared the late 1960s, others mentioned 1971 and 1975 as the years of emergence of the NGT (Guruz & Tanriover, 2025;

Vardaman et al., 2025; Yepes-Cortés et al., 2025). Although there is controversy about when the structured technique was created, there is consensus that Andre Delbeq and Andrew Van de Ven proposed it (Black et al., 2025; Elwyn et al., 2025). They implemented the technique for organisational planning (Neto et al., 2025). Besides, there is an agreement that the NGT works on consensus planning where participants are assembled to discuss an issue that will be coordinated by a moderator (Aryansinghe et al., 2024; Abdul Aziz & Ali, 2025).

Summary: For the meeting, individuals write their ideas on a paper silently without discussion with any other member of the group. These papers are usually plain sheets that are used in schools or offices. Before graduating the ideas into final form agreed by the group, the generated ideas may not be as neatly, organized. Therefore, the individual has the liberty of using sheets of paper at his/here disposed. Besides, the clarification of ideas occurs when all participants have signaled that they have completed the generation of an idea and rank them. Thus, the results by each participant are discussed in the group. Voting usually occur when there is no consensus on the idea generated. However, it is rare to have consensus before voting due to the varying participant experience and understanding of the hazards, operations and accident potentials of activities with the bottling plant. After agreeing on an idea, it is thrown open to the participants to rank. Meanwhile, the coordinator has experience in the bottling plant process and may raise an objection to the suggestions of any member of the group, which is not consistent with his experience and knowledge of the process. However, the ultimate decision belongs to the participants of the meeting. Meanwhile the outcome of the NGT is the summary table, which is the prioritized relationship between pairs of sub-segments for all the five segments discussed in the present study. Moreover, the priority scale of the DEMATEL method is a standard framework used to judge the relationship between two parameters and is presented to the participants at the start of the session. Thus, the participants need not to worry themselveson land to generate the scale of importance used in DEMATEL methodical application. However, detailed explanation on what each value on the scale means is provided to the participants by the convener.

Specifically, the research is on the bottling process plant, focusing on the safety conformity in operations and other units within the plant. The segment is divided into five, namely warehouse (segment 1), manufacturing corridor (segment 2), quality assurance (segment 3), fleet workshop (segment 4) and contractors (residents and others) (segment 5). By considering all these segments, a possible observation is that they are disjointed and raises the question of how all these segments affect safety. However, to clarify this issue, consider quality control as a segment.It has two major safety aspects, namely food safety and human safety. Food safety regarding bottled drinks in the quality control (assurance) segment substantially influences safety conformity by ascertaining that beverage brands meet established quality standards in terms of taste, flavour, colour, odour, filling height of beverage in bottles and the absence of leakages for the carbonated drink. All these, which are food safety related, are not within the scope of the present study.Furthermore, to address human safety in the quality control section of the bottling plant, discussion centres on the physical and chemical hazards as well as ergonomic risks in the quality assurance segment of the bottling plant. In the quality assurance article of the plant, met floors around where titration of the liquid substances that constitutes the beverage to determine their unknown concentrations are physical hazards, which can produce falls, trips and trips. Similar hazards are found in other segments of the bottling plant. The holistic consideration of these hazards and their relationships within the bottling process plant is the main focus of the present study. In essence, quality control segment is related to the other segments such as the manufacturing corridor as the later also have hazards. The collection and analysis of all hazards in the bottling plant and their international ship are the principal elements of safety conformity presented in the present study.

4. RESULTS AND DISCUSSION

To extend the frontier of knowledge on safety conformity and the parametric interrelationship research in the bottling process plant, the NGT-DEMATEL-PROMETHEE method was used. The results of the NGT-DEMATEL method were used for further analysis with the PROMETHEE method. At present, what is known is that the parameters of the bottling process plant could be analysed for their interrelationships whereby the causal and effect parameters, which can influence others and be influenced, respectively are analysed. It was also possible, from recent research that in a bottling process plant, such as segmented into five, including the warehouse, manufacturing corridor, quality assurance, fleet of vehicles and contractors, the most important and segment from each of the segments could be determined. Also, the least important parameter could be identified to know where resources could be less channeled. The practical implication of assessing the interrelationships among parameters is that safety managers could identify which of the parameters the decision makers could depend more on the establish and tackle bottling process risks proactively which eventually reduces accidents and injuries, enhancing the well-being of the workers in various segments and tackling the productivity and efficiency of the safety evaluation and control process. At present, what is lacking is information useful to determine the potentials of the bottling process plant for excellence in safety performance. Understanding how to rank parameters in the bottling plant, for safety competitiveness and advantage across the industry is not known. How do we use safety information to prioritize opportunities learning on strategic alignment is missing. All these desirable's points to the need for a framework to rank alternatives within the safety conformity domain of the bottling process plant. From the above discussion, the need to introduce the PROMETHEE method as an appendage of the existing NGT-DEMATEL method is justified introducing the appendage will help the decision makes in the bottling process plant to assess and rank alternatives when multiple characteristics of the process is considered regarding the parameters analysed in the scenario. The PROMETHEE one of the methods in multicriteria decision making and is effectively deployed for reliable results in the present study.

4.1. Segment 1: Warehouse

Table 1 shows the results of the DEMATEL method obtained from previous research by Martins et al. (2025).

Table 1. *Results of DEMATEL method (Martins et al., 2025)*

	S_r	S_c	S_r+S_c	S_r-S_c	S_r-S_c
FDR	5.5513	6.3851	11.9364	-0.8338	-ve (Receiver/influenced by other criteria)
SOR	4.9346	4.5823	9.51683	0.3523	+ve (Cause/influence other criteria)
RER	4.8803	4.2532	9.13349	0.6271	+ve (Cause/influence other criteria)
SHR	0.8400	0.4069	1.24690	0.4332	+ve (Cause/influence other criteria)
HDR	5.7918	4.6960	10.4878	1.0958	+ve (Cause/influence other criteria)
HTM	5.5040	5.2598	10.7638	0.2442	+ve (Cause/influence other criteria)
CNR	2.3910	3.8954	6.28636	-1.5044	-ve (Receiver/influenced by other criteria)
EBR	2.3941	2.8085	5.20258	-0.4143	-ve (Receiver/influenced by other criteria)

The bottling process plant is divided into five segments and the first segment is considered here. Under segment 1, the following parameters should be considered: FDR, SOR, REP, SHR, HDR, HTM, CNR and EBR. Under the PROMETHEE method, step 1 is which entails the definition of alternatives, criteria or attributes. Notice that segment 1 is based on the warehouse and the mention acronyms above, such as FDR are regarded as alternatives for the present study. To further understand them, their definitions are as follows:

FDR	-	Forklift drivers
SOR	-	Sorters
RER	-	Rescuers
SHR	-	Sugarhandlers
HDR	-	Haulage drivers
HTM	-	Haulage truck mates
CNR	-	Chip neck removers
EBR	-	Extra bottle removers

For the criteria or the attributes consider Sr, which is the summation of values along the row, obtained from the DEMATEL results. However, for the present analysis, Sr will be denoted by A for computational ease. The Sc notation is also carried forward from the final results of the DEMATEL method, which means the summation of values along the column of the parameters studied earlier in the DEMATEEL method. This symbol Sc is denoted by B. However, the summation of Sr and Sc (i.e. (Sr + Sc), which sums up the two variables, the addition of row and column summation, is denoted as C. Notwithstanding (Sr – Sc), the subtraction of the column summation from the row summation, is denoted as D. The application of the next step involving decision evaluation matrix is as follows (Table 2): for the evaluation matrix, there is alternatives along the vertical axis while criteria or attributes are shown along the horizontal axis. Viewing this structure reveals the presence of 8 alternatives and 4 attributes, which gives an 8 x 4 evaluation matrix that is presented in Table 2. In summary, Table 2 originated from the output of Table 1, which originally was transformed from the field data on safety conformity operations in the bottling company. Table 2, which has columns A and D are the creation of the outputs of Table 1, namely Sr, Sc, (Sc + Sr), (Sc - Sr). This is a matrix, which could be interpreted from both the rows and columns.

Table 2. *Decision/Evaluation Matrix*

Alternative/Criterion	A	B	C	D
FDR	6	6	12	-1
SOR	5	5	10	0
RER	5	4	9	1
SHR	1	0	1	0
HDR	6	5	11	1
HTM	6	5	11	0
CNR	2	4	6	-2
EBR	2	3	5	0

Now, step 3 (Table 3) is applied which involves criteria weightage (i.e. to determine the weight of each criterion).

Table 3. *Criteria weight*

Weight	0.15	0.15	0.4	0.3
	BC	BC	BC	BC
Alternative/Criterion	A	B	C	D
FDR	6	6	12	-1
SOR	5	5	10	0
RER	5	4	9	1
SHR	1	0	1	0
HDR	6	5	11	1
HTM	6	5	11	0
CNR	2	4	6	-2
EBR	2	3	5	0

Key: Beneficial criterion – BC; Non-Beneficial criterion – NBC

Notice that the criterion involves A, B, C and D. Notice also that from the results of the results of the DEMATEL method, presents the importance of each criterion, which is the summation of rows and columns. The criterion with the highest summation of Sr and Sc is the most important while the least important criterion is assigned to the criterion with the lowest (Sr +Sc). Thus, (Sr + Sc), denoted by C in thus work has the highest weight, where the total weight is given as 1. It implies that attribute C is now given the weight of 0.4. Then, attribute D, which is the difference between Sr and Sc, in DEMATEL method shows the relationship of one criterion to another; if it has the positive value, it has the most influence on other criteria a. Also the one with the negative value has the least influence over other criteria, which means it has the least important weight. It will be given a value less than criteria C, and a value of 0.3 is given to it. Notice that Sr and Sc are of equal weight, where 0.3 is divided by 2 to yield 0.15. Therefore, the weightage of A is 0.15 and that of B is 0.15. Next, the results of step 4 are shown in Table 3. The implementation of step 4 is shown in Table 3, whose objective is to establish the beneficial and non-beneficial criteria. In the perspective of the present authors, a criterion is said to be beneficial if a high value of it is desired while it is not beneficial if a low value of it is the target.

Notice that the Sr and Sc, which are criteria A and B, which are summation of rows and columns, obtained from theDEMATEL results are beneficial while. (Sr + Sc), which is represented as C is also beneficial because the higher the chances of a criterion being the most important criterion on the better. However, for D, which is the difference between Sr and Sc, it means that any item is being influenced by other items. As such, it is said to be non-beneficial. Therefore, alternative D is the only one that is defined as the non – beneficial attribute while A, B and C are beneficial attributes. The implementation of step 5 is presented at the normalization stage of the evaluation matrix transformation process.

In this work, the idea of ranking alternatives in a safety conformity evaluation scheme is addressed. However, safety conformity is remarkably complex and challenging in the presence of widely expanding regulations, the requirement for workers participation in the process and the risks involved in the manufacturing process. Therefore at this stage of PROMETHEE implementation in the validation of the NGT-DEMATEL-PROMETHEE method, the idea of normalization comes into play to scale the original Sc, Sr, (Sr + Sc) and (Sr-Sc) variables to obtain dimensions workers quantities between 0 and 1, revealing the most important parameters and the fundamental relationships between parameters. This idea is similar to normalization utilized in fluid mechanics where the variables and equations are transformed into a dimensionless from by using a characteristics value to divide them. The benefits of normalizing in this work include complexity reduction, making it easier to obtain the ranks of the alternatives. Tables 4 to 6 show the results of normalization as applied to the NGT-DEMATEL results as inputs.

Table 4. *Evaluation Matrix- Identifying the Highest and Lowest Entries in the Columns*

	BC	BC	BC	NBC
Weightage (w)	0.15	0.15	0.4	0.3
ALT./CRI.	A	B	C	D
FDR	6	6	12	-1
SOR	5	5	10	0
RER	5	4	9	1
SHR	1	0	1	0
HDR	6	5	11	1
HTM	6	5	11	0
CNR	2	4	6	-2
EBR	2	3	5	0
Max(X_{ij}), Min(X_{ij})	6, 1	6, 0	12, 1	1, -2

Table 5. *Normalizing the Evaluation Matrix- Formula Application*

Weightage (w)	0.15	0.15	0.4	0.3
ALT./CRI.	A	B	C	D
FDR	(6-1)/(6-1)	(6-0)/(6-0)	(12-1)/(12-1)	(1-(-1))/(1-(-2))
SOR	(5-1)/(6-1)	(5-0)/(6-0)	(10-1)/(12-1)	(1-0)/(1-(-2))
RER	(5-1)/(6-1)	(4-0)/(6-0)	(9-1)/(12-1)	(1-1)/(1-(-2))
SHR	(1-1)/(6-1)	(0-0)/(6-0)	(1-1)/(12-1)	(1-0)/(1-(-2))
HDR	(6-1)/(6-1)	(5-0)/(6-0)	(11-1)/(12-1)	(1-1)/(1-(-2))
HTM	(6-1)/(6-1)	(5-0)/(6-0)	(11-1)/(12-1)	(1-0)/(1-(-2))
CNR	(2-1)/(6-1)	(4-0)/(6-0)	(6-1)/(12-1)	/(1-(-2))/(1-(-2))
EBR	(2-1)/(6-1)	(3-0)/(6-0)	(5-1)/(12-1)	(1-0)/(1-(-2))
Max(X_{ij}), Min(X_{ij})	6, 1	6, 0	12, 1	1, -2

Table 6. *Normalized Evaluation Matrix*

Weight (w)	0.15	0.15	0.4	0.3
ALT./CRI.	A	B	C	D
FDR	1	1	1	0.67
SOR	0.8	0.83	0.82	0.33
RER	0.8	0.67	0.73	0
SHR	0	0	0.00	0.33
HDR	1	0.83	0.91	0
HTM	1	0.83	0.91	0.33
CNR	0.2	0.67	0.45	1
EBR	0.2	0.5	0.36	0.33

To achieve this, Equations (1) and (2) are used for beneficial and non-beneficial alternatives, respectively. Tables 4 and 5 show the highest and lowest entries in a range of values. Under step 5, the highest entry in the column is identified. For column A, the highest entry is 6 and the lowest entry is 1. For the second, third and fourth columns, the highest entries are 6, 12 and 1, respectively, while the lowest entries are 0, 1 and -2 for B, C and D alternatives, respectively. The summarised results of Tables 4 and 5 are shown in Table 4c. In the last row of Table 7, the details described above are mentioned. These are stated as (6, 1) (6, 0), (12, 1) and (1, -2), respectively in the last row of Table 6. By further normalizing the evaluation matrix, Equations (1) and (2) are applied. For the beneficial alternatives, the first entry is 6, where the minimum entry in the row is subtracted (i.e. 1); the result is divided by the maximum entry, which is 6 and the minimum entry is 1. The logic of computation is applicable for all the other entries in rows A, B and C. However, for row D, which is a non-beneficial criterion in which the maximum in the row is 1, subtracted by the item itself, which is – 1 for the first row, (i.e.) (1 - (-1) (1 (1-)-2)). The same idea of computation is applicable to all entries in that column. Thus, evaluating this for all the entries brings out Tables 4 to 6 (i.e. normalized evaluation matrix).

Now, step 6 is implemented as shown in Table 7, which is to calculate the difference of ith alternative with respect to other alternatives. In this work, there are 8 alternatives where each of the alternatives will be evaluated with respect to each of the other 7 alternatives. Thus, the differences between FDR and SOR, FDR and RER, FDR and SHR, FDR and HDR, FDR and HTM, FDR and CNR, FDR and EBR. This will be treatment for all other 7 alternatives. This will yield Table 8, which is a 56 x 4 matrix.

Table 7. *Evaluative Differences of i^{th}Alternative w.r.t other Alternatives*

Weightage (w)	0.15	0.15	0.4	0.3
ALT./CRI.	A	B	C	D
D(FDR - SOR)	0.2	0.17	0.18	0.33
D(FDR - RER)	0.2	0.33	0.27	0.67
D(FDR - SHR)	1	1	1	0.33
D(FDR – HDR)	0	0.17	0.09	0.67
D(FDR – HTM)	0	0.17	0.09	0.33
D(FDR - CNR)	0.8	0.33	0.55	-0.33
D(FDR – FBR)	0.8	0.5	0.64	0.33
D(SOR - FDR)	-0.2	-0.17	-0.18	-0.33
D(SOR - RER)	0	0.17	0.09	0.33
D(SOR - SHR)	0.8	0.83	0.82	0
D(SOR – HDR)	-0.2	0	-0.09	0.33
D(SOR – HTM)	-0.2	0	-0.09	0
D(SOR - CNR)	0.6	0.17	0.36	-0.67
D(SOR – FBR)	0.6	0.33	0.45	0
D(RER - FDR)	-0.2	-0.33	-0.27	-0.67
D(RER - SOR)	0	-0.17	-0.09	-0.33
D(RER - SHR)	0.8	0.67	0.73	-0.33
D(RER – HDR)	-0.2	-0.17	-0.18	0
D(RER – HTM)	-0.2	-0.17	-0.18	-0.33
D(RER - CNR)	0.6	0	0.27	-1
D(RER – FBR)	0.6	0.17	0.36	-0.33
D(SHR - FDR)	-1	-1	-1	-0.33
D(SHR - SOR)	-0.8	-0.83	-0.82	0
D(SHR - RER)	-0.8	-0.67	-0.73	0.33
D(SHR – HDR)	-1	-0.83	-0.91	0.33
D(SHR – HTM)	-1	-0.83	-0.91	0.00
D(SHR - CNR)	-0.2	-0.67	-0.45	-0.67
D(SHR – FBR)	-0.2	-0.5	-0.36	0
D(HDR – FDR)	0	-0.17	-0.09	-0.67
D(HDR – SOR)	0.2	0	0.09	-0.33
D(HDR – RER)	0.2	0.17	0.18	0
D(HDR – SHR)	1	0.83	0.91	-0.33
D(HDR – HTM)	0	0	0	-0.33

***Table 7.** continued*

Weightage (w)	0.15	0.15	0.4	0.3
ALT./CRI.	A	B	C	D
D(HDR – CNR)	0.8	0.17	0.45	-1
D(HDR - FBR)	0.8	0.33	0.55	-0.33
D(HTM – FDR)	0	-0.17	-0.09	-0.33
D(HTM – SOR)	0.2	0	0.09	0
D(HTM – RER)	0.2	0.17	0.18	0.33
D(HTM – SHR)	1	0.83	0.91	0
D(HTM – HDR)	0	0	0	0.33
D(HTM – CNR)	0.8	0.17	0.45	-0.67
D(HTM – FBR)	0.8	0.33	0.55	0
D(CNR - FDR)	-0.8	-0.33	-0.55	0.33
D(CNR - SOR)	-0.6	-0.17	-0.36	0.67
D(CNR - RER)	-0.6	0	-0.27	1
D(CNR - SHR)	0.2	0.67	0.45	0.67
D(CNR – HDR)	-0.8	-0.17	-0.45	1
D(CNR – HTM)	-0.8	-0.17	-0.45	0.67
D(CNC - FBR)	0	0.17	0.09	0.67
D(FBR – FDR)	-0.8	-0.5	-0.64	-0.33
D(FBR – SOR)	-0.6	-0.33	-0.45	0
D(FBR – RER)	-0.6	-0.17	-0.36	0.33
D(FBR – SHR)	0.2	0.5	0.36	0
D(FBR - HDR)	-0.8	-0.33	-0.55	0.33
D(FBR – HTM)	-0.8	-0.33	-0.55	0
D(FBR - CNR)	0	-0.17	-0.09	-0.67

***Table 8.** Preference Funcitions, Pj (a,b)*

Weightage (w)	0.15	0.15	0.4	0.3
ALT./CRI.	A	B	C	D
D(FDR - SOR)	0.2	0.17	0.18	0.33
D(FDR - RER)	0.2	0.33	0.27	0.67
D(FDR - SHR)	1	1	1	0.33
D(FDR - HDR)	0	0.17	0.09	0.67
D(FDR - HTM)	0	0.17	0.09	0.33
D(FDR - CNR)	0.8	0.33	0.55	0
D(FDR - FBR)	0.8	0.5	0.64	0.33
D(SOR - FDR)	0	0	0	0
D(SOR - RER)	0	0.17	0.09	0.33
D(SOR - SHR)	0.8	0.83	0.82	0
D(SOR - HDR)	0	0	0	0.33
D(SOR - HTM)	0	0	0	0
D(SOR - CNR)	0.6	0.17	0.36	0
D(SOR - FBR)	0.6	0.33	0.45	0
D(RER - FDR)	0	0	0	0
D(RER - SOR)	0	0	0	0
D(RER - SHR)	0.8	0.67	0.73	0

Table 8. *continued*

Weightage (w)	0.15	0.15	0.4	0.3
ALT./CRI.	A	B	C	D
D(RER - HDR)	0	0	0	0
D(RER - HTM)	0	0	0	0
D(RER - CNR)	0.6	0	0.27	0
D(RER - FBR)	0.6	0.17	0.36	0
D(SHR - FDR)	0	0	0	0
D(SHR - SOR)	0	0	0	0
D(SHR - RER)	0	0	0	0.33
D(SHR - HDR)	0	0	0	0.33
D(SHR - HTM)	0	0	0	0
D(SHR - CNR)	0	0	0	0
D(SHR - FBR)	0	0	0	0
D(HDR - FDR)	0	0	0	0
D(HDR - SOR)	0.2	0	0.09	0
D(HDR - RER)	0.2	0.17	0.18	0
D(HDR - SHR)	1	0.83	0.91	0
D(HDR - HTM)	0	0	0	0
D(HDR - CNR)	0.8	0.17	0.45	0
D(HDR - FBR)	0.8	0.33	0.55	0
D(HTM - FDR)	0	0	0	0
D(HTM - SOR)	0.2	0	0.09	0
D(HTM - RER)	0.2	0.17	0.18	0.33
D(HTM - SHR)	1	0.83	0.91	0
D(HTM - HDR)	0	0	0	0.33
D(HTM - CNR)	0.8	0.17	0.45	0
D(HTM - FBR)	0.8	0.33	0.55	0
D(CNR - FDR)	0	0	0	0.33
D(CNR - SOR)	0	0	0	0.67
D(CNR - RER)	0	0	0	1
D(CNR - SHR)	0.2	0.67	0.45	0.67
D(CNR - HDR)	0	0	0	1
D(CNR - HTM)	0	0	0	0.67
D(CNC - FBR)	0	0.17	0.09	0.67
D(FBR - FDR)	0	0	0	0
D(FBR - SOR)	0	0	0	0
D(FBR - RER)	0	0	0	0.33
D(FBR - SHR)	0.2	0.5	0.36	0
D(FBR - HDR)	0	0	0	0.33
D(FBR - HTM)	0	0	0	0
D(FBR - CNR)	0	0	0	0

For instance, FDR minus SOR is computed with the knowledge of FOR as 1 and SOR as 0.830 for column A. For column A, FDR is 1, SOR is 0.80 for the column A, the result will be (1 – 0.8), which gives 0.2. Then, for column B, FDR is 1, SOR is 0.83, which is (1- 0.83), that gives 0.17.The same is done for the C and D columns. Then the difference between FDR and RER is used in computations as follows: For column

A, The FDR is 1 while RER is 0.2. Then (1 – 0.2), which is 0.8. For column B, FDR is 1, SOR is 0.82, while gives 1 – 0.82, i.e. 0.33. The same procedure is followed for all other items (columns) for all the six alternatives, which contains the evaluation. Then step 7 is implemented, which is the evaluation of the preference function. This function is expressed in Equations (3) and (4). The second function is also considered. From Table 6, the values that are less than 0 or equal to 0 will become 0. However, the values greater than 0 will be left unchanged. Thus, the preference function is presented in Table 9.

Table 9. *Aggregated Preference Function, п (a,b)- Formula Application*

Weightage (w)	0.15	0.15	0.4	0.3	п (a,b)
ALT./CRI.	A	B	C	D	
D(FDR - SOR)	0.03	0.03	0.03	0.10	0.18
D(FDR - RER)	0.03	0.05	0.04	0.20	0.32
D(FDR - SHR)	0.15	0.15	0.14	0.10	0.54
D(FDR – HDR)	0	0.03	0.01	0.20	0.24
D(FDR – HTM)	0	0.03	0.01	0.10	0.14
D(FDR - CNR)	0.12	0.05	0.08	0.00	0.25
D(FDR - FBR)	0.12	0.08	0.09	0.10	0.38
D(SOR - FDR)	0	0.00	0.00	0.00	0.00
D(SOR - RER)	0	0.03	0.01	0.10	0.14
D(SOR - SHR)	0.12	0.13	0.11	0.00	0.36
D(SOR – HDR)	0	0.00	0.00	0.10	0.10
D(SOR – HTM)	0	0.00	0.00	0.00	0.00
D(SOR - CNR)	0.09	0.03	0.05	0.00	0.17
D(SOR - FBR)	0.09	0.05	0.06	0.00	0.20
D(RER - FDR)	0	0.00	0.00	0.00	0.00
D(RER - SOR)	0	0.00	0.00	0.00	0.00
D(RER - SHR)	0.12	0.10	0.10	0.00	0.32
D(RER – HDR)	0	0.00	0.00	0.00	0.00
D(RER – HTM)	0	0.00	0.00	0.00	0.00
D(RER - CNR)	0.09	0.00	0.04	0.00	0.13
D(RER - FBR)	0.09	0.03	0.05	0.00	0.17
D(SHR - FDR)	0	0.00	0.00	0.00	0.00
D(SHR - SOR)	0	0.00	0.00	0.00	0.00
D(SHR - RER)	0	0.00	0.00	0.10	0.10
D(SHR – HDR)	0	0.00	0.00	0.10	0.10
D(SHR – HTM)	0	0.00	0.00	0.00	0.00
D(SHR - CNR)	0	0.00	0.00	0.00	0.00
D(SHR - FBR)	0	0.00	0.00	0.00	0.00
D(HDR – FDR)	0	0.00	0.00	0.00	0.00
D(HDR – SOR)	0.03	0.00	0.01	0.00	0.04
D(HDR – RER)	0.03	0.03	0.03	0.00	0.08
D(HDR – SHR)	0.15	0.13	0.13	0.00	0.40
D(HDR – HTM)	0	0.00	0.00	0.00	0.00
D(HDR – CNR)	0.12	0.03	0.06	0.00	0.21
D(HDR - FBR)	0.12	0.05	0.08	0.00	0.25

Table 9. *continued*

Weightage (w)	0.15	0.15	0.4	0.3	п (a,b)
ALT./CRI.	A	B	C	D	
D(HTM – FDR)	0	0.00	0.00	0.00	0.00
D(HTM – SOR)	0.03	0.00	0.01	0.00	0.04
D(HTM – RER)	0.03	0.03	0.03	0.10	0.18
D(HTM – SHR)	0.15	0.13	0.13	0.00	0.40
D(HTM – HDR)	0	0.00	0.00	0.10	0.10
D(HTM – CNR)	0.12	0.03	0.06	0.00	0.21
D(HTM – FBR)	0.12	0.05	0.08	0.00	0.25
D(CNR - FDR)	0	0.00	0.00	0.10	0.10
D(CNR - SOR)	0	0.00	0.00	0.20	0.20
D(CNR - RER)	0	0.00	0.00	0.30	0.30
D(CNR - SHR)	0.03	0.10	0.06	0.20	0.39
D(CNR – HDR)	0	0.00	0.00	0.30	0.30
D(CNR – HTM)	0	0.00	0.00	0.20	0.20
D(CNC - FBR)	0	0.03	0.01	0.20	0.24
D(FBR - FDR)	0	0.00	0.00	0.00	0.00
D(FBR - SOR)	0	0.00	0.00	0.00	0.00
D(FBR - RER)	0	0.00	0.00	0.10	0.10
D(FBR - SHR)	0.03	0.08	0.05	0.00	0.16
D(FBR - HDR)	0	0.00	0.00	0.10	0.10
D(FBR – HTM)	0	0.00	0.00	0.00	0.00
D(FBR - CNR)	0	0.00	0.00	0.00	0.00

Next, the aggregated preference function is calculated, which is given in Equation (4). In this case, the researcher will apply the weighted average for each column to multiply all the entries in the column. For column A, it will be 0.15 multiplied by every entry in that column. For column B, it is 0.15 multiplied by all entries in column B. For column C, it is 0.4 multiplied by all the entries in column C. For column D, it is 0.3 multiplied by all the entries in column D. Then for the summation of the weightage, it is 0.15, 0.15, 0.40, 0.30 added to give 1, which is used to divide every row. This is done after multiplying the weight by each of the entry Ps of P_j. The results for this are presented in the last column of Table 10.

Table 10. *Aggregated Preference Function, п (a,b)*

	FDR	SOR	RER	SHR	HDR	HTM	CNR	FBR
FDR	-	0.18	0.32	0.54	0.24	0.14	0.25	0.38
SOR	0	-	0.14	0.36	0.1	0	0.17	0.2
RER	0	0	-	0.32	0	0	0.13	0.17
SHR	0	0	0.1	-	0.1	0	0	0
HDR	0	0.04	0.08	0.4	-	0	0.21	0.25
HTM	0	0.04	0.18	0.4	0.1	-	0.21	0.25
CNR	0.1	0.2	0.3	0.39	0.3	0.2	-	0.24
FBR	0	0	0.1	0.16	0.1	0	0	-

Then Table 10 summarizes the aggregated preference function. For FDR against FDR, it means that the same alternative cannot be compared. But an alternative can be compared with another one. Therefore, the FDR against FDR will have "nil" instead of a value. SORagainst SOR, RER against RER, SHR against SHR, HDR against HDR, HTM against HTM, CNR against CNR and FBR against FBR will all be nill. The next phase of analysis is the implementation of PROMETHEE II. It starts with the computation of entering and leaving flows.

PROMETHEE II- Full Ranking

Step 1: Determine the Leaving and the Entering Outranking Flows: $\phi^+(a)$, $\phi^-(a)$

$= 1/(m-1)^m\sum_{b=1} \pi\ (a,b);\ a\neq b$ where m is the number of alternatives

$= 1/(m-1)^m\sum_{b=1} \pi\ (b,a);\ a\neq b$ where m is the number of alternatives

Entering and leaving and flows:

At this stage of computation, the principles of working for the leaving flow are introduced (Table 11). Here, some researchers call the leaving flow the positive outranking flow since it exhibits the level at which on option influences the other. In executing the PROMETHEE method, it is critical to establish how an alternative influences the other because decision makers that contribute to the evaluation of the process are enlightened on the comparative weaknesses of the options and their strength thereby indicating the efficient and superior options which can improve the decision making process. Moreover, the principles of the entering flow are also used here, which others refer to as the negative outranking flow due to its characteristic that it shows how the option is being influenced by others. Furthermore, investigating how a particular option may be dominated by other options is compelling to decision makers as the comparative strengths and weaknesses of options in the perspective of multicriteria analysis will be known.

Table 11. *Leaving and Entering Outranking Flows: $\phi^+(a)$, $\phi^-(a)$*

Aggregated preference function	FDR	SOR	RER	SHR	HDR	HTM	CNR	FBR	Leaving flow (ϕ^+)
FDR	-	0.18	0.32	0.54	0.24	0.14	0.25	0.38	0.29
SOR	0	-	0.14	0.36	0.1	0	0.17	0.2	0.14
RER	0	0	-	0.32	0	0	0.13	0.17	0.09
SHR	0	0	0.1	-	0.1	0	0	0	0.03
HDR	0	0.04	0.08	0.4	-	0	0.21	0.25	0.14
HTM	0	0.04	0.18	0.4	0.1	-	0.21	0.25	0.17
CNR	0.1	0.2	0.3	0.39	0.3	0.2	-	0.24	0.25
FBR	0	0	0.1	0.16	0.1	0	0	-	0.05
Entering Flow (ϕ^-)	0.01	0.07	0.17	0.37	0.13	0.05	0.14	0.21	

Table 12 shows the output of a computational exercise for the net outranking flow.

Table 12. *Net Outranking Flow for Each Alternative: $\phi(a) = \phi^+(a) - \phi^-(a)$*

Parameters	Leaving Flow $\phi^+(a)$	Entering Flow $\phi^-(a)$	$\phi(a)$
FDR	0.29	0.01	0.28
SOR	0.14	0.04	0.1
RER	0.09	0.13	-0.04
SHR	0.03	0.29	-0.26
HDR	0.14	0.1	0.04
HTM	0.17	0.03	0.14
CNR	0.23	0.1	0.13
FBR	0.05	0.16	-0.11

Arising from this knowledge is the ability of the decision maker to establish superior trade-offs which motivates to choose best options in the bottling process plant being examined. In general the leaving and entering flow analysis is classified under the group of dominance analysis and knowledge of the results will help to understand which options are outranked and what options outrank offers with the aim of obtaining more informed decisions in the bottling process. At the point, it is either PROMETHEE II or PROMETHEE I that is adopted. However, the research strategy here is to consider PROMETHEE II first, which entails full ranking to determine the leaving and outranking flows. Equations (6) and (7) are used for this purpose. Notice that the number of alternative used in this problem is 8. For segment 1, which is the warehouse? Notice that 8 - 1 is 7, which is used to divide the summation of each row and column. Thus, the columns will be added, and the sum is divided by 7. Also, the rows will be added and the summation will be divided by 7. When the column summation is divided by 7, it gives the entry flow while the row summation after being divided by 7 gives the leaving flow. The results are presented in Table 13, which is the first step of PROMETHEE II method for full ranking.

Table 13. *Ranking of all the Considered Alternatives Based on the Values of $\phi(a)$*

Parameters	Leaving Flow $\phi^+(a)$	Entering Flow $\phi^-(a)$	$\Phi(a)$	Ranking
FDR	0.29	0.01	0.28	1
SOR	0.14	0.04	0.1	4
RER	0.09	0.13	-0.04	6
SHR	0.03	0.29	-0.26	8
HDR	0.14	0.1	0.04	5
HTM	0.17	0.03	0.14	2
CNR	0.23	0.1	0.13	3
FBR	0.05	0.16	-0.11	7

However by applying step 2 of the method, Table 14 is obtained. Also see Tables 15 to 17.

Table 14. *PROMETHEE I- Partial Ranking-Determine the Leaving and the Entering Outranking Flows: $\phi^{+}(a)$, $\phi^{-}(a)$*

Aggregated Preference Function	FDR	SOR	RER	SHR	HDR	HTM	CNR	FBR	Leaving Flow (ϕ^{+})
FDR	-	0.18	0.32	0.54	0.24	0.14	0.25	0.38	2.05
SOR	0	-	0.14	0.36	0.1	0	0.17	0.2	0.97
RER	0	0	-	0.32	0	0	0.13	0.17	0.62
SHR	0	0	0.1	-	0.1	0	0	0	0.20
HDR	0	0.04	0.08	0.4	-	0	0.21	0.25	0.98
HTM	0	0.04	0.18	0.4	0.1	-	0.21	0.25	1.18
CNR	0.1	0.2	0.3	0.39	0.3	0.2	-	0.24	1.63
FBR	0	0	0.1	0.16	0.1	0	0	-	0.36
Entering Flow (ϕ^{-})	0.10	0.28	0.90	2.03	0.70	0.20	0.72	1.11	

Table 15. *Leaving/Entering Flows Table*

	Leaving Flow $\phi^{+}(a)$	Entering Flow $\phi^{-}(a)$
FDR	2.05	0.1
SOR	0.97	0.28
RER	0.62	0.9
SHR	0.2	2.03
HDR	0.98	0.7
HTM	1.18	0.2
CNR	1.63	0.72
FBR	0.36	1.11

Table 16. *Alternatives Comparison Scale*

Alternative a is preferred over/outranks alternative b, aPb if:
$\Phi+(a) > \phi^{+}(b)$ and $\phi^{-}(a) < \phi^{-}(b)$; OR
$\Phi+(a) > \phi^{+}(b)$ and $\phi^{-}(a) = \phi^{-}(b)$; OR
$\Phi+(a) = \phi^{+}(b)$ and $\phi^{-}(a) < \phi^{-}(b)$.
Indeference situation, aIb if:
$\Phi+(a) = \phi^{+}(b)$ and $\phi^{-}(a) = \phi^{-}(b)$
Incomparable situation, aRb if:
$\Phi+(a) > \phi^{+}(b)$ and $\phi^{-}(a) > \phi^{-}(b)$; OR
$\Phi+(a) < \phi^{+}(b)$ and $\phi^{-}(a) < \phi^{-}(b)$.

Table 17. *Alternatives Comparison Table*

(a)	Result	(b)
FDR	P	SOR
FDR	P	RER
FDR	P	SHR
FDR	P	HDR
FDR	P	HTM
FDR	P	CNR
FDR	P	FBR
SOR	P	RER
SOR	P	SHR
SOR	R	HDR
SOR	P^{-1}	HTM
SOR	R	CNR
SOR	P	FBR
RER	P	SHR
RER	P^{-1}	HDR
RER	P^{-1}	HTM
RER	P^{-1}	CNR
RER	P	FBR
SHR	P^{-1}	HDR
SHR	P^{-1}	HTM
SHR	P^{-1}	CNR
SHR	P^{-1}	FBR
HDR	P^{-1}	HTM
HDR	R	CNR
HDR	P	FBR
HTM	R	CNR
HTM	P	FBR
CNR	R	FBR

This calculates the net outranking flow for each alternative. This is based on the value for the difference between the leaving flow and the entry flow. This is shown in the last column of Table 15. Now, implementing step 3, the ranking of the entire considered alternative based on the values of the net outranking flow. The highest value would be ranked first and the least value would be given the least rank, rank 8. This is because there are eight alternatives in Table 16, which are repeated in the last column of Table 17. Thus, for the first row, which is FDR, the value of the net outranking is 0.28 and it is the highest, which justifies its ranking as the first. This is followed by 0.14, 0.13, 0.10, 0.04, - 0.04, - 0.11 and – 0.26 for HTM, CNR, SOR, HDR, RER, FDR, and SHR, for ranks 2, 3, 4, 5, 6, 7 and 8, respectively. These ranks denote the importance of each alternative. This analysis is for PROMETHEE II.

Now, for PROMETHEE I, the results gives partial ranking and the idea to compare every alternative with others. For instance are of the eight alternatives can be compared with the other seven alternatives. Thus, the first step under PROMETHEE I was implemented as the leaving and entering outranking flows were determined. The difference between PROMETHEE II and PROMETHEE I in determining the leaving and entering outranking flows is that instead of dividing the sum of the row and the sum of the column by the number of alternatives less 1, which is 7, the division is ignored but only the sum is considered. Thus, the rows are summed up to have the leaving flow and every column summed up to have the entering flow. This is presented in Table 13. Table 14 shows the leaving and entering flow table. Thus, leaving and entering flows of the parameters are as follows: ForFDR, it is 2.05 and 0.10, SOR gives 0.97 and 0.28, RER yields 0.62 and 0.9, SHR gives 0.2 and 2.03, HDR yields 0.98 and 0.7, HTM gives 1.18 and 0.2 while CNR yields 1.62 and 0.72 for leaving and entering flows, respectively. The next phase of computation is the alternative comparative scale, which presents the condition for determining the outcome of alternative comparisons. Some of the eight alternatives for segments 1 are compared based on the mentioned comparison scaled above. The results are presented in Table 15. Considering FDR compared with SOR, the leaving flow for FDR is 2.05 and the leaving flow for SOR is 0.90. It means that the leaving flow for FDR is greater than that of SOR. On this basis FDR is preferred over SOR. In other words, FDR outranks SOR. However, there is need to look at the entering flows whether the condition also holds. The entering flow for FDR is 0.1 while for SOR it is 0.2, which shows that the entering flow of FDR is lower than the entering flow of SOR. It means FDR is preferred to SOR. Therefore it can be concluded that FDR is preferred over SOR. This is what is shown in the first row. Now, comparing SOR with RER, SOR has the leaving flow of 0.97 while RER has a leaving flow of 0.62. From this data, SOR is preferred over RER based on the value of the leaving flow. However, before this conclusion is made, their entering flows are compared. The entry flow for FDR is 0.1. the entry flow for SOR is 0.28, which shows that the entry flow of FDR is lower than the entry flow of SOR. This implies that FDR outranks SOR. Thus, it could be asserted that FDR is preferred to SOR. This is displayed in the first row. Now, comparing SOR and SOR has a leaving flow of 0.97 while RER has a leaving flow of 0.62. From this information, SOR is preferred to RER since the leaving flow of the earlier is greater than that of the latter. Notwithstanding, prior to concluding on this issue, the entry flows of the two parameters are considered. The entry flow of SOR is 0.28 while that of RER is 0.93. As the entry flow of SOR is less than that of RER, given the entry flow values of the two parameters, SOR is preferred to RER. Thus it can be said that SOR RER. This viewpoint is applicable to all other parametric comparison shown in the table, including RER against SHR, HTR against SHR, HTM against HTR, TMR against SER and SDR against SHR. However, in the case of HTM compared with TMR, the leaving flow for HTM is 1.18 and the leaving flow for TMR is 1.67. On the basis of only the leaving flow, TMR is preferred to HTM because it has higher leaving flow. Notwithstanding, before the conclusion on these parameters, their entry of lows are compared. The entry flow of HTM is 0.2 and that of CNR is 0.02, which means that the entry flow of CNR is also higher than the entry flow of HTM. On the basis of entry flow, HTM is preferred over TMR. Soon the basis of leaving flow, TMR outranks HTM. On the basis of entry flow, HTM outranks TMR, in which case, the two parameters are incomparable and this denoted by j. This means that HTM j CNR.

The results of the alternative comparison table are presented in Table 16. Next is the result interpretation. Here, the results of PROMETHEE I are compared with those of PROMETHEE II. Considering the 8 alternatives in segment 1, namely FDR, SOR, RER, SHR, HDR, HTM, CNR and FBR, the number of cases where FDR outranks the comparison is in cases. There is also no case where the comparison outranks FDR. So, 0 R 0 i, is the expression of this interpretation. For P, it is posited d. However, for p e bar, it is negative. This means that where there is pe bar, the comparable outranks what is compared with. For R, it is also negative, which means comparison. For i, it means indifference. A is indifference and also negative. Thus, for SOR, P 3 and P inverse 2, which is -2, R is 2, which is -3. The aggregate of this is -1. The aggregate for FDR is 7. The aggregate for SOR is – 1. For RER, P is 2, p inverse is 5, R is 0, i is 0. The aggregate of this is- 3. Then for SHR, p is 0, p inverse is – 7, R is 0, i is 0. So it gives an aggregate of -7. For SHR, p is 3, p inverse is -2, R is – 2 and the aggregate of this is -1. For HTM, p is 5, p inverse is -1, R is – 1, i is 0. The aggregate of this is 3. For CNR, p is 2, p inverse is -1, R is-4, i is 0. The aggregate of this gives – 3. For FBR, p is 1, p inverse is – 5, R is-1, i is 0. The aggregate of this is -5. The aggregate point is shown in column 6, which shows FDR as 7, SOR as -1, RER as -3, SHR as -7, HDR is -1, HTM is 3, CNR is 5 and FBR is 5. The next issue is to look at the magnitudes of these values, rank from first to the last as the highest to the lowest magnitude of values. The FDR has the highest aggregate point of 7, which is given rank 1. This is followed by HTM which 3 aggregate points, which is given rank 2. Then SOR follows with an aggregate point of -1, then HDR which have the same aggregate point of -1. Both SOR and HDR have rank 3. This eliminates having an entry as rank 4. Following this is the RER, which has -3 as the aggregate point and it is given rank 5. Notice that RER and CNR have the same aggregate point of -3. Thus CNR also assumes rank 5. This eliminates rank 6 for any of the parameters in segment 1. Now, there is rank 7, which is FBR that has an aggregate point of -5. The last rank of 8 goes to SHR, which has an aggregate point of -7. Thus, there exists the rank for parameters evaluated with PROMETHEE I, as shown above. These ranks could be compared with the ranks of PROMETHEE II. PROMETHEE II ranking has the following: FDR is 1, which in this case shows that PROMETHEE II and PROMETHEE I are the same. The same results result is obtained where FDR and RER give I. Henceforth, PROMETHEE I is shortened as PI while PROMETHEE II is shortened as P II. It means that there is the same result for PI and PII, where they both rank HTM as the alternative for rank 2. Rank 3 for PI has two alternatives that the ranks are 3, while for P II, has only one alternative which is CNR ranked 3. However, PI ranked SOR and HDR as rank 3. It then ranked RER and CNR as rank 5. What does this means? It means that for P II, it is a fullranking and it was able to identify the characteristics of the parameters no matter indifferent the relationship between the two alternatives is. However, since PI is a partial ranking, if two alternatives have aggregate points close, then PI lacks the capacity to differentiate and rank them accordingly. In this situation, such alternatives will be attached with the same ranks. This is the case in SOR and HDR. It also exists in RER and TMR. They have the same rank for FDR (i.e. rank 7), which means PI and P II ranks FDR as rank 7. Also they have the same rank for SHR, which is rank 8. Both of them rank SHR as rank 8. So these four parameters have their figures paired such that PI ranks them as PII. The parameters are FDR, HTM, SOR and SHR. However, four other parameters (alternatives) i.e. SOR, and HDR have their members from their former group. It implies that PROMETHEE II was unable to differentiate their ranking. Notwithstanding the full ranking, which is P II was able to identify it, ranking SOR, as 4, HDR as 5. The same thing applies to RER and TMR, which P I was unable to rank differently, which PII ranked RER as 3 and TMR as 3 (Table 18). The above analysis is for segment 1 of the bottling process plant, which is the warehouse section of the plant. Analysis of segment 2: manufacturing corridor of the bottling plant.

Table 18. *Results Interpretation*

Alternatives	P	P^{-1}	R	I	Aggregate Point	Ranking (PI)	Ranking (PII)
FDR	7	0	0	0	7	1	1
SOR	3	-2	-2	0	-1	3	4
RER	2	-5	0	0	-3	5	6
SHR	0	-7	0	0	-7	8	8
HDR	3	-2	-2	0	-1	3	5
HTM	5	-1	-1	0	3	2	2
CNR	2	-1	-4	0	-3	5	3
FBR	1	-5	-1	0	-5	7	7

4.2. Segments 2, 3, 4 and 5

The results of NGT-DEMATEL-PROMETHEE method for segments 2, 3, 4 and 5 are presented in Tables 19 to 22.

Table 19. *Results Interpretation (segment 2)*

Alternatives	P	P^{-1}	R	I	Aggregate Point	Ranking (PI)	Ranking (PII)
SGR	6	0	0	0	6	1	1
FOR	5	-1	0	0	4	2	2
PDR	0	-4	-2	0	-6	6	6
WOR	0	-5	-1	0	-6	6	7
CNR	1	-2	-3	0	-4	5	4
TOU	2	-3	-1	0	-2	4	5
PUO	3	-2	-1	0	0	3	3

Table 20. *Results Interpretation (segment 3)*

Alternatives	P	P^{-1}	R	I	Aggregate Point	Ranking (PI)	Ranking (PII)
SLR	0	-5	0	0	-5	6	6
SMR	5	0	0	0	5	1	1
LTN	3	-2	0	0	1	3	3
WTN	4	-1	0	0	3	2	2
ETN	2	-3	0	0	-1	4	4
OTR	2	-3	0	0	-1	5	5

Table 21. *Results Interpretation (segment 4)*

Alternatives	P	P^{-1}	R	I	Aggregate Point	Ranking (PI)	Ranking (PII)
FTN	0	-2	0	0	-2	3	3
WLR	2	0	0	0	2	1	1
BCT	1	-1	0	0	0	2	2

Table 22. *Results Interpretation (segment 5)*

Alternatives	P	P^{-1}	R	I	Aggregate Point	Ranking (PI)	Ranking (PII)
STY	4	0	0	0	4	1	1
KTN	1	-1	-2	0	-2	3	3
CTR	0	-4	0	0	-4	5	5
CSS	2	-1	-1	0	0	2	2
CCS	1	-2	-1	0	-2	3	4

4.3. Novelty of the Work

In this work, the significant safety conformity evaluation problem is addressed to avoid serious human and economic consequences from failure to comply to safety regulations. Thus, the novelty or this work could be defined as follows. The work is the first to attempt a tripartite combination of NGT, DEMATEL and PROMETHEE to concurrently prioritize safety conformity parameters through idea generation, weight assignment to each criteria and out lining criterions preference function coupled with examining associations of a parameter to the other for the process plants. In this work, a novel element is that the potential of NGT-DEMATEL-PROMETHEE method as an hybrid group decision and multicriteria method which eliminates substantial data gathering and cost while achieving robust decision making for the beverage plant is demonstrated.

5. CONCLUSION

This study effectively establishes the ranks of the bottling parameters in a safety conformity evaluation framework, using the NGT-DEMATEL-PROMETHEE method. The PROMETHEE method was introduced to the established NGT-DEMATEL method to systematically establish ranks from the interactive results of the parameters in a cause and effect scheme thereby explaining the interactions among parameters and concurrently ranking them in the context of a group decision making framework. Findings from the operational analysis in the process plant showed the various degrees of importance of the parameters within all the five segments studied. The outcomes aligns with a previous study on NGT-DEMATEL method investigation which reports that certain parameters are of high ranks while others are not. Moreover, this research demonstrates that the decision maker’s preferences may be achieved in an integrated framework that combines a complex interactions seeking model with one that rank parameters according to some desired framework. Insight from this study will provide a reliable approach to enhance how parameters could be evaluated and compared in the safety domain.

Furthermore, the conclusions from the findings are as follows:

1. With five segments analysed, forklift drivers, sighters, syrup mixers, welders, security emerged as superior parameters influencing and outperforming other parameters in segments warehouse manufacturing corridors, quality assurance, fleet workshops and contractors, respectively.

2. The use of NGT-DEMATEL-PROMETHEE method to evaluate the ranks of safety conformity parameters in a bottling process plant represents an efficient approach to mitigating risks in the plant. The method can reduce the requirement for a wide ranging data collection at the bottling floor, offering a safe approach and a safer work environment with minimum risks on the workers.

3. This is the first time that NGT, DEMATEL and PROMETHEE methods are combined to develop multicriteria decision for safety conformity in bottling process plant.

4. The ranking order of options according to the PROMETHEE I and PROMETHEE II coincides with 5/8, 3/7, 4/6. 3/3 and 4/5 options, equivalent to 62.5%, 42.86 %, 66.67%, 100 % and 80 %for warehouse, manufacturing corridor, quality assurance, fleet workshop and contractors, respectively.

5. The NGT-DEMATEL-PROMETHEE method shows an impressive association with the DEMATEL method of a coefficient of determination (R^2) of 1, indicating its high reliability and effectiveness in predicting the ranks of parameters of the safety conformity process. A polynomial of the 8th degree was captured as the most appropriate predictive model for the situation.

6. Implementing NGT-DEMATEL-PROMETHEE method assists the bottling plant in making better decisions by looking at the diverse parameters of the bottling process.

7. Among the five segments of warehouse, manufacturing corridor, quality assurance, fleet workshop and contractors, the segment called warehouse (segment 1) is the best with forklift driver (FDR) leading in aggregate points. Forklift drivers can influence all other parameters in the warehouse more than any other parameter in the other four groups could influence others.

8. Other results: For segment 1 (warehouse), the worst parameter is EBR (Extra bottle removers) with -5 as the aggregate points. In segment 2, (manufacturing corridor), SGR (sighters) is the best parameter with an aggregate of 6 points while WOR (chip neck removed is the worst parameter with an aggregate of -6 points. For segment 3, SMR (syrup mixers) is the best, which has an aggregate of 5 points while SLR (sugar lifter) is the worst with an aggregate of – 5 points. In segment 4, WLR (welders) is the best with an aggregate of 2 points while. FTN (forklift technicians) is the worst, having an aggregate of -2 points. In segment 5, STY (security) is the best with an aggregate of 4 points while CTR (contractor 1 – Tailors) is the worst which an aggregate of -4 points.

9. For non-production based best performers, security, as a parameter is the main parameter that could influence others segment 2 (manufacturing corridor).

By comparing the NGT-DEMATEL-PROMETHEE method it to the existing baseline method of DEMATEL, results show that the proposed method performs well regarding the outcome values, and generalization capability. Thus the NGT-DEMATEL-PROMETHEE method has the capability to perform well on new data such as those on foundry which is high risk industry that produce metal castings. Moreover, the proposed approach is methodologically innovative as it develops and implements a new research method, utilizing groups' potentials to transform bottling process safety conformity ever in with paucity of data. Besides new analytical safety conformity metrics are introduced while also aligning with contemporary international safety standard, ISO 45001,which compels bottling plants to align with a robust occupational health and safety management system.

Differences between the proposed method and existing works:

The method called NGT-DEMATEL-PROMETHEE is a completely new with major differences from other methods used in parametric association and selection studies in the following ways:

- By deploying PROMETHEE method in the integrated method, the proposed method provides a more intricate method to ranking safety conformity parameters in preference to the traditional ranking approaches. Although the traditional ranking approaches. Although the traditional ranking method order items in the best to worst perspective, the two unique PROMETHEE methods; namely the PROMETHEEI and PROMETHEE II demonstrate both partial and complete ranking of safety conformity alternatives, yielding a more detailed and accurate ranking, than traditional ranking.

- Though the introduction of DEMATEL method in the integrated proposed method, a systematic method to safety conformity practice is established. This provides insights in the analysisand management of complex associations between the parameters influencing safety conformity. Through this, crucial elements impacting safety conformity are recognized. Moreover, the cause and effect associations among parameters could be visualized, leading to enhanced strategy formulation for improved safety conformity in the bottling process plant.

- By using the NGT to develop the proposed method, the NGT- DEMATEL-PROMETHEE method brings improved safety practices to the bottling process plant by promoting various viewpoints, equal contribution of members and a structural alliance among them. Moreso, NGT is impactful as it opens up hesitant workers that are unwilling to share their ideas on risk mitigation and safety conformity in the plant because of their status in the plant and dissatisfaction with the system possibly concerning workers welfare.

- Also, the NGT projects positive impact on safety conformity in bottling plants, aiding through collaboration with workers in structured meetings, the establishment of safety hazards and creation of priorities to parameters very critical to safety conformity.

Moreover, future work could include integration of the NGT-DEMATEL framework with other multicriteria method such as COPRAS, and ELECTRE among others. Besides, the fussy approach may be integrated with the NGT-DEMATEL method with a great potential in reducing uncertainty and imprecision in safety conformity evaluation parameters during measurements. In addition to future studies, a safety app for safety conformity could be developed. In particularly, for the five segments analyzed in this work, safety app designed to accurately and efficiently perform safety conformity evaluations could be developed. He is how it could work. The user could open the app on a mobile device or on the web, enter the description of the segment. This could be any of the following: warehouse, manufacturing corridor, quality assurance, fleet of vehicles or contractors. Then the relevant context could also be described. Then the safety conformity may be generated in seconds with great precious. In addition, features such as the following could be integrated into the work compliance tracking, communication media, safety training modules and emergency reporting. The app could leverage on various data within the bottling plant, including training records, location tracking, employee feedback, sensor data, incident reports audit results and inspection data. There is used to design the mobile and web versions of the safety app. This app should allow decision makers to create and update safety conformity frameworks across multiple factories and work centres in manufacturing such as high risk industries in foundries, sawmills and plastic manufacturing. These industries have elevated thresholds of potential for substantial losses and uncertainty. A natural language chat box interface, which resembles chat GPT may be developed for the creation and update of the safety conformity app. It is envisaged that the app; facilitates receiving approvals and to store the safety conformity indices in a control document library. It is possible to use it for training and tool box talks.

AUTHOR CONTRIBUTIONS

Conceptualization, SAM and SAO methodology, SAM, SAO, SBA; fieldwork, SAM, SAO; title, SAM, SAO; validation, JR, SJ; formal analysis, SAM, SAO, SBA; research, SAM, SAO, SBA; manuscript-original draft, SAM, SAO, SBA; manuscript-review and editing, JR, SJ; supervision, SAO, JIO; project management, SAO, JIO; All authors have read and legally accepted the final version of the article published in the journal. All human authors have read and legally accepted the final version under the CC BY-SA 4.0 framework.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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