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EVALUATION OF THE SUSTAINABILITY OF PARTY LOGISTICS SERVICE PROVIDERS WITH FAILURE MODES AND EFFECTS ANALYSIS METHOD: APPLICATION IN A COMPANY

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ABSTRACT

Purpose- The purpose of this research is to increase customer satisfaction and business performance in the sector to eliminate failure situations of the processing phases of the departments of the business and to develop the quality of the system. The objective of this research is to enhance customer satisfaction and business performance by addressing and eliminating failure situations in the processing phases of the business departments and improving the quality of the system. To achieve this, the study focuses on evaluating third-party and fourth-party logistics service providers in the context of sustainability. While there are existing approaches to evaluate party logistics under general headings, there is a lack of specific studies focusing on companies operating in a single field. Therefore, this study aims to fill that gap by examining the business evaluation criteria of third-party and fourth-party logistics service providers for a white goods company in Turkey.
Methodology- During the research, the concept of third-party logistics has gained attention within the scope of sustainability, the competition among organizations providing this service has become more intense, as have customer expectations. The research utilizes Failure Mode and Effects Analysis (FMEA) and Pareto Analysis (PA) to assess the sustainability of the supply chain and batch logistics for the company.
Findings- As a result of the research, the findings in the direction of quality improvement-development within the scope of the service provided by the business are presented. The initial phase of process enhancement for logistics operations begins with the FMEA results. Development initiatives may begin if improvement initiatives are maintained. Development activities and resources ought to be distributed in accordance with this level of priority with regard to the first work that has to be performed to enhance the process.
Conclusion- All risk considerations might not be realized inside a particular process since there are only a limited number of possibilities to be assigned for enhancement prosperity. By conducting risk prevention studies in accordance with the priorities that will be decided upon each period, it is intended to produce continuous improvement. Overall, while it may not be possible to address every risk, prioritizing risks and conducting risk prevention studies can help organizations achieve continuous improvement and increase their chances of success.

Keywords: Failure Mode and Effects Analysis (FMEA), Pareto Analysis (PA), party logistics, quality, supply chain, sustainability.
JEL Codes: 030, N01, L15, L21, L84

1. INTRODUCTION

Sustainability is defined as maintaining the balance and continuity of a system, such as an ecosystem or supply chain, while avoiding disruptions, excessive strain on resources, and waste. It involves ensuring the long-term viability and well-being of both the natural environment and human societies. Sustainability encompasses the concept of balancing ecological, economic, and social factors to ensure the long-term well-being of our planet and future generations. It recognizes the interconnectedness of environmental, economic, and social systems and aims to minimize negative impacts while maximizing positive outcomes. Responsible resource management is a crucial aspect of sustainability. It involves using resources efficiently, minimizing waste and pollution, and promoting renewable and sustainable alternatives.

To achieve sustainability, it is important to involve stakeholders and communities in decision-making processes. Participatory approaches allow for diverse perspectives to be heard, knowledge to be shared, and solutions to be collectively developed. This helps to create a sense of ownership, inclusivity, and transparency in the pursuit of sustainable practices. It involves finding a harmonious equilibrium between the environmental limits of the planet, the economic needs of society, and the values and aspirations of communities. In order to determine the best strategies for achieving sustainability, researchers advocate for participatory methods that involve community engagement. This means involving various stakeholders in the decision-making process to analyze choices, assess trade-offs, and make informed decisions that align with their values and aspirations. By involving the community, it becomes possible to tailor restoration efforts and sustainable practices to the specific needs and conditions of each location. Researchers believe that participatory methods of community engagement, in which various individuals analyze the choices and trade-offs facing their community, are the best ways to determine how restoration should really be carried out in each specific site or condition. Overall, sustainability requires a holistic and integrated approach that considers the interconnectedness of environmental, economic, and social factors. It strives for a balance that enables current and future generations to thrive while preserving the integrity of our natural systems and promoting social well-being (Munasinghe, 1993; Hueting and Reijnders, 1998; Sezgin and Kalaman, 2008).

There are two components to the idea of sustainable development. These components are discussed in the first section, and the ability of the environment to satisfy both present-day wants and demands in the second. The use of technology has its limitations. To put it another way, sustainable advancement refers to a strategy which ensures the wise management of natural supplies and leaves a natural, physical, and social surroundings deserving of future generations in a way that will support ongoing economic advancement through preserving human wellness and the natural equilibrium. Such a strategy necessitates those environmental issues be managed concurrently with global economic and social strategies at every level of growth. When it is taken into account for society, sustainable development becomes more significant in the context of social, economic, cultural in nature and natural assets (Munasinghe, 1993; Dulupçu, 2000; Altunbaş, 2003). A sustainable population, contraception, health care, and education are all guaranteed by sustainable development. The centralized government, regional governments, and departments all benefit from this idea's development of relationships. It involves everyone in society in the decision-making procedure so that they may help create ethical and moral standards which ensure sustainable growth and take into account how the environment and the economy are interdependent. It encourages multidisciplinary research and helps students comprehend natural systems via science and education. Resource distribution and population are both important factors in the pursuit of sustainable development. It needs to be compatible with demographic changes (Munasinghe, 1993; Hamilton, 1995; Dulupçu, 2000; Dollar and Kraay, 2001; Redclift, 2005; Hepburn, 2006).

Terms like "logistics outsourcing," "logistics alliances," "third party logistics," "contract logistics," and "contract distribution" have recently been utilized interchangeably to refer to the business practice of contracting-out all or a portion of logistics operations that were formerly handled internally. A company or a person that requires cargo, freight, products, commodities, or merchandise moved from point A to point B is known as a first-party logistics provider (1PL). Institutions like government organizations, as well as people or families migrating, might also fall under this category. *First party logistics providers are those who arrange for the transportation of products from their origin to their final destination. *An asset-based carrier known as a second-party logistics provider (2PL) really controls the transportation equipment. Shipping firms that own, lease, or chartered their vessels, airlines that own, lease, or charter their planes, and trucking businesses that own or lease their automobiles are examples of conventional 2PLs. * Third-Party Logistics (3PL) facilitates supply chain connections between buyers and providers. The top automakers in the world today are taking use of 3PL, and their demand for this idea is expanding daily. 3PL is the practice of outsourcing most or all of a company's logistical functions to a specialist business. A company known as a third-party logistics provider offers consumers a variety of logistical services. These services are ideally merged or "bundled" by the supplier. These businesses streamline the flow of components and supplies from suppliers to manufacturers as well as completed goods from manufacturers to wholesalers and retailers. Transportation, storage, cross-docking, inventory management, packing, and shipping are just a few of the services they offer (Holweg and Miemczyk, 2003; Reeves et al., 2010; Ko et al., 2010; Jayaram and Tan, 2010; Rajesh et al., 2011; Ho et al., 2015). Numerous environmental problems have an impact on logistics, some of which are outside of its purview and others which are. The aspects of logistics that are all impacted by the environment are as follows: Controlling transportation, fuel economy, emissions, warehousing, office and administrative functions, and manufacturing (Remmel, 1991; Prendergast, 1995). Due to the importance of following lean principles, distribution and logistics may appear crucial to the company's continuing the competitive edge. As a result, businesses might either improve and supply these goods and services locally, hire a third-party logistics company, or adopt a combination approach in which some functions are transferred and others are supplied internally. In particular, for both dynamic forward flows and reverse flows, 3PLs could supply dependable services to meet client requests thanks to advanced information systems and specialized equipment. Due to 3DayCar, distribution of the finished car costs 28% of the entire cost of the sold vehicle, while inbound logistics costs 1%, outbound logistics costs 1.2% (Holweg and Miemczyk, 2003; Ko et al., 2010; Reeves et al., 2010; Rajesh et al., 2011).

The scope of this research focuses on evaluating third-party (3PL) and fourth-party (4PL) logistics service providers in the white goods sector, specifically for sustainability. The evaluation criteria for these logistics companies are determined based on existing studies, and the Failure Modes and Effects Analysis (FMEA) method and Pareto Anlysis (PA) are applied to the supply chain of XYZ white goods manufacturing business in Turkey. . FMEA is a method used to identify potential failures, their causes, and their effects, allowing for preventive measures to be implemented. PA, on the other hand, helps prioritize issues based on their significance and impact. By applying these analytical techniques, the study aims to identify areas of improvement due to criteria of sustainability the supply chain and batch logistics processes, enhance the sustainability of operations, and ultimately improve customer satisfaction and business performance. These criteria are established based on existing studies and are aligned with the goal of sustainability. When choosing a 3PL or 4PL supplier, white goods firms in Turkey should consider a variety of business assessment criteria that were established by the authors of the research. it has become more important for businesses to meet customer needs accurately and to be a leader in the sector for this issue. By conducting this issue and this research, the aim is to assess the performance and sustainability of 3PL companies serving the white goods manufacturing industry. This evaluation helps identify the business's position in the market and its strengths and weaknesses compared to competitors. It also sets clear objectives for improving operations and maintaining a strong market presence. To enhance its market exposure and competitiveness, the XYZ Company needs to address areas where it falls short compared to other logistics services. This may involve strengthening technical requirements, such as technology infrastructure and physical equipment. The FMEA analysis serves as a practical roadmap for the company, providing guidance for operational and strategic goals. It is worth noting that with appropriate adjustments, the findings and methodologies of this research can potentially be applied to various industries or businesses beyond the white goods sector. The insights gained from evaluating logistics service providers and utilizing FMEA can be adapted to suit different contexts, helping businesses enhance their sustainability and operational performance.

The flow of the paper is organized as; Section 2 presents information about research methodology, the importance of Party Logistics Service Providers for the development of the industry and the company as a significant scientific scope so as to the future research in development organization and process for prioritization of the identified product recovering option and drivers In addition, this second section elaborates and comprises the subjects about 3PL Market in Competitive Marketplace. Section 3 and Section 4 present Failure Mode and Effects Analysis (FMEA) and Pareto Analysis model approach. These sections highlight and utilize Failure Mode and Effects Analysis (FMEA) and Pareto Analysis (PA) to assess the sustainability of the supply chain and batch logistics for a company in white goods sector. Companies may improve their operational performance and sustainability by applying the lessons learned from analyzing Failure Mode and Effects Analysis (FMEA) and assessing logistics service providers (LSPs) to various scenarios. Companies may increase their sustainability and efficiency in operation, lower their risk of expensive interruptions, and obtain a competitive edge by exploiting the insights acquired from reviewing LSPs and implementing FMEA and PA. Finally, Section 5 concludes the findings of this study along with limitations and assessing logistics service providers, FMEA and PA due to application of the issue for white goods sector.

2. LITERATURE REVIEW

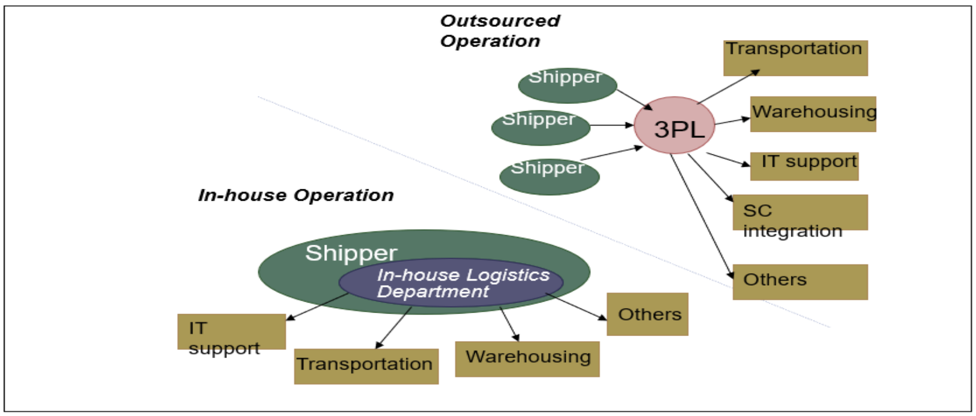
2.1. Definition of the Concepts of Party Logistics Service Providers

Supply Chain Management (SCM) is indeed beneficial for organizations in terms of financial efficiency, customer loyalty, and partner revenues. An effective SCM system enables organizations to respond quickly and efficiently to demand fluctuations. This can be achieved through agile production and distribution processes, efficient inventory replenishment strategies, and flexible supply chain networks. SCM helps in achieving a stable and reliable supply of materials and products. It involves building strong relationships with suppliers, implementing robust supplier management processes, and establishing backup plans for supply disruptions. Some of the business potential of supply chain management are listed below. Through utilizing the period between customer orders and distribution effectively, it boosts revenues, contributes to a decrease in industry investment in capital, optimizes response to demand fluctuations, and boosts supply stability. In the context of this study, the integration of Failure Modes and Effects Analysis (FMEA) programs with SCM offers an enhanced output configuration. It addresses the application of FMEA in the context of SCM systems and provides examples of its utilization as a supply chain management strategy and continuity guideline. By implementing SCM with the FMEA approach, organizations can proactively identify and mitigate potential failures and risks in their supply chains. This ensures a more resilient and efficient supply chain operation. It is important to recognize the significance of customers within the supply chain network, as meeting their demands and expectations is crucial for sustainable business success (Gunasekaran and Ngai 2009; Jayaram and Tan, 2010).

2.2. Why 3PL

It is evident from the preceding slide that in a time-constrained, global marketplace, the efficacy and effectiveness of the logistics procedure, together with a synchronized and coordinated supply chain management, performs a critical strategic role. Many manufacturers have also recognized that their core competencies are not in the area of logistics in this competing environment where financial resources are restricted and have gradually sought to purchase logistics capabilities and operations from third party suppliers (see Figure 1; Gunasekaran and Ngai, 2009; Jayaram and Tan, 2010; Rajesh et al., 2011).The certain Marketing automation approach- Customer Relations Management (CRM) should develop a vision and plan that outlines the goals and objectives of the company. So, you need to change the procedures and internal systems so that you can successfully enforce the approach. Such systems need to be underpinned by a CRM system that integrates contact networks with CRM software and consumer data repositories. In fact, the expenditure in CRM will provide resources from all three application areas – integrated, organizational and strategic CRM – in order to serve the four stages of the CRM lifecycle (Gray and Byun; 2001; Greenberg, 2004; Bohling et al., 2006; Kumar, 2010).

Figure 1: Supply Chain Integration with Capabilities and Operations Third-Party Logistics Providers



Supply Chain Integration with Third-Party Logistics Providers, by Jayanth Jayaram and Keah-Choon Tan, is the research. The research titled "Supply Chain Integration with Third-Party Logistics Providers" by Jayanth Jayaram and Keah-Choon Tan highlights four crucial components of supply chain management. Four supply chain management components are identified in this research as being crucial elements. The degree of these characteristics' believed significance was analyzed between the two groups of businesses in order to predict company performance. The data backs up the assertion that developing connections, performance assessment, information integration, and 3PL selection criteria are all positively connected with company success. , the research demonstrates that companies that involve 3PLs in their supply chain management efforts tend to place a greater emphasis on these supply chain management structures compared to companies that do not engage 3PLs. This, figure 1 highlights the importance of integrating and leveraging the capabilities of 3PLs to enhance supply chain performance and achieve better business outcomes (see Figure 1; Gunasekaran and Ngai, 2009; Jayaram and Tan, 2010; Rajesh et al., 2011).

The model created in Strategic logistics outsourcing: An integrated QFD and fuzzy AHP approach by William Ho, Ting He, Carman Ka Man Lee, and Ali Emrouznejad is chosen as the foundation to use on the automotive sector in order to construct a house of excellence for 3PL Business after reviewing examines about the 3PL notions (Jayaram and Tan, 2010; Rajesh et al., 2011; Ho et al., 2015) .

Customer requirements can be accommodated by third-party logistics in the white goods industry using their descriptions without the need for substantial adjustments. Below are attempts that describe these 8 conditions (Gunasekaran and Ngai, 2009; Jayaram and Tan, 2010; Ho et al., 2015).

1. Lower overall logistics expenses: Rather than focusing on lowering the costs of specific logistical operations, the goal ought to be to minimize overall logistics costs. Transportation, storage, handling of materials, packaging, reorganization, and other charges are all included in the overall cost of logistics.
2. Shorten cycle times: Getting 100% of deliveries done on time and cutting down on client wait times may both be accomplished by getting the correct number of items to the right place at the right time.

3. Guarantee distribution quality: To guarantee product delivery security and lower the risk of damage and malfunction, special packaging, devices, and attention are required.
4. Offer specialized logistical services. Various outsourcing organizations will have different requirements for specialized logistical services. It is crucial to choose a 3PL that can offer adaptable, custom solutions to match their changing demands.
5. Increase customer happiness: By maintaining a high level of service quality, the 3PL may assist in increasing customer satisfaction.
6. Possess cutting-edge hardware and software: The 3PL could assist to increase the competitiveness of the outsourcing business by possessing both cutting-edge hardware (such as a fleet of vehicles, storing and handling equipment, RFID, or radio frequency GPS satellite tracking equipment) and software (vehicle routing containers, carrier transferring optimization software, data transfer and reception structures).
7. Capable of giving timely advice: This relates to the 3PL's capacity to advise and offer insights to the outsourced firm in a prompt, effective way.
8. Effective problem-solving skills: This pertains to the 3PL's capacity to handle issues successfully and lessen their effects on the outsourced firm.

Considering some necessary adjustments, 20 assessment elements are adapted to the automobile industry as 15 technical performance metrics. Performance indicators and measures are crucial managerial instruments for wisely allocating precious resources for the production of high-quality products and services and maintaining competitiveness in order to succeed in a global marketplace. Performance measures are shown below (Gunasekaran and Ngai, 2009; Jayaram and Tan, 2010; Ho et al., 2015);

(1) Proactively reducing costs; (2) Accountability for additional expenses brought through 3PL; (3) Low cost sustainability leveraging; (4) Shipping Quantity fulfillment consistency; (5) Delivery circumstance; (6) The capacity to meet deadlines for delivery; (7) Flexibility when it comes to changing the manufacturing capacity; (8) Services offered; (9) Quality, Accuracy, and Dependability; (10) Knowledge of the industry and Client References; (11) Capabilities of technology-based information systems; (12) Capabilities for optimization; (13) Size and quality of physical equipment are two aspects of fixed assets; (14) Risk Capacity for spotting and avoiding possible issues; (15) Financial endurance and strength.

A thorough study of 3PL services is given in "Third Party Logistics (3PL) Market Outlook to 2022 - By Freight Forwarding and Warehousing 3PL Services and By International Companies and Domestic Companies." The market size for third party logistics in Vietnam as a whole, segmentation of the market according to industry (freight forwarding and storing), and market fragmentation by firms (local and foreign) are the main subjects of this research. The general competitive environment in the Vietnam 3PL marketplace is also covered in the study. The expert recommendations and market prediction for third party logistics are included in the conclusion of the report, which also highlights the key potential and risks for the Vietnam 3PL industry (Holweg and Miemczyk, 2003; Gunasekaran and Ngai, 2009; Jayaram and Tan, 2010; Rajesh et al., 2011; Vietnam Third Party Logistics, 2023).

2.3. The 3PL Market in Competitive Marketplace

As more businesses throughout the world outsource their logistical tasks to 3PL suppliers because they are reluctant to handle their complicated supply chains, third-party logistics outsourcing is rapidly acquiring prominence in the nation. Due to reduced capacity and greater supply chain combining, which has led to fewer partners for 3PLs and higher costs, competitiveness in the logistics sector is escalating. Through providing a variety of value-added services to the clients, the businesses operating in the Vietnam 3PL market compete with one another. DHL Logistics, Damco, FedEx, and APL are the industry leaders. Nevertheless, a lot of Vietnamese brand names, such Gemadept, Vinafco, and Transimex Saigon, have lately entered the marketplace (Holweg and Miemczyk, 2003; Gunasekaran and Ngai, 2009; Jayaram and Tan, 2010; Rajesh et al., 2011; Vietnam Third Party Logistics, 2023).

3. FAILURE MODE AND EFFECT ANALYSIS

Failure Mode and Effects Analysis (FMEA) is a versatile and effective method used in various stages of operations, including product development, process improvement, and service enhancement. It helps identify and evaluate potential failure modes, their causes, and their effects on products, services, systems, or processes. During the FMEA process, failure modes are examined individually or in comparative groupings to determine their potential impact. This evaluation involves assigning weights or ratings to failure modes based on factors such as severity, occurrence, and detectability. These weights help prioritize the most critical failure modes and guide decision-making regarding preventive actions. The measurement and evaluation phase of FMEA is crucial as it helps uncover significant failure modes that require attention. By identifying these outstanding failure modes, organizations can focus their resources and efforts on mitigating the associated risks and improving the overall performance and quality of their operations. It's important to note that the specific details and outcomes of the FMEA process, including the weights assigned to failure modes, may vary depending on the specific context and application. Organizations may have their own criteria for assigning weights or ratings based on their industry, expertise, and risk tolerance. By addressing potential failure modes proactively, organizations can reduce risks, enhance product and service quality, improve customer satisfaction, and increase operational efficiency. Overall, FMEA is a valuable tool for organizations to identify and mitigate risks, prioritize improvement efforts, and drive continuous improvement in their operations (Ford, 1992; Pillay and Wang, 2003; Estorilio and Posso, 2010).

In the early years of FMEA analysis, its use was more common in technical issues such as product design, but later it shifted to system, process and service designs and development and improvement applications. FMEA is a tool used to detect and prevent problems that may arise in the design, service and process stages before they occur. In FMEA applications, errors that may arise are identified and eliminated before they reach the Customer (Denson, 1992; Yılmaz, 1997; Dizdar, 2001; Elitaş and Eleren, 2007). It is a systematic approach to analyzing the causes of product and service defects. The preventive quality strategy has many tools for error prevention, virtual prevention of the probability of occurrence of a defect that has not fully occurred, error proofing, performance failure, consequences and risk. These tools apply to both proactive and reactive defect types. FMEA focuses on the type of failure (fatigue, leakage, kink, fracture, too salty, eraser stain, pencil stain), mechanism, effects. FMEA is a tool to identify problems that may arise in the design, service and process stages before they occur and to take actions. Errors that may arise are identified and eliminated before they reach the customer. It can be based in 2 ways (Dale and Shaw, 1990; Ford, 1992; Sahnı, 1993; Yılmaz, 1997; Dizdar, 2001).

- To bring the customer's value definition to the system by making use of previous data
- Deciding on the state of the process based on statistical data.

In preventive applications, FMEA is indeed a flexible and valuable tool for analyzing and improving products, services, systems, and processes in their early stages. It allows for the identification and evaluation of potential failure modes and their associated effects, enabling proactive measures to be taken to prevent or mitigate them. FMEA is adapted to focus on error prevention. Often, the failure type is thought of as the physical description of the failure, whereas the failure mechanism relates to the process that produces the failure. FMEA seeks methods to find and identify possible failure modes, mechanism, effects or consequences indicating failure modes, and preventive tools. Product and process action plans are used to eliminate significant types of defects resulting from an effective FMEA study. Nowadays, it is seen that studies are carried out in combination with methods such as fuzzy logic, multi-criteria decision making, artificial neural networks, simulation, etc., which have recently become widespread. An example is the use of Analytic Hierarchy Process or Fuzzy TOPSIS methods from multi-criteria decision-making methods in the calculation of the risk priority indicator, which is an important part of the FMEA analysis, and the ranking of risk factors accordingly. FMEA is more effective at the following points: Systematic evaluation of the product or process at certain levels of system complexity, assumption of individual failures, identification of possible failure mechanisms and determination of their respective effects, probability and preventive measurements of occurrences, adverse situations caused by potential failure to fulfill the product or Process (Dale and Shaw, 1990; Sahni, 1993; Yılmaz, 1997; Dizdar, 2001).

Three factors are taken into account when examining defects with FMEA. These are: Occurrence (frequency), Impact (severity), Detection (detection). In line with these three factors, the Risk Priority Indicator (RPI) of the failure in question is calculated. RSI is an indicator of criticality ranging from 1 to 1000. By calculating this number, the error sources that need to be addressed first are identified and corrective actions are performed in this order. The aim is to develop a variety of preventive actions to move the RPI towards 1. For an FMEA exercise to be optimally effective, the work should be initiated at the earliest possible time. However, this is often not done due to insufficient available data and the FMEA study is never started. This has detrimental consequences, especially for organizations implementing total quality management philosophy. The support of the management should definitely be provided before starting the FMEA application. Considering that FMEA is a team work, the animator (motivator) should emphasize the rules to be followed during the meetings in order to keep the FMEA project group alive until the end of the project. When forming the group, it should be ensured that everyone related to the process to be examined is included in the group. In this way, more objective results can be achieved. It is generally accepted that there are four types of FMEA. Accordingly, FMEA: System FMEA, Design FMEA, Process FMEA and Service FMEA (Denson, 1992; Gilchrist, 1993; Teng and Ho, 1996; Yılmaz, 1997; Dizdar, 2001; Seung, 2003; Eryürek and Tanyaş, 2003; Baykasoğlu et al. , 2003; Teoh and Case, 2004; Elitaş and Eleren, 2007).

When developing or improving systems, processes, methods, models, services or products, FMEA is a method developed to identify and rank existing or potential types of errors/risks in advance and to set priorities in the improvement/development phase. The FMEA method is a simple but effective method applied to identify, classify, eliminate or prevent potential failure/risk types and reduce their effects. Risks or changes in products or processes are usually caused by the variability of inputs. Variability can be categorized in two groups (Denson, 1992; Elitaş and Eleren, 2007). These are general variability arising from the natural structure of the processes themselves and special variability arising from a number of unexpected effects. While general variability affects the whole mass, special variability affects only a limited structure. Although FMEA studies are aimed at the management of variability in both groups, the primary goal is to eliminate or reduce the variability in the second group (Gilchrist, 1993; Teng and Ho, 1996; Seung, 2003; Teoh and Case, 2004).

Sinha et al. utilized FMEA to content datasets to support party logistics reduces the energy needed for transportation, enhances to support the seriousness of risk criteria, which includes the airline/aircraft generating Supply chain, (Sinha et al., 2004). Utilization for the medical industry includes FMEA implementations, which describe the risk of each stage of reverse logistics actions (Kumar et al., 2009). This idea allows for the analysis of risk arranging while considering reasonable monitoring of drugs (Van Leeuwen et al., 2009). In order to broaden his research and evaluate the impact of invisible failures, such as consumer complaint and the failure of bazaar proportion including the volume of service levels, Chuang (2010) examined and revealed the 126 influences of demands and objectives.

FMEA enables the identification and calculation of risks and unfavorable outcomes. FMEA, nevertheless, has a wide range of application stages and is a challenging assessment technique for preventing failures through roughly assessing the important risks. FMEA is a powerful method for identifying and assessing risks and potential adverse outcomes. It provides a structured approach to systematically analyze potential failure modes, evaluate their effects, and determine the associated risks. (Chin et al., 2009; Wang et al., 2009; Liu et al., 2013).

The advantages of the system FMEA are given below (Franceschini et al., 2001; Pillay and Wang , 2003; Chin et al., 2009);

(i) İmproving the project's overall quality, dependability, and safety. (ii) Boosting client happiness and provide for it. (iii) Cutting down on the time, money, and resources spent on product or system improvement. (iv) Determining the order of importance for design or development of processes tasks. (v) Looking at all possible failure modes, their impacts, and commonalities across all goods and processes. (vi) Offering an analysis of the design requirements and design options. (vii) Aiding in the defining of possible, vital, and crucial traits. (viii) Offering feedback on new manufacturing or research processes. (ix) Continuing an extensive brainstorming session for failure prevention. (x) Improving and realize the explanation of preventative measures. (xi) Identifying and keep monitoring on the infrastructures that reduce risk.

3.1. Failure Mode Effect Analysis (FMEA) Elements and Calculation Method

The objective of this research is to identify advancements and improvements that can enhance logistics systems and propose effective delivery structures and attributes for system populations. To achieve this, the study incorporates the analysis of Failure Modes and Effects Analysis (FMEA) and the utilization of Pareto Analysis (PA) to control and prevent potential failures in the third-party (3PL) logistics for Supply Chain Management (SCM) in the white goods industry. Building on previous research, the study aims to develop specific business assessment criteria that are relevant to sustainability for third-party (3PL) and fourth-party (4PL) logistics service providers in the white goods industry. These criteria will then be applied using the FMEA approach to evaluate the sustainable development of the Supply Chain for XYZ White Goods Manufacturing Company, considering the involvement of Party Logistics providers in Turkey. Additionally, the research includes a sample study focusing on process failure types and impact analysis to proactively prevent potential failure types encountered in the logistics department. The aim is to ensure the sustainability of third-party logistics within the scope of the Supply Chain in a white goods manufacturing enterprise located in the Marmara region. By combining FMEA and PA, the research intends to provide valuable insights into identifying critical factors and mitigating risks in the 3PL logistics and processes OF SCM. The ultimate goal is to enhance the sustainability and performance of the logistics systems within the white goods industry.

Weak/strong sustainability: trade-offs and minimal standards- the idea of include governance as a fourth dimension has been floated. Systems for supply chain management have a wide range of implications on ecological, social, cultural, and economic factors as well as on land use and urban situations. The provision of sustainable transportation system actually depends on these elements.

The aim of FMEA is to sort the failure modes in order of importance, three indexes are defined for each failure mode: the occurrence rating (O), the severity rating (S), and the detectability rating (D). A ten-point scale is used to score each category, ten being the number indicating the most severe, most frequent and least detectable failure mode, respectively.

The priority of a failure mode is determined through the Risk Priority Number (RPN), which is defined as the product of the Occurrence (O), Severity (S) and Detection (D) of the failure,

Those potential causes, with high RPN values, are selected for the corrective action to reduce the risk of failure occurrence.

Risk priority Number (RPN) for FMEA; is calculated by multiplying the Occurrence (O), Severity (A), and Detectability (S) levels

RPN= S(Severity)* O(Occurrence) * D(Detectability) (1)

The probable issues including high Risk Priority number (RPN) variables are preferred in order to decrease the risk level of the failure situations for the suitable action. Concentration is also presented to the components of a system, where failure could construct unfavorable consumer opinion and loss of business prestige. Risk priority levels (RPL) or numbers (RPN) for FMEA - Eq. (1) is measured by accumulating the Occurrence (O), Severity (S), and Detectability (D) levels (Chin et al, 2009; Xiao et al, 2011; Su et al, 2012).

To reduce the chance of failure scenarios preventing appropriate action, likely issues with high RPN variables are chosen. The parts of a system also require attention since failure might result in a negative consumer perception and a loss of corporate status. For FMEA Eq. (1), risk priority levels (RPL) or numbers (RPN).

Severity (S) : The importance of the influence on consumer circumstances frequently leaves little room for action outside of building innovative system fundamentals or reassessment structures.

Occurrence (O): Frequency with which certain occasions, problem, and failure modes are generated (or perhaps this could happen).

Detectability (D): The capacity of the current oversight and disciplinary methods to find earlier or subsequent growth, the occurrence of a stated cause.

According to Table 1, the three components O, S, and D have the ability to be evaluated using point sequences that range from 1 to 10. Higher RPN failures are implied to offer greater significance and necessity and may be claimed to have higher preferences.

3.2. Risk Priority Number

Risk Priority Number (RPN) shows the relative likelihood of a failure mode, in that the higher the number, the higher the failure mode. It must be calculated for each cause of failure. From the RPN, a critical summary can be drawn up to highlight the areas where action is mostly needed. Regardless of the resultant RPN, special attention must be given to any cause of failure with a severity rating of “9” or “10”. The higher the RPN, the higher the priority for taking action to mitigate or eliminate the associated failure mode. It helps in identifying the failure modes that require immediate attention and allocation of resources for improvement. While it is essential to address failure modes with high RPN values, it is equally important to pay special attention to failure modes with severity ratings of "9" or "10". These severity ratings indicate that the failure mode could have severe consequences, potentially leading to significant impacts on safety, quality, or other critical aspects of the system or process. By highlighting the failure modes with high RPN values and focusing on those with severe consequences, organizations can prioritize their improvement efforts and allocate resources effectively to address the most critical risks. As shown in Table 1, On a rating system of 1 to 10, the three RPN components, occurrence (O), severity (S), and detection (D), could be rated. The likelihood that the failure mode may occur increases with increasing RPN. Corrective steps ought to be given priority to failure scenarios with greater RPNs.

The Three Factors of System FMEA: S (Severity), O (Occurrence) and D (Detection) Table 1 was modified from Slinger’s research, the literature of FMEA subject, opinions of experts of this sectors, author and applied to the application of this research. For all fatal failure causes at the root, the RPN is taken into account. The bigger the statistics variable, the greater the failure mode, with this value defining the connection likelihood of a failure mode. A large overview might be carried up to highlight the subjects, corresponding the RPN, where the procedure is often necessary. Despite the impact RPN, every component of failure may be given special concern by receiving a severity rating of "9" or "10" (Ford, 1992; Van Leeuwen et al., 2009). The firm should ensure that the fundamental flaws are removed from the detection after generating RPN values arithmetically. There are three options, which undoubtedly encompass (Sankar et al., 2001; Pillay and Wang, 2003). The firm should ensure that the fundamental flaws are removed from the determination after computing RPN values arithmetically. Three options are available, including (Sankar et al., 2001; Pillay and Wang, 2003).

(i) Reduce the likelihood that the failure could happen or show up, (ii) eliminate the problem as a whole via an arrangement change, (iii) increase the prospects for finding around developmental quality control.

Table 1: The three factors O(Occurrence), S(Severity) and D (Detection) of System FMEA (modified by opinions of experts of this sectors and author from Slinger, 1992)

Rating	**Severity** How severe is the effect on the customer?	**Occurrence** How often does the cause or failure mode occur?	**Detection** How well can you detect the cause or the failure mode before passing to next step?
10	Serious hazard to people or damage to equipment	Very high chance of occurence	Almost impossible to detect, no controls in place
9	Loss of primary function- serious of medium level	High repeated failures	Impossible chance of detection
8	Loss of primary function- serious of normal level	Medium High repeated failures	Medium chance of detection (less than high)
7	Customer dissatisfied, disruption to business	Moderate chance of occurence	Low chance of detecting, may have some controls in place
6	Loss of secondary function- medium level	Moderate failure	Moderate chance of detection
5	Loss of secondary function-normal level	Occasional failure	Good chance of detection
4	Customer may notice but only minor concern, minor disruptiion to business	Low chance of occurence	High chance of detecting, controls are in place
3	Minor effect	Less Low chance of occurence	Higher chance of detecting
2	Less Minor effect	Failure unlikely	More High chance of detecting
1	No effect	Remote chance of occurence	Almost certain to detect, reliable controls are in place

With the help of failures and their sub-failure components, a fault tree structure was developed. On the FMEA form, the potential severity, likelihood, and detectability levels of various failure modes have been established and noted (Zairi and Duggan, 1999; Franceschini and Maurizio, 2001). Risk Priority Levels (RPL-RPN) were derived from these reported values. These estimated values have been arranged according to the level of danger, and preventive research has been done to lower the danger Priority Levels. Observing the development operations, performing a fresh evaluation of the severity, occurrence, and detection values, and computing a new RPN value are all undoubtedly options. The unpredictability of the mode's fall is greater the higher the RPN value, and this mode ultimately asks a higher configuration for enforcement (Franceschin and Maurizio, 2001; Chang and Sun, 2009; Chin et al., 2009).

3.3. Implementing FMEA and Calculating Risk Priority Levels (RPL) in Quality-Oriented System Design

For the purpose of addressing potential risk variables and challenges that may arise during the design, process system, and application of the quality focused system design, it is important to conduct failure control, quality analysis, social, economic, and ecological sustainability, among other dominations, at each stage of production system concentrated quality-oriented science and technology system design. This reality necessitates the implementation of an effective risk execution strategy for both the dimensions and the goals of these flaws. This inquiry and its directives will provide a sound framework for the upcoming investigations to be planned on dimensional frameworks while enabling the seamless development of adopted quality-based investigations. This comprehensive approach ensures that the design and implementation of the quality-oriented science and technology system align with desired outcomes and minimize potential flaws. To achieve this, it is important to implement an effective risk execution strategy that encompasses the dimensions and goals of these potential flaws. By incorporating risk management practices and risk mitigation strategies, organizations can proactively identify and address risks throughout the production system. This inquiry and its directives aim to provide a solid framework for future investigations, focusing on dimensional frameworks that enable the seamless development of quality-based investigations. By emphasizing quality-oriented research and development, organizations can continually improve their systems and processes, ensuring better outcomes and sustained success. By integrating the principles of failure control, quality analysis, and sustainability considerations, organizations can enhance their understanding of potential risks, address them effectively, and drive continuous improvement in their quality-focused system design.

The Failure Mode and Effects Analysis (FMEA) table, as shown in Appendix 1, serves as a valuable tool for conducting a comprehensive evaluation of potential risk aspects and failures in fundamental investigation applications and engineering measurements. It provides a structured framework to identify and analyze potential failure modes, their causes, effects, and associated risk levels. The FMEA table typically includes columns for different parameters such as the failure mode description, potential causes, current controls or prevention measures, detection methods, severity of the failure mode, occurrence probability, and the resulting Risk Priority Number (RPN) or Risk Priority Level (RPL). These parameters allow for a systematic assessment of the risks associated with each failure mode and prioritize them based on their potential impact.

Evaluations for these investigations determining via FMEA methods and in accordance with experts' experience form Risk Priority Numbers- Levels (RPN-RPL) table (see Appendix 1). The RPN or RPL values in Appendix 1 indicate the relative priorities or levels of risk for each failure mode. These values are calculated based on the severity, occurrence, and detectability ratings assigned to each failure mode during the FMEA process. The higher the RPN or RPL, the higher the priority for taking corrective or preventive actions to reduce the associated risks. Additionally, you mentioned the importance of business requirements in guiding the project and ensuring alignment with client or market needs. Business requirements specify the goals and objectives that the client, corporation, or project team wants to achieve. These requirements serve as a framework for the project, guiding the development of functionality and specifications that meet the market demands. It's important to note that business requirements alone may not provide sufficient information for developers to determine exactly what to build. This is where additional inputs, such as technical specifications, user feedback, and collaboration with the project team, come into play to define the detailed requirements and guide the development process effectively. Business requirements evaluate the business goals that the client, corporation or project team wishes to achieve. The business objectives set a guidance framework for the remainder of the project. All other functionality and specifications of the company should comply with market requirements. Company specifications therefore do not have adequate information to tell developers what to build. By utilizing FMEA and considering business requirements, organizations can identify and address potential risks and failures, align their project objectives with market needs, and ensure that the final product or solution meets the desired standards and expectations. FMEA table is a valuable resource that promotes a thorough evaluation of potential risks and failures, helping researchers and engineers make informed decisions and take necessary actions to enhance the quality and reliability of their investigations and engineering measurements.

4. PARETO ANALYSIS

The range of the data may be divided into groups to create a pareto graphic. In a Pareto chart, the frequency or count of each category is plotted on the left vertical axis. The categories are listed on the right vertical axis. The categories are typically sorted in descending order based on their frequency or impact, with the most frequent or impactful category at the top. The bars representing each category are arranged from left to right in decreasing order of frequency or impact. The cumulative frequency is also shown as a line graph, usually plotted against a secondary vertical axis on the right side. The Pareto chart provides a visual representation of the distribution of the categories and helps to identify the vital few categories that contribute the most to the total count or impact. This allows decision-makers to prioritize their efforts and focus on addressing the most significant issues or factors. The frequency vertical axis on the pareto chart's left side lists the total counts for each category. The collective names of the response variables are indicated on the pareto chart's right-side vertical axis (Akın, 1996; Akın and Ozturk, 2005).

This approach entails investigating the root causes of issues in order to promote a workable solution. This method often follows the 80/20 rule. The visual aid used in Pareto analysis is the Pareto diagram. Quality oriented process development is applied in this study. In the implementation critical risk value is chosen as 80 %.

Pareto analysis (PA) focused on failures and risks that could happen when designing transportation-based sustainable engineering projects and ranked according to the severity of the risk factors with regard to the nature of each risk factor, and calculated values of relevant percentage. In this investigation, quality-oriented development of processes is used. The critical risk threshold for implementation is set at 80%. These failure modes (critical risks) are unacceptable risk factors. It must be absolutely avoided, in taking measures. Due to the severity of the risk variables in relation to the features of each risk component, Pareto analysis rated potential failures and risks which may occur while planning transportation-based sustainable engineering initiatives and computed values of pertinent percentages.

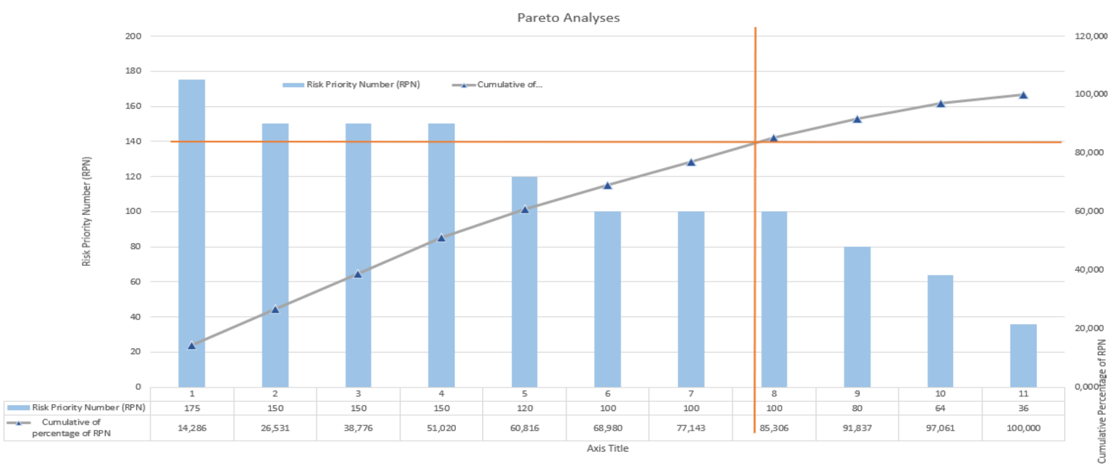
Table 2: Designed Pareto Analysis in Sustainability Assessment of Party Logistic Providers (XYZ White Goods Manufacturing Business)

	# of Failure Modes	Failure Modes Potential	Risk Priority Number (RPN)	Percentage of RPN	Cumulative of percentage of RPN	Situation
1	11	Industry knowledge and References from current customers	175	14,286	14,286	Unacceptable Risk
2	10	Risk Ability in identifying and preventing potential problems	150	12,245	26,531	Unacceptable Risk
3	5	Improve transportation consistency	150	12,245	38,776	Unacceptable Risk
4	6	Stock accounting	150	12,245	51,020	Unacceptable Risk
5	2	Return on total assets Sales over assets	120	9,796	60,816	Unacceptable Risk
6	3	Assure quality in distribution	100	8,163	68,980	Unacceptable Risk
7	8	Increased microbial activity in food due to inappropriate temperature in transport vehicles	100	8,163	77,143	Unacceptable Risk
8	9	Chemical contamination of belts due to poor rinsing after cleaning	100	8,163	85,306	Medium Risk
9	7	Contamination of the product with chemicals used in storage area cleaning and carcinogenic effect	80	6,531	91,837	Medium Risk
10	4	Able to provide guidance on time	64	5,224	97,061	Medium Risk
11	1	Foreign material contamination during stacking and storage	36	2,939	100,000	Medium Risk

In the framework of quality-oriented engineering research as seen Table 2, eleven points of control that might serve risk criteria are evaluated between existing control dimensions that could enhance risk dimensions, of which four are designated as Medium Risk degrees. These are little significant and there are benefits in taking measures. In the context of quality-oriented engineering research, the evaluation of eleven control points that can address risk criteria is crucial. Among these control points, four have been identified as having a Medium Risk level. While these risks may not be highly significant, there are still benefits in taking measures to address them. Identifying and evaluating risks in the early stages of engineering research is essential for ensuring the quality and reliability of the final product or process. By addressing these risks, you can prevent potential failures, improve performance, and enhance overall system effectiveness. Taking measures to mitigate even moderate-risk factors is important because they can still have an impact on the overall quality and performance of the system. Addressing these risks helps to minimize potential issues, increase efficiency, and reduce the likelihood of failures or negative outcomes. Implementing control measures for medium-risk factors demonstrates a proactive approach to risk management and highlights the commitment to delivering high-quality results. It allows for better control over the variables that can affect the system's performance and helps to ensure the successful implementation of quality-oriented engineering research. By evaluating and addressing risks, including those with medium significance, you can enhance the overall effectiveness and reliability of the system, leading to improved outcomes and increased stakeholder satisfaction (see Table 2).

The preventative measures that have been supplied will be evaluated for lowering the high and medium risk variables that are specified by providing referencing in the Failure Mode and Effects Analysis (FMEA) application. Risk Priority Level variables are determined to be lower as a result of the substantial protective actions stated in the FMEA, particularly during quality-oriented engineering investigations. Therefore, it is intended that high and medium risk factors be eliminated for the benefit of the advancement of research in a proper and healthy manner. The PA is added on top of the Failure Mode Effect Analysis and addresses the 75–80% important demanding barrier risk measurement. Combining FMEA and PA provides a comprehensive approach to risk management and improvement. It helps researchers and practitioners identify and address the most significant risks that have the potential to hinder progress or impact the desired outcomes. By prioritizing and mitigating these risks, the research can proceed in a more effective, efficient, and reliable manner. Overall, the integration of FMEA and Pareto Analysis allows for a systematic and targeted approach to risk reduction and problem-solving, ensuring that the research progresses in a robust and healthy manner.

Figure 2: Pareto Analysis (PA) Chart for Assessment Logistic Sector (Sustainability of Supply Chain-white goods business System Problem) in Turkey



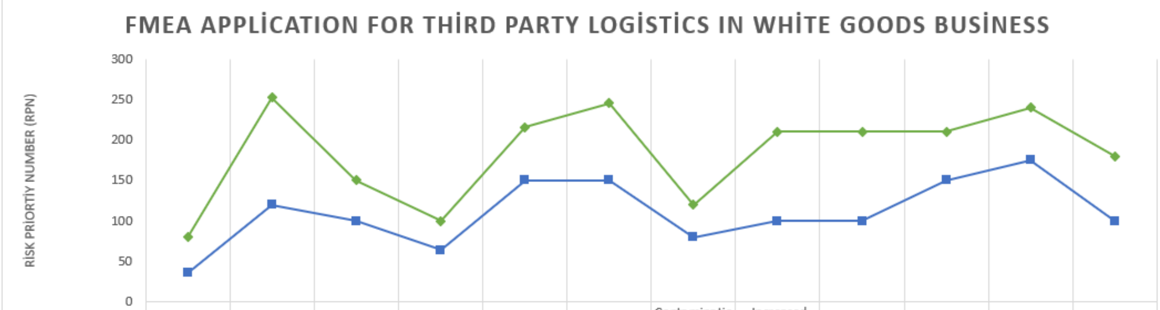
The pertinent schematic is displayed in Figure 2 and Appendix 1 and Table 2. As a result, the following are listed in priority order of importance while creating and making modifications to engineering studies that are quality-focused and seeking ordered failures and oversights:

- Industry knowledge and References from current customers
- Risk Ability in identifying and preventing potential problems
- Improve transportation consistency
- Stock accounting
- Return on total assets Sales over assets
- Assure quality in distribution
- Increased microbial activity in food due to inappropriate temperature in transport vehicles

The previously mentioned issues are found to keep out in the group of high-risk ones. When determining and evaluating the high-risk level supporting failure point sources in a Pareto analysis, conformance with 80% threshold risk variable, the first seven failure point sources precedence. This method aids in identifying the top 20% of reasons that must be addressed in order to fix the other 80% of issues.

Figure 3 demonstrates the trend observed in the Risk Priority Numbers-Levels (RPN-RPL) of identified potential errors in the system before and after implementing preventive measures as part of the FMEA procedure. The initial assessment of the RPN values indicated a high level of risk associated with these failures. However, after conducting the second risk analysis, which involved reviewing and implementing preventive measures, a diminishing trend in the RPN risk levels is observed. This diminishing trend suggests that the actions taken based on the preventive measures have been effective in reducing the severity, occurrence, and detectability of the identified failures. As a result, the overall risk associated with these failures decreases, leading to lower RPN values.

Figure 3: Before and After the FMEA Critical Risk Values (Risk Priority Numbers-RPN) Graphical Representation



	Foreign material contamination during stacking and storage	Return on total assets Sales over assets	Assure quality in distribution	Able to provide guidance on time	Improve transportation consistency	Stock accounting	Contamination of the product with chemicals used in storage area cleaning and carcinogenic effect	Increased microbial activity in food due to inappropriate temperature in transport vehicles	Chemical contamination of belts due to poor rinsing after cleaning	Risk Ability in identifying and preventing potential problems	Industry knowledge and References from current customers	Commitment to quality
R.P.N Before FMEA	80	252	150	100	216	245	120	210	210	210	240	180
R.P.N After FMEA	36	120	100	64	150	150	80	100	100	150	175	100

Exactly, the declining trend of RPN indicates that the implemented preventive measures have been effective in mitigating risks and improving the system's performance. The FMEA procedure allows for a systematic analysis of potential failures, their impact, and the implementation of preventive measures to reduce associated risks. By assigning RPN values to failure modes and continuously monitoring them throughout the FMEA process, you can track the progress in risk reduction. This helps in identifying the most critical failure modes that require immediate attention and prioritizing the allocation of resources for preventive actions. The declining RPN trend signifies that the implemented preventive measures have successfully reduced the likelihood and severity of potential failures. It indicates that the system's performance is improving and moving closer to the desired standards and objectives. Regularly evaluating and updating the FMEA analysis allows for ongoing improvement and ensures that the system remains robust and resilient against potential risks. It provides valuable insights into the effectiveness of the preventive measures and helps in identifying any areas that may require further attention or enhancement. Overall, the declining RPN trend in the FMEA process is a positive indication of the system's progress in risk reduction, highlighting the successful implementation of preventive measures and the continuous improvement of the system's performance. This allows for the identification of areas where further improvements can be made and helps prioritize actions to address the remaining risks. Overall, Figure 3 provides visual evidence of the positive outcomes achieved through the application of the FMEA procedure and highlights the importance of proactive risk management in enhancing system reliability and performance.

Managing the assets is different from FMEA, which is a classified decision perspective that could not be done on subjective foundation. Group elements from an FMEA might provide a unique evaluation approach. Risk factors are compiled in a most undoubtedly nonlinear manner that neither extends the scope of the risk aspects nor serves as their fundamental component. If this framework is necessary, other risk factors may be implicated. The recommended FMEA is applicable to a variety of risk criteria and is not just limited to O, S, and D.

In order to support the risks items being focused on the priority regulation of significance and the development studies for these researches to be focused on and made expeditiously, FMEA analysis plays a significant role in sustainability researches, particularly during the design stage of research. It appears that there might be some repetition in the provided statement. However, based on the information provided, it is clear that FMEA analysis plays a significant role in sustainability research, particularly during the design stage. The identification and prioritization of risk factors through the RPL are important for the sustainability of lifecycle studies. Figure 3 demonstrates the diminishing tendency of high-Risk Priority Levels (RPN) following the implementation of preventive measures as part of the FMEA procedure. This indicates that the actions taken after reviewing the preventive measures have been effective in reducing the risk associated with potential failures. The presence of the first seven important risk factors suggests that these factors require special attention and should be addressed promptly. The FMEA procedure provides a suitable approach for specialists in their field who are conducting development research.

5. CONCLUSION

Process improvement and development methods are frequently used in studies aimed at increasing productivity, performance and quality, as well as reducing transaction times, losses and costs. When target costs are exceeded due to past problems in target costing applications, implementing process improvement and development methods becomes essential to effectively control and reduce costs. In this context, if our target costs are exceeded due to some problems experienced in the past in target costing applications and these problems, process improvement and development methods can be applied to control and reduce costs. FMEA provides us with very easy but very useful data in terms of use and interpretation. Through the application of FMEA, organizations can identify potential failures in their processes, evaluate the severity and impact of each failure, determine the likelihood of occurrence, and assess the effectiveness of current controls or preventive measures. This information can then be used to prioritize improvement efforts and allocate resources effectively to reduce costs and enhance overall performance.

By utilizing FMEA alongside other process improvement and development methods, organizations can streamline their operations, identify areas for optimization, and make informed decisions to achieve their target costs while maintaining or improving the quality of their products or services.

FMEA constitutes the beginning of these methods, functionally evaluating past systems or processes, evaluating possible risks with the help of past statistical or experience-based data, and seeking answers to the question of which risks should be spent primarily to remove our scarce resources such as time, money and energy.

In this study, the risks that negatively affect the service status, do not bring profitability and increase costs have been identified, taking into account the past data and experience of our sample business. The study is based on a qualitative basis, so the relative valuation of the person or persons making the valuation directly affects the results. In addition, the accuracy of the data on recurring risks in the past is another influencing factor. The continuation of this research is the process improvement and development application. At this stage, the risks ranked according to the RPN scores given in Table-6 will be evaluated in order of importance. However, this will be discussed in another study. FMEA analysis is a method that can be used in many studies such as product, technology development, method, process improvement and development, reorganization, etc. It is foreseen that our study will contribute to the literature for the dissemination and development of such met. In this study, the risk factors that adversely affect logistics activities within the scope of supply chain management were identified and ranked with the FMEA method. As a result of the evaluation of the individual weights of the risk factors by taking into account the Risk Priority coefficients, the relative weight of the risks occurring in the measurement and evaluation phase stands out.

The results obtained from the Failure Mode and Effects Analysis (FMEA) provide valuable insights into the potential risks and failures in logistics activities. These results serve as the first step in the process improvement phase, allowing for the identification of areas that require remedial measures and further studies. By prioritizing the risks based on their Risk Priority Number (RPN) scores, resources can be allocated efficiently. Focusing on the most significant risks allows for effective utilization of scarce resources such as physical facilities, time, and money. By addressing the high-risk areas first, organizations can maximize the impact of their improvement activities and achieve more effective results. The improvement activities initiated based on the FMEA results aim to mitigate the identified risks, prevent failures, and enhance the overall performance of the logistics activities. Remedial measures can be implemented to eliminate or minimize the potential failure modes that have high RPN scores. This targeted approach ensures that the improvement efforts are directed towards the most critical areas, maximizing the chances of success. Continued improvement activities, guided by the FMEA results, enable organizations to refine their logistics processes and achieve higher levels of efficiency, reliability, and effectiveness. By systematically addressing and reducing the identified risks, organizations can enhance their operational performance, optimize resource utilization, and improve overall customer satisfaction.

In summary, FMEA results provide a foundation for process improvement in logistics activities. By focusing on the most important risks identified through the analysis, organizations can allocate their resources effectively and achieve more significant improvements in their logistics processes. FMEA can be easily applied in the early stages of product, service, system and process development/improvement activities and provides useful results. With the initial work to be done to improve the process, improvement activities and resources should be allocated according to this level of importance. Since the opportunities to be allocated for improvement development are limited, all risk factors may not be realized within a certain process. It is aimed to develop continuous improvement by repeating risk preventive studies according to the priorities to be determined each period.

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Appendix 1: Comprehensive Analysis of Potential Risks and Failures to be Encountered During the Sustainability Assessment of XYX Sustainability of Supply Chain-white Goods Manufacturing Business (Party Logistic Providers) in Turkey

Firm Name **Assesment Party Logistic (for Sustainability of Supply Chain-white goods business) in *FMEA***
Product/Item : **Third Party Logistics in Business** FMEA No : **125-1** Security Class :: -
Model / vehicle Prepared By :: **FMEA Team**
Process Resp.: **A** Key Date : FMEA Date : Rev : **0**
Core Team : **AE-Project Team Members**

Proses / Steps / Function	Potential Failure Mode	Potential Effect(s) of Failure	Severity (S)	Potential Cause(s)/ Mechanism(s) of Failure	Occurence (O)	Current Process Control Prevention	Current Process Control Detection	Detection (D)	R:P:N	Recommended Action(s)	Responsibility &Target Completion Date	Action Results: Action Taken	Severity	Occurence	Detection	R:P:N
1	Foreign material contamination during stacking and storage	Pro-active in cost reduction	5	Sustainable low cost through	4	Delivery Accuracy of quantity fulfillment	Industry knowledge and References from current customers	4	80	Risk Ability in identifying and preventing potential		assess ongoing service performance.	4	3	3	36
2	Return on total assets Sales over assets	Strategic commitment to customers	6	Heavy metals and formaldehyde in stripping and depigmentation	6	Improve process responsiveness	Increase supply chain flexibility	7	252	Help to focus on core competencies.		Reduce logistics costs	5	4	6	120
3	Assure quality in distribution	Improvement in sales revenue	5	Working capital improvement	5	Capital asset reduction	Production cost reduction	6	150	Labour cost reduction		Logistics cost reduction	4	5	5	100
4	Able to provide guidance on time	Fixed Logistics asset	5	reduction Average order cycle length	5	Cash-to-cash cycle reductions	Service level improvements	4	100	Customer satisfaction		Employee morale	4	4	4	64
5	Improve transportation consistency	Risk minimisation	6	Supply chain optimisation	6	Marketing Performance Indicators	Profit margin	6	216	Return on sales		Approved supplier list Input acceptance/Specifications	6	5	5	150
6	Stock accounting	Order planning and processing	5	IT management	7	Invoicing	check every hour	7	245	Payment collection		Approved supplier list Input	5	6	5	150
7	Contamination of the product with chemicals used in storage area cleaning and carcinogenic effect	Contamination of foreign substances such as band-aids, gloves, etc. used by	4	Improve process lead time	5	Strategic Service	offerings Reliability Cost Reputation	6	120	Employee training Reliability		Cost Reputation	4	4	5	80
8	activity in food due to inappropriate temperature in transport vehicles	Value Chain Service Offerings	6	Reduce total logistics costs	5	Reduce cycle time -Increase customer satisfaction	-Possess state-of-the-art hardware and software	7	210	Able to provide guidance on time		Able to resolve problems effectively	4	5	5	100
9	contamination of belts due to poor rinsing after cleaning	Compatibility with the users	6	Flexibility in increasing production capacity	5	Service category	Perfect rate	7	210	References from current customers		Able to resolve problems effectively	4	5	5	100
10	Risk Ability in identifying and preventing potential	On Time Delivery/ Service Delivery	7	Quality Production/Service	5	Ability to meet delivery due dates	Flexibility in increasing or decreasing production capacity	6	210	Service category		Quality Perfect rate and Reliability	6	5	5	150
11	Industry knowledge and References from current customers	Value Chain Service Offerings	8	Physical equipment - Size and quality of fixed assets	5	Risk Ability in identifying and preventing potential problems	Financial stability and staying power	6	240	Key tenets of the theory (or mid-range theory)		Firms consider attributes of transactions when deciding on integrating business processes through internal governance mechanisms or	7	5	5	175
12	Commitment to quality	Reserve capacity or the ability to respond to unexpected	6	Financial stability and staying power	6	Reduce cycle time -Increase customer satisfaction	-Possess state-of-the-art hardware and software	5	180	Able to provide guidance on time		Ongoing assessment of transactions/business processes to ensure re-visiting of past decisions in favor of either internal or external governance	5	5	4	100