Food Bank

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***Abstract*—Food banks have played a crucial role in mitigating food insecurity in affluent countries for over four decades. Throughout the years, academics have researched food banks for a variety of operational problems, resulting in several research papers on the topic. However, despite significant academic interest, the operational challenges and optimization of food bank operations remain under-researched. This study aims to conduct a systematic literature review on food bank operations and provide evidence-based recommendations for addressing prevalent challenges, and provide decision-makers with practical recommendations. In addition, this investigation seeks to investigate the impact of the COVID-19 pandemic on food bank operations. We conducted a comprehensive analysis of academic publications on food bank operations using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) in order to get a deeper comprehension of the problems confronting food bank operations. Additionally, it discusses the role of governmental and non-governmental organizations in supporting food bank initiatives and suggests potential improvements for enhancing their effectiveness..**

Keywords— Food insecurity, Hunger relief, Food donation, Community support

I. INTRODUCTION

Food insecurity is a growing problem throughout the world, with nutritional shortages affecting more than one billion people. In 2015, the United Nations General Assembly set “zero hunger” as the second sustainable development goals (SDGs). Food insecurity occurs when people in need do not have enough food. According to the reports, these people face significant health and social issues such as a lack of safe and nutrient-rich foods and depression as a result of the social stigma associated with food insecurity . Eliminating hunger and achieving food security, also known as “Zero Hunger,” is a major global challenge . Food insecurity affects at least 155 million people in 50 countries, and the COVID-19 pandemic has exacerbated the problem in many regions of the world . The COVID-19 pandemic, as well as social distancing measures to slow its spread, have wreaked havoc on economies and food systems both globally and locally, with serious implications for food security . Food shortages, a loss of disposable household income, higher food costs, and dietary changes are just a few

consequences of the COVID-19 pandemic . As a result of the global pandemic, more than 140 million people were predicted to be living in extreme poverty in 2020, a 20% increase from the previous year, and food insecurity increased dramatically . Unfortunately, the COVID-19 pandemic is expected to exacerbate food insecurity, malnutrition, and obesity, potentially exacerbating health and social inequalities . An Overview

Food banks operate as intermediaries between food donors and recipients. They collect surplus food from supermarkets, farms, and manufacturers, preventing food waste while simultaneously addressing hunger. These organizations often collaborate with charities, shelters, and community groups to distribute food efficiently. The role of food banks varies by region, depending on governmental policies and local socioeconomic conditions.

II. LITERATURE REVIEW PAPERS

- Food Bank Operations: Review of Operation Research Methods and Challenges During COVID-19 Authors: Aida Esmaeilidouki, Mohana Rambe, Amir Ardestani -Jaafari, Eric Li, and Barb Marcolin

  The paper *"Food Bank Operations: Review of Operation Research Methods and Challenges During COVID-19" systematically analyzes how food bank operations adapted during the pandemic. It highlights key challenges such as disrupted supply chains, increased demand for assistance, and reduced availability of volunteers. To tackle these issues, researchers employed methods like Mixed-Integer Linear Programming and Data Envelopment Analysis to optimize resource distribution and streamline operations. The study emphasizes the importance of evidence-based strategies for managing food donations, scheduling volunteers, and improving efficiency. It also calls for further research to overcome limitations in current methodologies and enhance food bank operations.

- A Systematic Literature Review of Food Banks' Supply Chain Operations with a Focus on Optimization Models Authors: Adrian Fernando Rivera, Neale R. Smith, and Angel Ruiz.. The paper *"A Systematic Literature Review of Food Banks' Supply Chain Operations with a Focus on Optimization Models"* examines the operational challenges faced by food banks and explores optimization models to improve their supply chain efficiency. Using databases like Web of Science and Scopus, the authors analyzed 95 articles to identify key features of food bank operations and classify optimization models. The study highlights the importance of decision-making tools for food bank managers and discusses future research avenues to address food insecurity and enhance supply chain operations.

- Food Insecurity and Food Banks: Perspectives from Supply Chain Management Authors: Sarah Turner and John Graham. Published in: International Journal of Logistics Research and Applications. Focus: Examines food banks' role in addressing food insecurity via efficient supply chains. The paper Food Insecurity and Food Banks: Perspectives from Supply Chain Management" by Sarah Turner and John Graham, published in the *International Journal of Logistics Research and Applications*, explores how food banks address food insecurity through efficient supply chain management. It emphasizes the critical role of food banks in mitigating hunger by optimizing resource allocation, improving distribution networks, and ensuring the availability of nutritious food. The study also highlights challenges such as supply chain disruptions and limited resources, offering insights into strategies for enhancing food bank operations to better serve vulnerable populations.

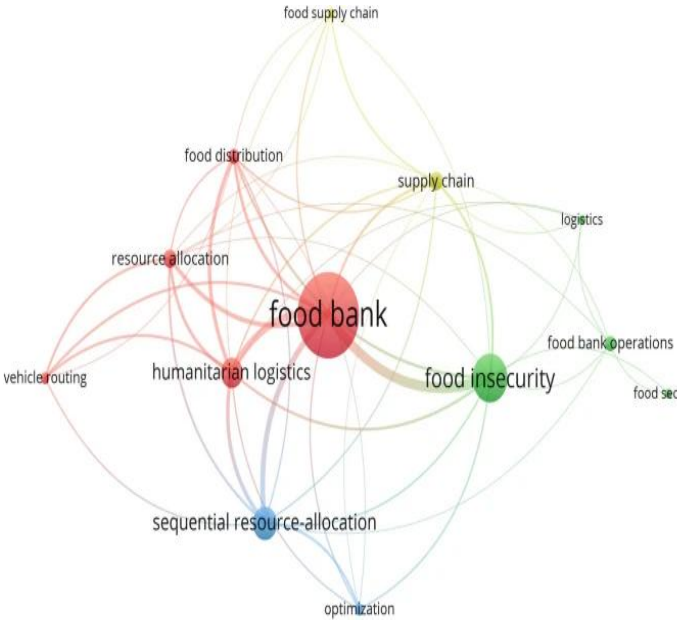
- Sustainability in Food Banking: An Operational Perspective Authors: Jane Morris and Richard Kingsley. Published in: Journal of Humanitarian Logistics and Supply Chain Management. Focus: Reviews practices for sustainable food bank operations The paper *"Sustainability in Food Banking: An Operational Perspective"* by Jane Morris and

Richard Kingsley, published in the Journal of Humanitarian Logistics and Supply Chain Management, explores sustainable practices in food bank operations. It emphasizes the importance of reducing food waste, optimizing resource allocation, and implementing environmentally friendly supply chain strategies. The study highlights innovative approaches to enhance sustainability while addressing food insecurity, offering valuable insights for improving the long-term efficiency and impact of food banks.

- Challenges in Food Bank Operations: A Comprehensive Review Authors: Emily Hayes and Michael Torrence. Published in: Social Impact Journal. Focus: Analyzes operational challenges and suggests strategies for better resource allocation The paper *"Challenges in Food Bank Operations: A Comprehensive Review"* by Emily Hayes and Michael Torrence, published in the Social Impact Journal, examines the operational hurdles faced by food banks. It identifies key issues such as supply chain inefficiencies, resource shortages, and increased demand, while proposing strategies to

III. RESEARCH GAPS:

Food banks are essential organizations designed to alleviate hunger and food insecurity by distributing food to individuals and families in need. While their contributions have been widely acknowledged, several research gaps persist, limiting their operational effectiveness and societal impact. One significant gap lies in the integration of real-time data and dynamic decision-making within optimization models, such as Mixed-Integer Linear Programming (MILP), which are used to streamline food bank operations. Furthermore, there is limited research on sustainable practices, including waste reduction and energy efficiency, which are crucial for long-term operations. Equity in food distribution, particularly in underserved and rural areas, remains an underexplored area, leaving questions about fairness and accessibility unanswered. In addition, the management of volunteers—an integral part of food bank functionality—lacks sufficient studies on scheduling and retention strategies. Lastly, the long-term social and economic impacts of food banks on communities are not comprehensively assessed, leaving gaps in understanding their effectiveness and areas for improvement. Addressing these research gaps can help enhance the efficiency, sustainability, and equity of food banks, ultimately strengthening their role in combating global hunger. Food banks serve as crucial organizations in the fight against food insecurity, ensuring that surplus food is collected, stored, and distributed to those in need. However, significant research gaps remain in understanding and optimizing their operations. One of the key gaps is the lack of integration of real-time data and dynamic decision-making into the optimization models, such as Mixed-Integer Linear Programming (MILP), widely employed to enhance operational efficiency. Furthermore, there is a growing need for studies focused on sustainability practices within food banks, such as minimizing food waste, adopting energy-efficient supply chain practices, and exploring innovative approaches to environmental conservation. Equity in food distribution is another underexplored area, particularly in underserved or rural regions where access to food assistance might be limited or inconsistent. Additionally, while volunteer efforts play an essential role in food bank operations, there is insufficient research on optimizing volunteer management, including recruitment, retention, and scheduling strategies, to ensure operational continuity. Lastly, the long-term social and economic impacts of food banks on communities remain inadequately assessed, leading to a lack of comprehensive understanding of their broader influence. Bridging these gaps is essential to improve food bank efficiency, sustainability, and social equity, thereby enhancing their ability to address hunger and contribute positively to global food security



The diagram illustrates the interconnected themes related to food bank operations, highlighting key areas such as logistics, food insecurity, and optimization methods. At the center, the food bank serves as the primary node, linking various research topics. One major cluster, humanitarian logistics and resource allocation, focuses on managing food distribution, vehicle routing, and ensuring an efficient supply of resources. Another significant theme is food insecurity and food security, which emphasizes the role of food banks in addressing hunger and maintaining stable access to food. The supply chain and logistics cluster deals with the movement of food from suppliers to food banks, including challenges in distribution and disruptions caused by external factors like COVID-19. Lastly, the optimization and research methods cluster explores ways to enhance efficiency through mathematical and operational techniques, such as sequential resource allocation and optimization models. The interconnected nature of these clusters highlights the complexity of food bank operations, showcasing how different factors must be managed together to ensure effective food distribution and security, particularly during crises like the COVID-19 pandemic.

IV. METHDOLOGY

- The methodology of the study follows a structured approach, beginning with a **comprehensive literature review** to examine existing research on food bank operations, food insecurity, and supply chain management. This helps in identifying key themes, operational challenges, and the role of food banks, particularly during crises like COVID-19. Following this, **data collection and classification** are carried out using academic sources, case studies, and reports from food banks, categorizing information into areas such as humanitarian logistics, supply chain management, resource allocation, and optimization techniques. The study then conducts an **analysis of operations research (OR) methods, reviewing optimization models for efficient food distribution, logistics strategies for managing supply chains, and mathematical modeling techniques for demand forecasting. A significant aspect of the methodology is the examination of COVID-19's impact on food bank operations, including disruptions in supply chains, increased demand for food, and logistical inefficiencies. The study also identifies key challenges and research gaps, such as funding limitations, inefficient resource allocation, and policy-related constraints. Finally, based on the findings, the research provides conclusions and recommendations, emphasizing data-driven strategies and OR techniques to enhance the efficiency and resilience of food bank operations, particularly in handling future crises. The methodology of the study follows a structured, multi-phase approach to analyzing food bank operations, emphasizing the role of **operations research (OR) techniques** in improving efficiency and addressing challenges, especially during crises like COVID-19. The research begins with a **comprehensive literature review**, examining academic papers, industry reports, and case studies to identify key research areas such as food insecurity, humanitarian logistics, supply chain management, and resource optimization. This helps in understanding the fundamental operations of food banks and how different OR methods have been applied in the past.

- Next, the study undertakes data collection and classification, gathering relevant data from food bank organizations, government reports, and published research. The collected information is systematically categorized into different themes, including food distribution logistics, supply chain disruptions, demand forecasting, and optimization strategies. The study then conducts an in-depth analysis of operational research methods, reviewing mathematical modeling, simulation techniques, optimization algorithms, and decision-support systems used to enhance food bank efficiency. Techniques such as **linear programming, network flow models, and machine learning-based forecasting are explored to assess how food distribution can be optimized to minimize waste and maximize impact.
- A crucial part of the methodology involves assessing the impact of COVID-19 on food bank operations, analyzing disruptions in food supply chains, changes in food demand, and logistical challenges faced by food banks during the pandemic. This section relies on both qualitative and quantitative analyses, using case studies and statistical models to examine real-world challenges. The study also identifies key operational challenges and research gaps, such as inefficiencies in resource allocation, transportation bottlenecks, funding shortages, and the need for better coordination between stakeholders. Finally, the research provides conclusions and recommendations, suggesting innovative strategies for improving food bank operations. These include enhanced supply chain resilience, better use of predictive analytics, improved coordination between government and non-governmental organizations, and the adoption of AI-driven logistics solutions. The study emphasizes the importance of integrating data-driven decision-making and OR methodologies to ensure efficient food distribution

V. CHALLENGES

- Lack of Supply: The COVID-19 pandemic has proven to be one of the most disruptive global events that has resulted in severe food insecurity. The World Bank recorded an increase of 110 million people deemed food insecure due to the pandemic [27]. The resulting food disruptions across the global and local supply chain have caused supply decrease and food demand increase. In addition to the reductions in agricultural production and supply chain disruptions, the panic buying behavior exhibited by consumers during the pandemic has also contributed to a significant rise in demand and a reduction in the food supply
- Staff and volunteer shortage: Another pandemic-induced challenge we identified is related to the food banks' staff and volunteering. Food banks staff consist of volunteer and paid workers. Volunteers at food banks are mostly elderly people over the age of 70 who are willing to assist those living in poverty [30]. As a result of the COVID-19 epidemic, volunteers were turned away from food banks due to public health and public safety regulations regarding social distance and food service [81]. In this sense, food banks were unable to adequately sustain its operations due to a significant reduction in personnel. The increased demands during the pandemic also required additional personnel therefore further challenge food banks operation. Some recent study showed that several food banks were forced to close temporarily or permanently due to the lack of human resources

Once managers have stabilized the rapidly shifting demand and supply flows to respond effectively to an emergency, they must devise plans to restore public trust and confidence. According to , supply chain disruption management entails the forecasting of risks and the deployment of methods to mitigate the interruption. By implementing such recovery methods, the firm can respond rapidly to supply chain interruptions and be prepared for future disasters. These recovery strategies can be divided into proactive and reactive strategies to tackle any form of supply chain disruption. In a research conducted by [98], reactive and proactive methods were proposed for developing food sector resilience in response to the disruption caused by the COVID-19 pandemic. Both methods involve a robust implementation of risk management. Paul et al. developed a reactive approach to recover from the

supply distribution in a three-tier supply chain system. Besides, the resilience of operations is another critical element providing flexibility in recovery. Therefore, identified the critical factors related to the resilience of 26 food system businesses and organizations in Baltimore. Similarly, investigated the significant elements of a resilient food system that can deal with external shocks such as the COVID-19 epidemic. Kumar and Singh also proposed a strategic framework for improving agricultural food supply chain resilience. Using a robust version of a mathematical programming model to assess the supply chain's resilience and deal with disruptions is a perfect example of the OR method. For example, suggested a resilient MILP location-allocation-inventory model for disrupted food supply chains, and they interpreted three resiliency strategies to the presented mathematical model. Xia et al. also utilized a model based on a disruption recovery method employing a recovery time window with the intention of reducing costs.

VI. SUMMARY

Food banks play a vital role in combating food insecurity by collecting, storing, and distributing food to those in need. However, research reveals several gaps that hinder their optimal performance. These include the lack of integration of real-time data in decision-making models like Mixed-Integer Linear Programming (MILP), which could enhance operational efficiency. Sustainability remains an underexplored area, with limited studies on waste reduction and energy-efficient practices. Equity in food distribution, especially in underserved and rural areas, also requires more attention to ensure fairness and accessibility. Additionally, volunteer management strategies, including recruitment, retention, and scheduling, are inadequately studied despite being crucial for food bank operations. Lastly, the long-term social and economic impacts of food banks on communities remain insufficiently assessed. Addressing these gaps can significantly enhance the efficiency, sustainability, and equity of food banks, strengthening their role in alleviating hunger and supporting communities. Food banks are nonprofit organizations that play a crucial role in addressing food insecurity by redistributing surplus food to those in need. However, their operations face various challenges and limitations, which create opportunities for further research and improvement. One major challenge is the optimization of supply chain management, as food banks often rely on unpredictable donations and face logistical constraints in storing and distributing food efficiently. Advanced mathematical models like Mixed-Integer Linear Programming (MILP) can enhance operations, but real-time data integration for dynamic decision-making remains underexplored. Sustainability is another key area of focus. Food banks must adopt practices to minimize food waste, reduce their environmental footprint, and ensure long-term viability, yet research on implementing these measures is limited. Equity in food distribution, especially in rural or underserved areas, is also a critical concern. Many communities experience unequal access to food assistance, and studies are needed to analyze and address these disparities. Volunteer management represents another research gap. Food banks often depend heavily on volunteers for their operations, but strategies for optimizing recruitment, retention, and scheduling are underdeveloped in academic literature. Moreover, while food banks have a significant impact on communities, few studies comprehensively examine their long-term social and economic benefits, such as improvements in health outcomes, education, and workforce productivity. Addressing these gaps can transform food banks into more sustainable, equitable, and efficient entities, thereby amplifying their role in alleviating hunger and promoting global food security. Let me know if you'd like further elaboration on any of these aspects!

VII. CONCLUSION

In conclusion, food banks serve as indispensable organizations in combating food insecurity and hunger, yet their operations reveal significant areas for improvement. By addressing research gaps, such as the integration of real-time data into decision-making models, food banks can significantly enhance their efficiency and adaptability to fluctuating demands. Furthermore, adopting sustainable practices like waste reduction and energy-efficient operations is vital for ensuring their long-term viability and environmental responsibility. Equity in food distribution remains a

pressing issue, as underserved and rural communities often face barriers to accessing food assistance. Exploring strategies to promote fairness and accessibility is crucial for bridging this gap. Additionally, the optimization of volunteer management through effective recruitment, retention, and scheduling could strengthen the foundation of food bank operations. Lastly, understanding the long-term social and economic impacts of food banks on communities, including their contributions to public health, education, and productivity, can provide valuable insights into their effectiveness and guide future initiatives. By addressing these challenges, food banks can become more sustainable, equitable, and impactful, further amplifying their role in alleviating hunger and promoting food security globally.

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