

## Chapter 35

# Allocation Optimization Problem for Peruvian Food Bank

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### ABSTRACT

*Food insecurity is a recurrent condition in which members of a household do not have enough food to cover their nutritional needs; this condition contributes to increasing social vulnerability of those affected. In Peru, there are more than 9 million people who suffer this condition, which generates malnutrition and anemia, mostly in children. On the other hand, the waste of food is associated with production the large amounts of greenhouse gas emissions that affect global warming. According to reports in Peru, 20% of what is food produced becomes waste. This scenario in terms of food for Peruvians represents 3 billion calories in wasted food that could feed 2 million people. The Peruvian Food Bank manages food donations, ensuring this food can reach people in need through humanitarian aid entities. This applied research work uses the tools of operations research to determine a solution to the problem of maximizing the combination of food orders to be distributed based on their total nutritional value to the beneficiaries, seeking maximum coverage and minimum logistic costs.*

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## **INTRODUCTION**

Social vulnerability is expressed by the risk of households to suffer a deterioration in the conditions of quality of life, i.e. to fall into a state of poverty that does not allow the individual to cover their basic needs, including housing, education, work and food. In Peru, although there is an increase in the GDP, the percentage of citizens living in extreme poverty reaches 24.4% (INEI, 2017: INEI; National Institute of Statistics and Informatics).

In Peru malnutrition was reduced from 25.4% to 15.2% (PAN, 2012); despite this, child malnutrition in our country continues to be an important reason for death according to UNICEF data, with nearly half a million children under of 5 years, those affected. This is one of the reasons why projects such as food banks seek to recover food that is in the period limit and conditions of consumption do not turn into waste, to benefit less favored people, involving participation and solidarity of NGO's and companies, who participate voluntarily with their donations.

Food banks are non-profit institutions that have the function of acquiring food from different entities or suppliers (national and international), so that they can then be distributed to people to cover their basic nutritional needs of a specific population. Therefore, these institutions not only contribute to the health and welfare of society, but also contribute to preventing the generation of food waste and the preservation of the environment. According to the FAO (Food and Agriculture Organization of the United Nations), around a third of the foods in the whole world are wasted before people consume them and this becomes, therefore, garbage. The contribution of the food bank for this case is that foods that have already reached their life cycle or that are obsolete so that other organizations are redistributed optimally, and solid waste management is improved (FAO, 2013). Food banks seek to promote the social development of vulnerable communities, through the management of donations of goods, under a quality control system; that is, to serve as a link between donors and the vulnerable population that suffers from poverty, hunger and malnutrition, improving nutritional levels and sensitizing the community through volunteering (McCrindle. 2017; Delpish et al., 2018; Gonzales-Feliu et al., 2018).

Another important aspect to consider is the environment, since the production of food affects this with the waste that is generated every day and these foods could be used by food banks. Using these resources in vain would be a very bad decision. The waste will be in the form of solids, liquids, oils and more, which will then have to go through a process of biodegradation. In addition, we must consider the carbon footprint of wasted food that increases the emission of greenhouse gases and the effect it has on water, which we will drink later; as well as nitrogen emissions that directly affect the air we breathe. (Wang et al., 2006).

This work is presented following next order: first, a literature review about main theory frame is presented, after main issues related to Peruvian food bank supply chain is analyzed, an optimization model is proposed, and finally main results are discussed. The results show that the food loads to be sent can be maximized, increasing the coverage to the institutions from the current 24 to 69 at a lower transportation cost.

## **BACKGROUND**

Because of seeking a solution for problems such as malnutrition caused by hunger and social vulnerability (Phil et al., 2017), Food Banks all over the world have occupied a very important place in dif-

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