Research Statement

By Freddy Pérez

Research field

Inventory management is one of the most fundamental and challenging logistic activities for any company dealing with raw materials, work-in-process, and/or finished goods. Since organizations usually make a significant investment in inventories, the correct management of this tied-up capital provides a very important opportunity for business improvements. In the agricultural industry, for example, post-harvest losses are still significant and unavoidable. It is well known that one-third of food produced for human consumption is globally lost or wasted throughout the food supply chain, which has a negative impact on economic development and environment. While reducing perishable inventory waste may increase profit margins and be benefic for society, mismanagement of perishable products can represent a major threat to any organization. Therefore, finding suitable inventory management policies has always been of great importance to both researchers and practitioners.

On the one hand, it is possible to make large replenishment orders to get trade credit benefits and volume discounts, to reduce production costs by means of long production runs and economies of scale, and to increase sales by providing a high customer service level. On the other hand, there is the possibility of keeping stock levels down to avoid the risk of suffering financial difficulty as a result of low or tight liquidity and to avoid excessive costs incurred for keeping and managing large inventories. In order to balance these and other conflicting goals of supply chains management, novel approaches are required to provide answer to at least the following three questions:

i. How often should the inventory status be reviewed and determined?
ii. When should an order be placed?
iii. How large should the order quantity be?

In recent years we are witnessing a fascinating phenomenon which requires a radically different way of thinking, namely, the advent of inventory management applications that involve the so-called industry 4.0. Problems that stem from such applications are very different from traditional inventory problems as problems become global in scope and highly dynamic with large amounts of data and disparate, heterogeneous data sources. From a technical point of view, these problems require new modeling and decision tools that integrates a broader perspective and technological factors from computer science, and above all, a novel set of ideas and methods. The new approaches must facilitate the construction and analysis of complex system models and their understanding is a fascinating and deep challenge.

Research background

Most of my research experience in the last years comes from my doctoral studies, so I will highlight the main contributions of my thesis to the field of inventory management. My Ph.D. dissertation focuses on optimization problems that arise in logistic and supply chain management. This work contains three major parts and was done in collaboration with Professor Fidel Torres from Universidad de los Andes, Armann Ingolfsson from University of Alberta, and Aida Huerta from Universidad Nacional Autónoma de México. The first part examines the literature of inventory models for deteriorating items. Here, we provide insights into the inventory management by evaluating what the lot-sizing theory applied for the management of perishable products has collectively accomplished and what directions might be fruitful for future research.

The second part of my dissertation provides a new method for jointly determining ordering quantity decisions and price-discount strategies by modeling the effect of the time value of money and allowing the existence of shortages. This study was motivated by a call for more research in context where a temporary price discounts strategy is used to deal with perishable inventory. Even though perishable products represent one of most important sources of revenue in grocery industry, very few studies had been designed to study the price discount effect on promotional sales for perishable products. Thus, we aim to address these issues by using an inventory modeling approach.

The third part of my dissertation responds to the increased public awareness about the importance of reducing food waste globally. As pointed out by several studies, food losses do not merely have a direct and negative impact on the income of both farmers and consumers, but also a negative impact to society through unnecessary and avoidable costs for waste management, greenhouse gas emissions, and loss of scarce resources, such as land, water and energy, used in their production. It is impossible to provide a precise answer as to how we can prevent food losses, and certainly, there is still much more research needed. However, it is widely accepted that the causes of food losses and waste in medium/high-income countries are closely linked to the behavior of consumers as well as the lack of coordination between different actors in the supply chain. Thus, in the light of this need, we propose a coordinated inventory model with the potential of being applied to evaluate and achieve just-in-time (JIT) purchasing alliances between retailers and farmers. Here, JIT agreements do not only generate a space for waste and costs reduction, but also create a great opportunity to increase sales and benefits throughout the supply chain of the retail sector, since, as a matter of fact, the quality of most food products would no longer be necessary to be sacrificed in order to tolerate current logistics and management practices of this industry.

Research opportunities

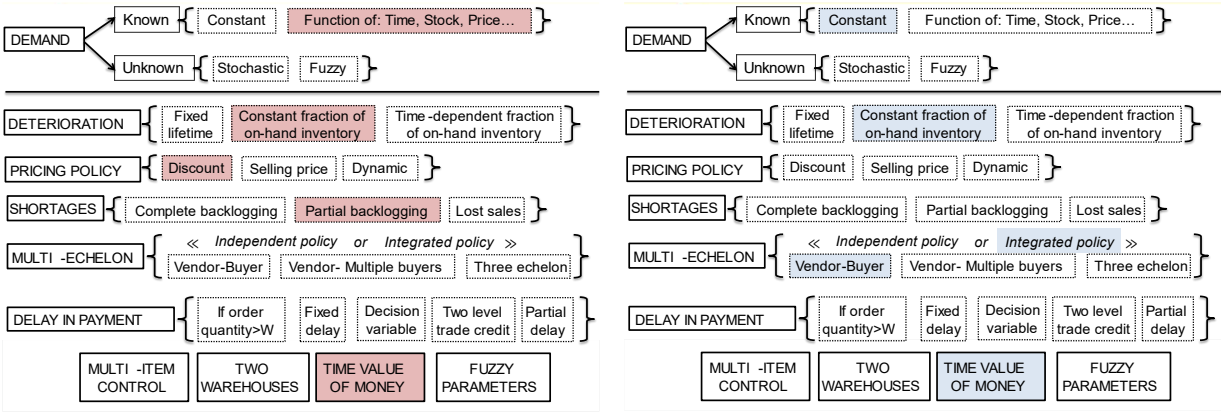
So far, my research has been focused on inventory management. My dissertation, "Inventory Models for Managing Deteriorating Products in the Retail Sector" provide new tools with the potential of improving complex logistic and management practice, as well as supporting sustainability and competitiveness in both domestic and international trading. I see this work as the starting point for my long-term research goal of expanding the field of supply chain management beyond the focus in current scholarship. My current research project includes the development of a new simulation-based optimization approach and the application of an algebraic method for modeling complex inventory systems. I believe that this projects not only will have a significant impact on the literature but also it will facilitate the design and development of long-term partnerships between small farmers and retailers for global sustainability and competitiveness, and I would be thrilled to have the chance to direct them as well as guide and be part of multidisciplinary studies dealing with the management and competitiveness of companies for sustainable development.

Although the approach adopted in the above research project was broad in scope and the results of all the experiments were satisfactory, further research is still needed. In the first part of my dissertation, I found enough evidence to indicate that the gap between theory and practice is increasingly growing along with a large number and broad range of papers. However, it would be interesting to find out whether the same is happening for perishable products subjects to obsolescence (like electronics components and fashionable products), or even for non-perishable products. If the gap between theory and practice is also an increasingly growing phenomenon in the modeling of these types of products, then it is likely that one or more concepts within the inventory modeling framework have become "reified".

For any research field, reification is problematic because it threatens the validity of studies using a theoretical framework. A particular concept or construct becomes taken for granted and researchers increasingly fail to specify the assumptions that justify its use. To the inventory modeling literature, this would mean that some of the modeling characteristics commonly used to represent inventory systems are being included or adapted out of context in an increasing range of papers instead of being treated as a building modeling approach that need to be constantly refined and revised. The problem created by reification, thus, can only be addressed through a systematic assessment of the literature in which the diverse interpretations and applications of the construct are investigated along with its underlying assumptions.

The literature on inventory management also suggests additional ways in which the inventory models included in my Ph.D. dissertation may be improved to obtain more suitable inventory policies in different contexts. For example, in the proposed models, we assumed that the deterioration rate of perishable products is constant over time. i.e., a constant fraction of the on-hand inventory is assumed to spoil over time. Although this modeling approach was originally proposed to accurately represent the deterioration nature

of volatile liquids and radioactive substances, it has also been extensively used by researchers as an approximation to represent a great variety of perishable products such as fresh produce. We found this modeling approach particularly useful when the spoilage of products comes from multiple sources. However, there are still situations in which modeling a time-varying deterioration rate may produce a better profitable inventory policy. The Figure bellow illustrate this and other topics that may be explored in future research. The non-red and non-blue highlights represent, respectively, the different contexts in which the models developed in the second and third part of my dissertation may be analyzed in future research.



Currently, I am working on in a new simulation-optimization approach that I specifically designed to apply, under stochastic environments, the models developed during my doctoral studies. Although I made significant advances when finishing my Ph.D., I still must investigate the performance of this approach when solving other complex stochastic inventory control problems. If I found this approach to be useful, then it will be a promising new tool from which researchers and software developers could benefit.