# Chapter 10
# Improvement of the Optimization of an Order Picking Model Associated With the Components of a Classic Volkswagen Beetle Using an Ant Colony Approach

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## ABSTRACT

*Warehouse operations, specifically order picking process, are receiving close attention of researches due to the need of companies in minimizing operational costs. This chapter explains an ant colony optimization (ACO) approach to improve the order picking process in an auto parts store associated with the components of a classic Volkswagen Beetle car. Order picking represents the most time-consuming task in the warehouse operational expenses and, according to the scientific literature, is becoming a subject matter in operational research. It implements a low-level, picker-to-part order picking using persons as pickers with multiple picks per route. The context of the case study is a discrete picking where users' orders are independent. The authors use mathematical modeling to improve de ACO metaheuristic approach to minimize the order-picking cost.*

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## INTRODUCTION

Warehouse management is an essential aspect of the manufacturing and service operational process in today's companies. The way in which companies manage their warehouses affects directly in the total operational cost. Nowadays, order picking is the most cost and time-consuming operation of warehouse management with an average of 50% to 75% of total warehouse operational expenses (Djatna & Hadi, 2017). The literature shows that the order picking process (OPP) is composed of several processes that can be improved such as picking, batching, zoning and layout design (de Koster, Le-Duc & Roodbergen, 2007).

This research aim is to explain an improvement of the optimization of an Order Picking Model associated with the components of a Classic Volkswagen Beetle using an Ant Colony Approach in an auto parts retail store context where customer service is a priority. This type of warehouse is considered as a traditional industrial layout due to the layout organization in linear aisles with crossovers (Beroule, Grunder, Barakat & Aujoulat, 2017). Ant colony systems approaches have been used to optimize combinatorial problems such as the Travelling Salesman Problem, which is the problem to solve in our context. In this research, the order picking process is transformed to a TSP to simplify the search of solutions. By carrying out the above described, we intend to improve the service of attention according to the three main characteristics of this type of warehouse: the high number of parts managed; the irregular demand patterns (having periods of very high demand), and the high responsiveness required due to downtime cost that customers have.

The remainder of the chapter is organized as follows. The Background section reviews the literature of the Ant Colony Optimization (ACO) algorithm and the Travelling Salesman Problem (TSP). The Main Focus of the Chapter section describes the issues, controversies and problems addressed. The Application Domain section describes the automotive spare parts warehouse context addressed in the research. In the Methodology section, we described the flowchart and pseudocode of the ACO algorithm. In the Related Work section, we describe similar research articles. Then, we described the process and instances used in the research in the Materials and Methods section. The Experimentation Section evaluates the performance of the proposed ACO algorithm with three sets of analyses. The first analysis is intended to evaluate the percentage improvement using the ACO algorithm. The second analysis is intended to evaluate the ACO algorithm with a larger set of orders. In the third analysis, we evaluate the ACO algorithm using a multivariable analysis to find the best parameter configuration that gives the best solution. Finally, we describe the future research direction, and we present the conclusions drawn from the results of our experiments.

## BACKGROUND

### Ant Colony Optimization

The ACO algorithm was proposed by Dorigo, Maniezzo & Colorni (1996). From this initial proposal, several variants have been developed to solve combinatorial optimization problems. At first, ACO can be applied to any discrete combinatorial optimization problem where a construction mechanism solution can be conceived.