Chapter 1
A Problem of Ecological Dynamic Logistics

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ABSTRACT

Companies have to be competitive to survive, offering their customers a more customized and complete service. Moreover, society is increasingly more aware of the need to solve problems in an ecological way trying to reduce pollution/environmental impact. Furthermore, when we try to solve management problems in crowded cities, companies expect their solutions not to depend excessively on traffic conditions and not to have an effect on the worsening of these conditions. In this chapter, the authors study how to handle the aforementioned requirements, defining the problem of ecological dynamic logistics in urban environments. In this problem, a fleet of agile environmentally friendly vehicles have to pick-up and deliver items. However, these vehicles have a limited storage capacity, and they need the support of larger environmentally friendly vehicles, mobile warehouses, to increment their range. The problem is solved by planning the routes for both delivery/pick-up vehicles and mobile warehouses in a coordinated manner, allowing the incorporation of new items during execution of the plan. To obtain a solution for this problem the authors propose to use the Ant Colony Optimization metaheuristic.

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INTRODUCTION

In a competitive economic environment, where the number of alternatives for companies and consumers is greater than ever, it is crucial for the companies to effectively organize their logistics activities in order to face the changing needs of the XXI century. Nowadays, companies work in an environment where customer’s requirements are very demanding, and in particular, they cannot allow themselves to have problems with the delivery of their goods. Delivery requirements may include, in many occasions, to perform them on the same day in which they are sent. For this reason, courier companies must make sure to provide really efficient services and to offer to the customers a more detailed and specific support.

Additionally, today’s concerns about the environment, are encouraging the search of solutions that try to reduce emissions, and consequently, environmental impact to a minimum. In this sense, courier companies can find new business opportunities by adopting more environmentally friendly policies. A good way to adapt to these requirements is to use low or no-emission vehicles to deliver their items, as for example, bicycles or electric vehicles. Along with these ecological requirements, courier companies are interested in finding solutions that can overcome cities’ traffic problems, which may include, changing traffic conditions, blocked streets… For this reason it is advisable to use agile vehicles like bicycles or small motorcycles that can move faster on a city, and that are less affected by traffic conditions. However, these vehicles have a limited capacity to carry items, and to improve their range of action it is useful to rely on bigger vehicles that can carry more items. These other vehicles may also be environmentally friendly, as electric vans or cars.

Taking all these requirements into account, a new niche market is appearing, which encourages the appearance of courier companies that focus on the delivery and pick up of items on cities, using a flexible and ecological approach. However this is a complex problem that includes many challenges:

1. It has to permit the traceability of goods, effectively and on time;
2. It needs to ensure a maximum utilization of resources;
3. It has to allow to make decisions on real time, like updating orders while the process has started;
4. It has to avoid as much as possible problems due to cities’ traffic conditions, taking into account the availability of online information; and
5. It needs to use ecological vehicles that can reduce environmental impact to a minimum.

Given this idea, this paper focuses on the problem of organizing the fleet of vehicles that carry out the delivery/pick-up activities. We have named this problem “ecological dynamic logistics in urban environments”. In order to solve this problem we have to define the routes that must be followed by the vehicles. Additionally, these routes have to reduce the cost for the company and provide an optimum service in terms of time. We propose to perform the delivery/pick-up operations using agile ecological vehicles (called terminal vehicles), which as was previously stated, have a limited storage capacity. For this reason, they must be supported by higher capacity vehicles (called mobile warehouses) that allow them to gather new items which must be delivered and to deposit the items that have already been picked up. This approach allows to reduce both the costs for the company and the environmental impact of their actions. Hence, the problem consists in planning the routes of both kinds of vehicles in a coordinated manner, given a set of delivery and pick-up points, and a set of points were mobile warehouses can wait for terminal vehicles. Additionally, the solution has to allow the adding of new elements of delivery/pick-up during the execution of a plan.