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Solving a multi-periods job-shop scheduling problem using a generic decision support tool

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Abstract

In this paper a generic and modular decision support tool developed to solve different planning, assignment or scheduling problems is presented. The utilization of this tool is illustrated by solving a real world multi-period job-shop scheduling problem proposed by a case study company which produces refrigerated foodservice equipment. The case study company problem and a list algorithm developed to integrate the proposed tool for this particular problem are presented. Preliminary results show that the proposed tool can be effectively used to solve the company problem. Besides the problem described in this paper, the proposed tool was used in the past to solve two other problems. Thus, it is demonstrated that the proposed tool can be easily adapted to several different planning or scheduling problems variants, overcoming the lack of flexibility generally associated to more problem-tailored methods proposed in the literature.

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Keywords: Decision support tool; multi-period job-shop scheduling; Metaheuristics, List algorithms, Case study.

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1. Introduction

Research in scheduling theory has evolved over the past forty years and has been the subject of much significant literature with techniques ranging from unrefined dispatching rules to highly sophisticated branch and bound algorithms and bottleneck based heuristics [1]. Numerous scheduling problems arise in industry and while they are relatively simple in their formulation, they typically involve only sequencing and resource constraints, they remain extremely challenging to solve [2].

The various scheduling problem variants has been widely explored in the literature but most authors still propose highly problem-tailored methods that are not applicable to other scheduling variants. As referred in [1], no solution approach with a guaranteed performance has been developed so far. The same authors state that for most approximation methods there are instances for which they perform badly and it is not completely known under which circumstances a given procedure is likely to succeed or fail.

In this paper a generic decision support tool which was developed to solve many different planning problems is presented. The proposed tool consists of a hybridization of a metaheuristic and a list algorithm. The metaheuristic can be used without any changes independently of the problem to be solved. The list algorithm must be adapted according to the studied problem.

The described decision support tool was already tested with two different planning/scheduling problems: (1) an activities planning and resources assignment problem in a multi-place hospital context [3] and (2) a lot-sizing and scheduling problem with setups and due dates, for a plastic injection company [4]. In both cases good results were obtained with the proposed tool.

The main objective of this paper is to explain how the proposed tool was adapted to solve a new problem encountered in a case study company which produces refrigerated foodservice equipment. This adaptation consists in using the base of the tool developed to the previous solved problems and only develop a list algorithm for the current specific problem. Thus, the intent is to demonstrate that the proposed approach is generic, in the sense that it can support the decision process for several different planning and scheduling problems with a minimum development work.

The paper is organized as follow: Section 2 starts with a description of the case study company and the problem to be solved is characterized. Then, a brief literature review on job-shop scheduling which is the type of problem encountered in the case study company is presented. Section 3 describes the tool proposed to solve the case study company problem, focusing on the list algorithm developed for the specific production planning case considered in this paper. In section 4, based on results obtained using a test instance, the ability of the proposed tool to deal with the case study company planning problem is discussed. Finally, section 5 presents some conclusions.

2. Problem description

2.1. The case study company

The case study company is a manufacturer of refrigerated foodservice equipment, like counters, cabinets, blast chillers, freezers and cold rooms. The products are mainly composed by an external structure, doors, shelves and a refrigeration unit. Some clients will buy company standard products, but the majority will demand a complete bespoke unit. Thus, equipment production will be made in small lots or they will be manufactured one of a kind.

The company shop-floor is composed by two main departments: part production and assembly. The assembly department is composed by two assembly lines where the external structure, the doors and the refrigeration unit (produced in house) and the internal partition elements, like shelves, drawers and baskets (purchased from suppliers) are assembled to obtain the final product. In the part production department, cutting machines and punching systems are used to manufacture external structure and door components from stainless steel sheets.

Based on customer firm orders, the company planner defines a production plan for the two assembly lines. A weekly demand file is generated to the part production department, containing the list of metallic parts required to feed the assembly lines, see Table 1 for an example.

Thus, the weekly demand for parts required to feed the assembly lines represents a list of jobs to be produced containing the following information: