22.1. Introduction

Audit staff scheduling is an integral part of audit planning and control. It is also a very important part of the audit planning and control process due to the desire of the management to control auditing costs, plan the impacted time of the auditors efficiently, and meet the clients' deadlines. In fact, efficient audit scheduling can be used to set these deadlines based on the audit or accounting firm's capacity. Through efficient scheduling, audit firms can determine the load and schedule of every auditor, over time requirements, travel schedules and costs, and can respond to changes in the information set (input data) easily.

A typical auditing or accounting firm employs many auditors with different levels of experience. An auditor has his/her preferences as to which experience (s)he wishes to accumulate. The firm also has its priorities with respect to serving its clients efficiently on one hand and honoring the wishes of its own and those of its auditors on the other hand. Hence, there is a match to be maximized, or equivalently a mismatch to be minimized between the workload of the firm and auditors. This gives rise to the performance measure to be used in the audit scheduling process.

The workload of the firm over a given planning horizon consists of several audit engagements. Each engagement is characterized by its type (industry), ready and due dates, processing requirements, and preferences of the client. Due to these characteristics each audit engagement can be perceived as a project, which is known to be a unique undertaking with specific starting and completion dates, and specific processing requirements. Consequently, each audit engagement can be broken down into interdependent, small and controllable units of work, each to be processed by an individual auditor, known as "audit tasks". The dependencies between the tasks
can be captured through a precedence relations structure. Hence, each audit engagement can be modeled as a PERT/CPM network. The precedence can be of the classical finish-to-start type with zero lags, or can allow for overlapping between the tasks, for example with a minimum gap between the start of an activity and the start of its direct predecessors. The networks of the several engagements can be combined together to model the load of the firm as an activity network. Hence, emerges the match between audit scheduling and project management. Therefore, managing the engagements is similar to managing multi-projects with many renewable resources.

The issues facing the audit firm is to determine the working schedule of each auditor, while accommodating their preferences to the maximum possible extent; and also to determine the schedule of each audit engagement while accommodating the objectives of the clients also to the maximum possible extent. It is the desire of the firm to have a scheduling tool which can integrate all of the above segments on one hand, and can be used to respond to changes in the information set, and answer the "what if" type questions on the other hand. As a side benefit and according to Blocher (1979), efficient audit staff scheduling reduces the rate of turnover among auditors; hence leading to reduction in the setup cost of hiring and training. It also leads to reducing the overall cost of the audit; and hence improves the competitive advantage of the firm, Bernstein (1978). Therefore, it is clear that effective audit scheduling is very important. However, it is very complex and difficult to accomplish. Some of these difficulties will be explained in the subsequent sections. They lead to the formation of a complex combinatorial problem.

This article deals with the above problem and develops the desired scheduling tool. It is organized as follows. In the next section the evolution of the research on the audit staff scheduling problem is presented. It is shown that the problem first moved from the stage of audit planning by inspection (trial-and-error) to audit loading using the methods of PERT/CPM or linear programming. Then, at a later stage, it moved from audit loading to audit scheduling, as it is known in project management. Within the stage of audit scheduling it moved also in several states, where in each state more realism was added to the scheduling tool or new solution methodology was developed. In Section 3 the latest mathematical model for the problem is presented; it is the 0 – 1 linear program developed by Dodin and Elimam (1997). This section ends with the classification of the problem using the proposed classification of Herroelen, Demeulemeester and De Reyck (1998). Section 4 deals with the solution methods and their efficiencies where computational experience is provided. Finally, in Section 5 concluding remarks are stated.

22.2. Evolution of the research on audit staff scheduling

Affiliation between audit scheduling and project management started shortly after the introduction of PERT and CPM. Burgher (1964) was the first to extend the PERT method to audit planning. His attempt was expanded in 1977 by Rackie et al to include extending PERT/Cost for audit planning and control. Similarly, network analysis was also extended to internal audit planning, Cirtin (1977). In all instances PERT was used to provide planning guidelines, and it was not used to schedule