In this research we extend the classical linear assignment problem by adding a dimension of resource to the problem, making it a resource dependent assignment problem (RDAP). In this problem, one has to not only assign an agent to each task, but also allocate a budget or other resources to the completion of that task. The allocation of budget and personnel are usually two of the most important decisions one has to make when substantiating a new project of any kind. Those two decisions are usually taken separately and independently, which might result in a non-optimal solution. In our assignment problem, one must simultaneously decide both on the assignment of agents to tasks and on the budgetary allowances that will guarantee an optimal solution. We show that this RDAP is reducible to a multitude of scheduling problems with resource-dependent times. In fact, the RDAP can be reduced to any such scheduling problem, which includes a positional penalty. On that basis, we determine the computational complexity of at least seven scheduling problems whose complexity has heretofore been an open question. Among these, the most important is minimization of the sum of completion times with resource-dependent processing times. The computational complexity of this problem has been an issue for almost three decades, for both linear and convex resource consumption functions.

A solution for our assignment problem is defined by the assignment of agents to tasks and by resource allocation to each agent. The quality of a solution is measured by two criteria: the first criterion being the total assignment cost and the second, the total weighted resource consumption. We address these criteria via four problem variations. We show that our assignment problem is solvable in polynomial time for one of the variation. However, and somewhat surprisingly, we prove that it is NP-hard for the remaining three variations even if all the resource consumption weights are equal. Moreover, we show that these variations are only NP-hard in the ordinary sense by providing a pseudo polynomial algorithm to solve them.