

# AN EFFECTIVE SOFTWARE DEVELOPERS' TOOL FOR PROJECT SCHEDULING

Dimple OGUNBIYI<sup>1</sup>, Esther ISOLA<sup>1</sup>, John ADENIRAN<sup>1</sup> and Pelumi AYENI<sup>1</sup>

<sup>1</sup>Osun State University, Nigeria.

<sup>1</sup>dimple.ogunbiyi@uniosun.edu.ng, <sup>1</sup>esther.isola@uniosun.edu.ng, <sup>1</sup>john.adeniran@uniosun.edu.ng,

<sup>1</sup>pelumi44@gmail.com

**Keywords:** project management, project scheduling, profit-based scheduling, software developer, weighted job scheduling.

**Abstract:** *A schedule in project management is a listing of a project's milestones and deliverables, typically with supposed begin and end dates. How do we effectively and automatically schedule projects in order to maximize time and profit? This paper presents the development of a profit-based project scheduling management system which was designed to meet the need of software developers who often have issues with effectively prioritizing projects. Unified Modelling Language (UML) was used in visualizing the design of the system. Also, a weighted job scheduling algorithm was adopted to determine the most viable project based on time management and profit return. The system was implemented following a sequential development approach and client-server architecture. The prototype developed is an interactive web-based one that can be used to manage, schedule and prioritize software developers' projects based on profits majorly considering the project cost, profits, duration of project and estimated time of completion.*

## 1. INTRODUCTION

A project is a temporary endeavor that comprises several tasks, with each task having a start and end or due date for delivery, so as to meet the set time for completion [1]. When skills, knowledge, tools, and techniques are applied to project activities in order to meet the project goals it is referred to as project management [2]. Project management is not limited to industrial use only; an average person can use the principles of project management to organize their own life, some application of project management to individuals are: homeowner renovation project, keeping track of all the family activities, coaching a team, vacation planning and planning a wedding, construction, manufacturing software development, etc., which usually involves making a procedural plan or an agenda that indicates the time and sequence of operations commonly referred to as a schedule.

A schedule may be defined depending on the context of use. In managing projects, the project schedule shows all the activities related

to delivering the project on time. The project manager will be unable to communicate the efforts of project roles without a complete schedule, in terms of cost and resources, necessary to deliver the project. A project management schedule outlines what work needs to be done, the order in which it needs to be done, what resources are required, how they will be distributed, and how long different parts of the work will take. The schedule helps project managers communicate and collaborate with team members and stakeholders, and keeps the project on track [3].

Project scheduling plays a vital role in ensuring the completion of a project. It is a process of ordering, controlling project activities by breaking down a project into small tasks which makes it easier to complete projects on time and within the estimated budget. Project scheduling management can be used in various professional fields like engineering, medical research, education, and even business and is a way to communicate tasks that needs to be done and how organizational resources will be allocated to complete those tasks within the time

frame allocated and a document that defines all the work needed to be done in order to deliver the work on time is the project schedule. Project scheduling helps to determine which task needs to be done, who it is assigned to, and what time it needs to be completed. Without a well-crafted project scheduling management, project managers cannot communicate the project cost, resources, and time needed to complete the project. While there are several project management tools specifically designed to perform operations such as planning, budget management, resource allocation, collaboration, communication, quality management, scheduling, etc., [4], [5], [6], there is no scheduling system in the context of listing and prioritizing projects as they are taken, especially focusing on the profit aspects with a business mind-set. Many project scheduling systems/tools in practice adopt project scheduling techniques as described in project management which may include (i) Mathematical Analysis such as Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) [7], [8] (ii) Duration Compression such as fast tracking [1] and crashing [8] (iii) Simulation and Resource Levelling Heuristics [9] as well as scheduling terms used in various areas of research as scheduling and the techniques used may depend on the problem to be solved.

In order to schedule a bulk of projects based on profit, professionals for a long time had to manually compute the project time completion, cost effectiveness and profits. This process is not only time consuming but it is also tedious. For software developers, software projects tasks can become overwhelming with several and varying projects from clients. Naturally, a First-In-First-Out approach is usually adopted in order to prioritize scheduled projects. Prioritization becomes crucial as the projects become more and the need to get profits is increased. Assume a developer takes five projects around the same time, the factors that may determine their time of completion are (i) the order in which the jobs were taken (ii) the size of the project in terms of all vital resources (iii) the amount that is to be realized after all expenses are made. These factors are considered and aforementioned issues resolved while developing the project scheduling management system presented in this paper. The proposed system can be used as a framework or extended for use by

other project-oriented businesses and may not be limited to software projects.

The remainder of this paper presents the review of related literature in Section 2, the methodology is presented in Section 3, the implementation of the system is discussed in Section 4 and finally the study is concluded in Section 5.

## 2. RELATED WORKS

The term “scheduling” generally in computing, project management and operations research have been used severally with varying goals and context in mind applying it to different instances including manufacturing, operations research/decision theory, modeling or finding solutions to project scheduling problems, machine job processing [10], [11], [13], [14], [15], and [16].

[10] proposed a dedicated technique coupled with simulated annealing to solve the problem of resource-constrained project scheduling problem with the discounted cash flow i.e., contractor’s expenses related to project execution and client’s payment after contractual stage completion in order to maximize criterion from contractor’s perspective. An experimental investigation showed the effective moves and techniques for generating solutions that are backward scheduling, optimizing the completion time of different project stages. Furthermore, [11] focused on scheduling a set of jobs (coupled tasks) with the sole objective of having a minimal job completion time. They depicted a full complexity representation for single-machine scheduling of coupled tasks with precise delay time in between two successive tasks in order to raise performance.

In addition to research articles, several tools have been implemented in order to carry out several project management aspects including scheduling. [12] reviewed several project management tools giving their features and quality according to IEEE standards and predicted the project management tool with great quality that can be standardized for future use. They also posited that development of software systems nowadays is significantly large, multifaceted and critical, that only through the use of automated approaches can such systems be developed and evolve in an economic and timely manner.

These tools implement one or more scheduling techniques. However, there are no articles or tools that match our concern or considered helping developers prioritize their schedules based on the profits from projects, which is one of the major goals of a developer from a business perspective. The context in which we use the scheduling is in line with its meaning including “arrangement”, “planning”. While there exist project management/scheduling software, they are generic and have not considered some other essential factors to schedule and prioritize tasks effectively aside start and end dates. Also, researchers and software developers have not considered implementing a system that provides a solution to the question raised in this study.

### 3. METHODOLOGY

To develop the profit-based project scheduling management system (PSMS), a sequential developmental methodology was followed. The system structure follows client-server architecture as shown in Fig. 1 and the behaviour of the system was modeled using UML. Fig. 2 shows the use case diagram for the system. A user will be able to register and login to the system, create new projects, add tasks, assign collaborators, and manage the schedule of the projects. Fig. 3 shows the class diagram for the implementation of the system giving the various classes, attributes and operation.

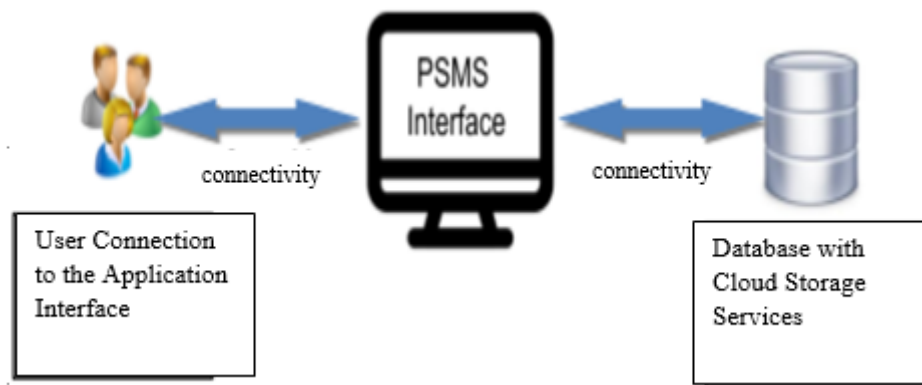


Fig. 1 Project Scheduling System Architecture

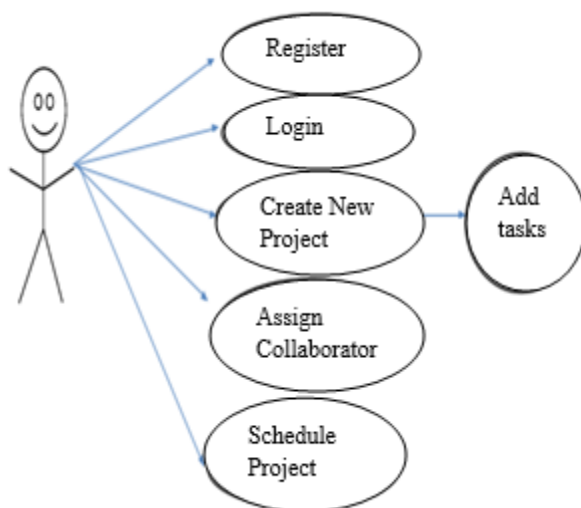


Fig. 2 Use Case Diagram for the Project Scheduling Management System

In order to prioritize the order of the estimated profits, the Weighted Job Scheduling (WJS) algorithm was adopted. This method of scheduling focuses on determining the maximum profit from a set of tasks/jobs instead of maximizing the number of jobs finished. Three elements are important in a task when using this algorithm: (i) start date (ii) end date and (iii) value associated with the task.

The subset of the task giving the maximum profit is returned. Given N tasks, find the maximum profit that can be gotten without tasks time range overlapping. The pseudo code for the weighted job scheduling is given as follows:

```

Procedure WeightedJobScheduling(Job)
sort Job according to finish time in non-
decreasing order
for i -> 2 to n
  for j -> 1 to i-1
    if Job[ j ].finish_time <= Job[ i ].start_time
      if Acc_Prof[j] + Profit[i] > Acc_Prof[i]
        Acc_Prof[i] = Acc_Prof[j] + Profit[i]
      endif
    endif
  endfor
endfor
maxProfit = 0
for i -> 1 to n
  if maxProfit < Acc_Prof[i]
    maxProfit = Acc_Prof[i]
  endif
endfor
return maxProfit

```

#### 4. IMPLEMENTATION AND DISCUSSION

A prototype of the project scheduling management system was implemented as a web-based system using HTML, CSS, JavaScript for the client side and PHP and MySQL (Database) for the server side. The system operations can be carried out after the verification process from the user according to the stored input in the database. New accounts can also be created for access to the system. The user is given access to the dashboard where new projects can be created and projects can also be managed. The user creates tasks to do, and can modify the tasks; creating the tasks entails entering the start and end time of the tasks, the amount to be paid and spent on the task.

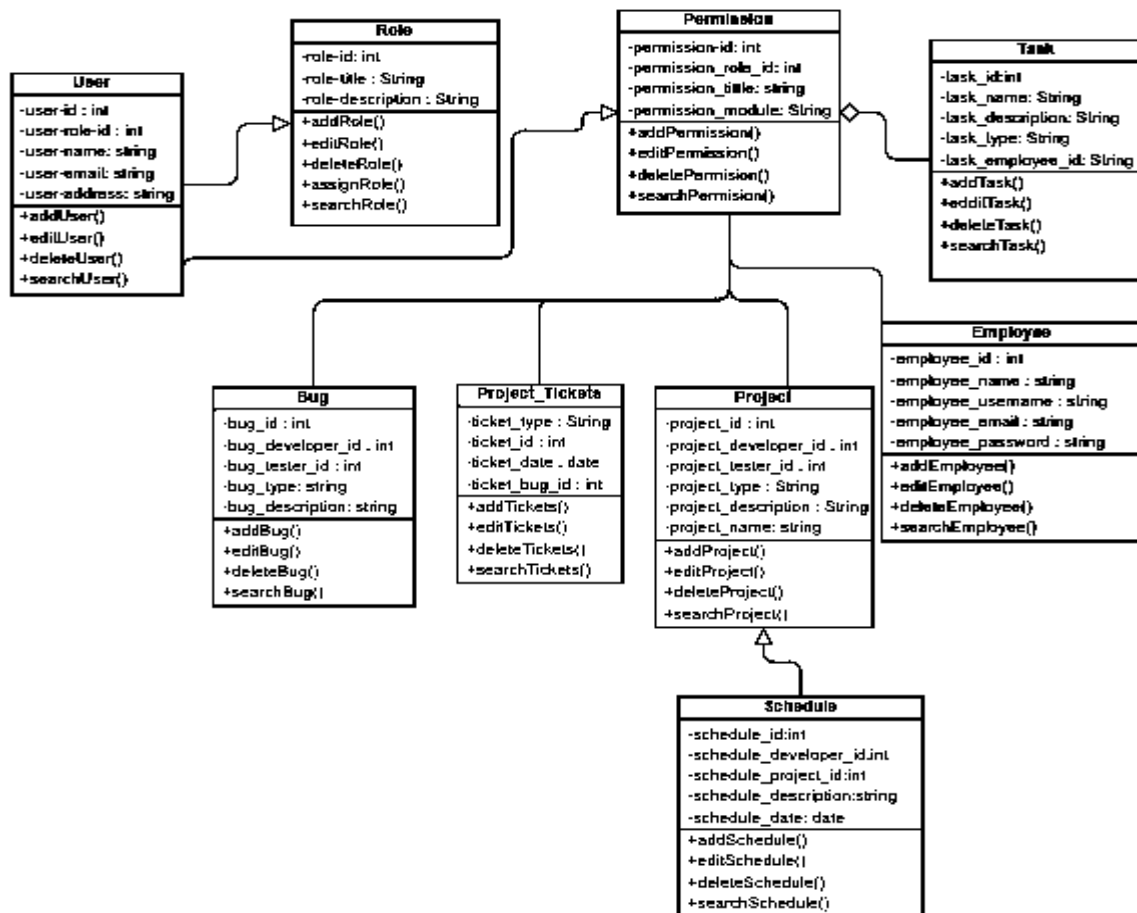


Fig. 3 Class Diagram for the Project Scheduling Management System

Then apply the weight job scheduling algorithm to prioritize the job according to the profits. The profit is assigned after the deduction of the total resources needed by the developer is deducted and the profit assigned weights that will be fed into the algorithm, after which a user can perform the task as scheduled by the algorithm and then submit the assigned job before/on the

stipulated date and time. A code snippet (schedule function) for the implementation of the job scheduling based on profit is shown in Fig. 4 as written in Sublime Text editor. In order to determine the value attached to each task for prioritization, the expense for the project is subtracted from the total cost of the project.

```
37 public function schedule (Request $request) {
38     $projects = $request->get('projects');
39     $jobs = array();
40     $all_projects = array();
41     $all_profits = array();
42
43     if(count($projects) > 0) {
44
45         foreach ($projects as $project) {
46             $the_project = Projects::findOrFail($project);
47             $cost = $the_project->cost;
48             $expense = $the_project->expenses;
49             $profit = $cost-$expense;
50             $all_profits[] = $profit;
51             $all_projects[] = $project;
52             $jobs[] = array($project, $the_project->start_date, $the_project->due_date, $profit);
53         }
54
55         $project_profit = array_combine($all_projects, $all_profits);
56         $max_profit = max($all_profits);
57         $the_project_profit;
58
59         foreach ($project_profit as $key=>$data) {
60             if($max_profit == $data) {
61                 $the_project_profit = $key;
62             }
63         }
64
65         $project_profit_data = Projects::findOrFail($the_project_profit);
66
67         Misc::scheduleJobs($jobs, count($jobs));
68         echo "<br/>The project with the maximum profit is <b><a href='/projects/view/$the_project_profit' class='text-info'>";
```

Fig. 4 Code Snippet for the Implementation of the Project Scheduling Management System

Fig. 5 shows some of the user interface and interpretations of some functions of the project scheduling management system prototype.

The details of available projects and their status are shown on the dashboard page (a), which allows users to add tasks to a desired project.

To add tasks, a project has to be selected from the manage button at the extreme top right corner, the page is then reloaded to display contents belonging to the project selected.

Afterwards, the user can then fill in the input fields displayed to add tasks to the project.

Other pages shown include the new project page (b), to add a new project, project description page (c) which shows the dates, cost of projects and tasks assigned to each project and schedule manager page (d). Once the project cost and price charged are filled, the profit is automatically calculated.

The user can then click on the submit button to save the project. Upon successful creation of more than one project, the project with the highest can be calculated.

PROJECT SCHEDULING SYSTEM Ayeni Oluwapelumi

Dashboard Projects

Welcome, Ayeni Oluwapelumi Manage my projects

1

Completed Projects

2

Uncompleted Projects

**Update Profile**

Fullname  Phone number

[Save Changes](#)

**5 RECENTLY COMPLETED PROJECTS**

Construction of 4th mainland bridge Oct. 23rd, 2019 - Nov. 4th, 2019

**5 RECENTLY UNCOMPLETED PROJECTS**

Reconstruction of VC Lodge Sep. 20th, 2019 - Sep. 28th, 2019

Design of Uniosun website Sep. 25th, 2019 - Oct. 21st, 2019

(a) Dashboard Page

PROJECT SCHEDULING SYSTEM Ayeni Oluwapelumi

Dashboard Projects

**+ Add New Project**

Title

Cost  Expenses

Start date  Due date

Do you want to add collaborators?

Description

[Close](#) [Continue](#)

**+ Add new project**

Completed

**+ Add new project**

Completed

**+ Add new project**

Completed

**+ Assign more collaborators**

**+ Add new task**

Completed

(b) New Project Page

PROJECT SCHEDULING SYSTEM Ayeni Oluwapelumi

Dashboard Projects

**+ Add new project**

Construction of 4th mainland bridge Completed

Collaborators - Ayeni Pelumi, Olaoeye Kolade, Ayodele Shile Assign more collaborators

N5,000.00 N2,300.00 Oct. 23rd, 2019 Nov. 4th, 2019

**Project Description**

The project starts on Oct 1st, 2020.

**Tasks** Add new task

**This is the goal**

Wow

Completed on Oct. 1st, 2019 01:10 PM Completed

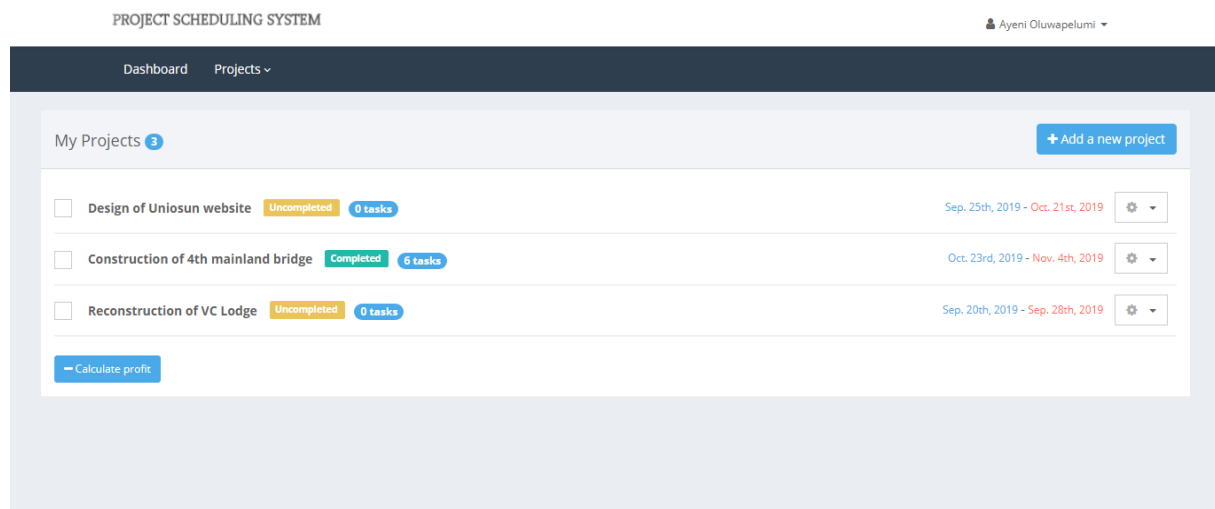
**This is it**

mehhnn

Completed on Oct. 1st, 2019 01:05 PM Completed

[Mark as completed](#) [Edit](#) [Delete](#)

(c) Project Description Page



(d) Schedule Manager Page  
Fig. 5 User Interface for Project Scheduling Management System

## 5. CONCLUSIONS

The work focused on the development of a project scheduling management system with the goal to improve how software developers can easily rank projects to earn more profits from projects with the view that proper task management will allow ease of prioritizing.

To guide developers in prioritizing jobs while maximizing profit, the system implemented the weighted job scheduling algorithm. A prototype implementation was developed using suitable programming tools.

The outcome is a web-based project scheduling management system which has been validated to meet the requirements and can be extended in matters of administrative management and organization. Though the intent for this study is for the system to be used by software developers, the tool can also be applicable to other business domains where management of project is eminent and can be used for scheduling other projects besides software projects.

## 6. REFERENCES

- [1]. Klastorin, T., "Project management: tools and tradeoffs" (3rd ed.), Hoboken, NJ, John Wiley, 2004.
- [2]. Shein, C., Robinson, H. E., Gutierrez, H., "Agility in the archives: Translating agile methods to archival project management", *RBM: A Journal of Rare Books, Manuscripts, and Cultural Heritage*, 19(2), 94-120, 2018.
- [3]. Lewis, J., "Fundamentals of Project Management" (2nd ed.), AMACOM, 2002.
- [4]. Kundu, J., Bishoi, T. K., Bhattacharya, M., Chowdhury, A., "Project management software—an overview", *International Journal of Current Innovation Research*, 1(6), 129-135, 2020.
- [5]. Liberatore, M. J., Pollack-Johnson, B., "Factors Influencing the Usage and Selection of Project Management Software", *IEEE Transactions on Engineering Management*, 50(2), 164-174, 2003.
- [6]. Wilkes, J., "Project management software", *Journal of the Operational Research Society*, 38(2), 209-209, 1987.
- [7]. Paweł, H., "Project Scheduling Techniques Every Project Manager Should Know", teamdeck, accessed 23.12.2020: <https://teamdeck.io/project-management/project-scheduling-techniques/>
- [8]. Kerzner, H., "Project management: a systems approach to planning, scheduling, and controlling", John Wiley & Sons, 2017.
- [9]. Huo, Z., Ma, N., Liu, B., "Joint user scheduling and transceiver design for cross-link interference suppression in MU-MIMO dynamic TDD systems", in *3rd IEEE International Conference on Computer and Communications (ICCC)*, pp. 962-967, IEEE, 2017.
- [10]. Klimek, M., "Financial optimization of the resource-constrained project scheduling problem with milestones payments", *Applied Sciences (Switzerland)*, 11(2), 1–14, 2021.

- [11] Chen, B., Zhang, X., “*Scheduling coupled tasks with exact delays for minimum total job completion time*”, Journal of Scheduling, 24(2), 209–221, 2021.
- [12]. Sajad, M., Sadiq, M., Naveed, K., Iqbal, M. S., *Software Project Management: Tools assessment, Comparison and suggestions for future development*”, International Journal of Computer Science and Network Security (IJCSNS), 16(1), 31-42, 2016.
- [13]. Tian, B., Tian, C., Wang, B., Li, B., He, Z., Dai, H., Liu, K., Dou, W., Chen, G., “*Scheduling dependent coflows to minimize the total weighted job completion time in datacenters*”. Computer Networks, 158, 193-205, 2019.
- [14]. Kasravi, M., Mahmoudi, A., Feylizadeh, M. R., “*A novel algorithm for solving resource-constrained project scheduling problems: a case study*”, Journal of Advances in Management Research, 16(2), 194–215, 2019.
- [15]. Almeida, B. F., Correia, I., Saldanha-da-Gama, F., “*Modeling frameworks for the multi-skill resource-constrained project scheduling problem: a theoretical and empirical comparison*”, International Transactions in Operational Research, 26(3), 946–967, 2019.
- [16]. Agnetis, A., Briand, C., Billaut, J. C., Šůcha, P., “*Nash equilibria for the multi-agent project scheduling problem with controllable processing times*”, Journal of Scheduling, 18(1), 15–27, 2015.