

An Enhanced Freelancer Management System with Machine Learning-based Hiring

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Abstract

Existing Freelancer Management Systems are not being adequately efficient, inconveniencing to a certain degree the freelance workforce, which comprises around 1.1 billion freelancers globally. This paper thereby aims to resolve the impediments of similar existing systems. Pertaining to the methodology, qualitative analysis was adopted. Interviews, participant observation, interface analysis, workshop documents, research papers, books and articles were used to draw data about similar applications. A web application was implemented to fulfil the objectives by using WAMP as a local development server, Visual Studio Code as a source code editor, and HTML, PHP, Python, SQL, JavaScript and CSS as programming languages along with Ajax for requests-handling functionalities, and already available APIs, and jQuery and Python libraries. The contributions brought forth are providing a shortlist of the best-qualified freelancers for each project via Machine Learning technique, generating an automated invoice and payment as soon as an entrepreneur supplies a monetary figure when approving the deliverable of a project, and enabling freelancers to sign contracts electronically to comply with business terms on one centralised repository, unlike existing systems which do not support these 3 features together on the same platform. The multivariate regression model used for intelligent hiring performs satisfactorily by yielding a R^2 of around 0.9993.

Keywords: Freelancer Management System, Freelance entrepreneur, Freelancer, Intelligent hiring, Machine Learning, Natural Language Processing

Introduction

Existing partially efficient Freelancer Management Systems(FMSs) still add to the challenges of freelance entrepreneurs and freelancers who are currently estimated to be 1.1 billion worldwide (Warner, 2021). A Freelancer Management System(FMS) generally acts as a software solution by assisting freelance entrepreneurs in streamlining their engagement with freelancers at scale at a company or a start-up with complex operational needs. As distinguished by studies, a freelance entrepreneur engages the service of freelancers to establish a business, whereas the latter vends knowledge, skills and abilities (Kazi et al., 2014). Meanwhile, the labour market has undergone drastic changes throughout the past decade and even more so with the advent of the global COVID-19 pandemic, paving an uptrend in freelance work (Dunn et al., 2020). Yet, existing FMSs still have numerous limitations. Deducing which freelancer is most suitable for a project for hiring purposes is cumbersome for freelance entrepreneurs.

Many entrepreneurs still handle invoices and payments manually, causing freelancers to face late payments (Shevchuk et al., 2012).

Furthermore, there is no assurance that a freelancer will comply with business regulations (Gupta et al., 2020). Entrepreneurs additionally endure hardship to monitor each freelancer's skills or progress with the project assigned, especially as the workforce expands.

Several entrepreneurs use different tools for specific tasks (Thabassum, 2013). For instance, some use Invoice Ninja, an open-source invoicing application, to prepare invoices and track expenses. Integrated payment gateways within this application enable entrepreneurs to make payments effortlessly. Some entrepreneurs also use Hive, a cloud-based system for chats, file sharing and project monitoring. However, administrative processes dependent on various tools rather than one application become exhausting as the number of freelancers augments. Others use freelance marketplaces such as Upwork and Freelancer.com, which serve as an intermediary between the entrepreneur and the freelancer, with downsides including a marginal fee for entrepreneurs (Gupta et al., 2020; Krishnamoorthy et al., 2016). On the other hand, some use FMSs such as Shortlist, Kalo and TalonFMS, which offer a centralized platform for hiring, project and payroll management, and tracking and reporting on the freelance workforce. They additionally open up a broad talent pool and boost productivity (Krishnamoorthy et al., 2016).

Freelancers and freelance entrepreneurs are not required to be in a specific country or region but can be all over the globe (Thabassum, 2013). Moreover, freelance work can enable freelancers to develop new skills to advance or change careers. Entrepreneurs also do not have to provide infrastructures such as buildings, furniture or electronic devices to freelancers (Thabassum, 2013). However, engagements between entrepreneurs and freelancers become difficult as the latter increase in number. Keeping track of each freelancers' skills, reviews or projects appointed, deciding which freelancer is most suitable to be hired for a project, or settling payments, turn exasperating on current platforms supporting businesses employing freelancers.

Furthermore, there is no guarantee that a freelancer will comply with the business terms and conditions or get paid (Gupta et al., 2020).

The aim of this paper is, therefore, to build an application for the purpose of resolving the issues in existing FMSs.

Literature Review

Limited research has been conducted on FMS, given that it is a relatively new platform that emerged after 2013 (Karpie, 2015).

Many existing FMSs such as Shortlist and Kalo currently provide only a responsive web application as a software solution. They cover onboarding, communications, project assignments, invoicing and payments. They help to fortify relationships between entrepreneurs and freelancers, and increase their productivity. However, hiring a freelancer is still tedious. These systems cannot automatically determine the right freelancer to hire for each particular project, thus requiring entrepreneurs to manually analyse each bidder's details such as reviews, skills, experience, qualifications or previous projects worked on.

Furthermore, many existing applications still do not allow freelancers to sign contracts electronically. There is no assurance that a freelancer will deliver assigned work by the specified deadline or that an entrepreneur will pay the former for a task completed (Gupta et al., 2020). Numerous existing systems do not, moreover, support automated payment. Freelancers still experience delays in payments owing to entrepreneurs preparing invoices and making payments manually (Shevchuk et al., 2012). On the other hand, though few latest existing systems dispense functionalities such as electronic signature, and automated invoice and payment, they still do not provide intelligent hiring facilities.

Since existing FMSs do not support automated hiring or list best-qualified freelancers for projects, Artificial Intelligence technology can be used to hire a proficient workforce to ensure success and growth for both the entrepreneur and freelancer following as example other online recruitment systems which rank candidates for jobs by leveraging Machine Learning algorithms (Geetha et al., 2018; Faliagka et al., 2012; Harris, 2018). Several techniques

score candidates based on keyword and phrase matches, while others employ associative rules, classification rules or clustering patterns (Harris, 2018). Classification rules and patterns were used to classify employees into different groups such as highly suitable, potentially suitable, and not suitable (Harris, 2018). Multi regression and Support Vector Machine(SVM) were also used for employee recruitment and selection(Vijayanand et al., 2018; Ye et al., 2009; Vedapradha et al., 2019). Other systems use Knowledge Discovery in Databases(KDD) to provide decision support which assesses the performance of other employees and make longitudinal predictions on candidates showing similar traits (Harris, 2018).

Methodology

Qualitative research design was adopted to inspect the workings and limitations of current FMSs, along with solutions and amendments to be brought forth. Studies conducted to draw data about existing Freelancer Management solutions utilised interviews of freelance entrepreneurs and freelancers, interface analysis, and participant observation while working as freelancer. Detailed demonstrations of existing systems, which were dispensed by freelance management solution providers such as TalonFMS and Kalo, were analysed. Global workshop documents, research papers, books and articles, amongst other materials revolving around the stakeholders, were examined.

Existing FMSs Typically Comprise the Following Features:

- Onboarding process
- Searchable directory with freelancer profiles
- Project posting and hiring
- Messaging and file-sharing
- Submission of project deliverable
- Ratings and reviews
- Invoice and payment
- Management Reporting

At first, when new freelancers make a registration, they can have access to the system after that an entrepreneur has made a background check and approves the latter's registration. When a freelancer's registration is approved, he or she can go through the onboarding process which includes adding qualifications, work details and portfolios,

and signing a contract. An entrepreneur can post new projects, and a freelancer can browse through the list of latest projects and make a bid with a sample file attachment, a price suggestion or the approximate number of days within which he or she can complete work on the project. An entrepreneur can hire a freelancer who has bidden on a project. Entrepreneurs and freelancers can communicate with each other about project work through the chat feature of the website. After deliverable submission, an entrepreneur reviews the work and pays the freelancer. An entrepreneur can also browse through a directory of freelancers and analyse detailed management reports such as financial reporting.

As a solution, a real-time responsive web application based on Machine Learning was proposed to resolve the impediments of current FMSs and bring about new improvements, and to automatically list one or more most suitable freelancers for each project.

The Software Development Life Cycle (SDLC) prototyping model was chosen for developing this project. This model is ideal because the system is large and has dynamic requirements. The prototyping model begins with requirements gathering. Known requirements are identified, and areas where the further definition is mandatory are outlined. Functionalities are defined, and a quick design is made. A throw-away prototype is constructed from quick design. The prototype is evaluated and used to refine requirements. Iteration occurs as the prototype is tuned. Table 1. shows the software specifications for the website.

Table 1: Software Specifications for the Web Application

Technology	Description
Visual Studio Code	Editor for PHP and Python development
WampServer	Windows web development environment used to create the web applications with Apache, PHP and MySQL database
Firefox	Browser used to test web pages to ensure that the website can be viewed from different browsers

Firefox Developer Tools	Web developer tools used to examine, edit, and debug HTML, CSS, and JavaScript
PHPMaile	Library for sending email from PHP
Mailtrap	Mock SMTP server used to test, view and share emails sent from the development environment without actually sending them to their intended recipient
PayPal sandbox	Virtual testing environment for simulating the live PayPal production environment
PayPal Payouts API	REST API used to send payments by just having the PayPal email address of the recipient
IP-API	IP Geolocation API used to determine a user's timezone based on his or her IP address
Postman	Postman was used for testing APIs
jQuery and Python libraries	Various jQuery and Python libraries were reused as mentioned further ahead in this section

The main features implemented for the FMS are more explicitly described further in this paper.

A. Freelancer's Registration

When a new freelancer registers, all entrepreneurs shall receive a notification, following which one of them will be able to approve the registration after conducting a background check. New freelancers shall be able to access their account until after an entrepreneur has approved the registration.

B. Contract

An entrepreneur can upload a new contract in PDF format and send contracts to all or just some selected freelancers, provided that the latter's accounts are active. Freelancers to whom the contract was sent, receive a notification informing them about the new contract. The freelancer can sign the contract electronically on the website before submitting it. We used Keith Wood's jQuery UI signature plugin to capture the freelancer's signature and Mozilla's pdf.js JavaScript library to render the PDF file of the contract using the web standards-compliant HTML5 Canvas. Upon signing and submitting the contract, a notification is sent to all entrepreneurs to inform them about the signed contract submission. The notification is sent to all entrepreneurs because if one of them is unavailable, then another one can see the new notification and view the signed contract.

C. Onboarding

New freelancers whose registration has been approved are required to go through the onboarding process whereby they may add details of their biography, skills, education, experience, portfolio or social links. Each freelancer can view, update or delete the aforementioned details. Within the onboarding phase, freelancers are also required to add their payment details, without which they will not be able to receive payment for work done.

D. Project Posting, Bidding and Hiring

An entrepreneur can create and update a project, and view and filter the list of ongoing or completed projects whereby most recent ones are displayed first. To create a new project, an entrepreneur should supply the title, description, budget, start date and

Figure 1. illustrates the core features of the system implemented.

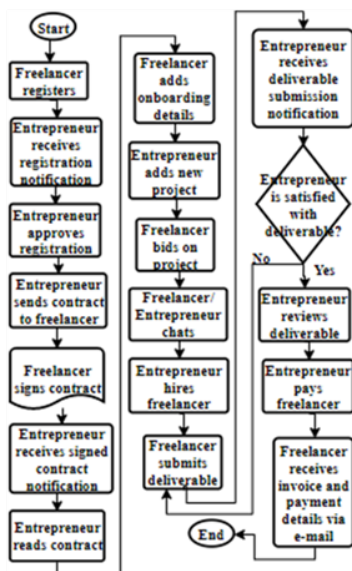


Figure 1 Flowchart Featuring the Prime Functionalities of the Web Application

deadline of the project, and select an entrepreneur who will supervise the project.

Freelancers can view and filter the list of the latest ongoing projects and place a bid on a project provided that they have not already bid on the project. Bids usually constitute the amount and duration the freelancers can work for, along with a sample file to showcase their suitability for a particular project. Freelancers can also view the bids of their competitors and download their bid sample files. The purpose of allowing a freelancer to view the bid proposal and download the bid sample files of other freelancers is to foster a sense of competition between the bidders, thus encouraging them to place substantial bids to help entrepreneurs make right hiring decisions.

After a freelancer has bid on a project, an entrepreneur can view the bid proposal and download the bid sample file. Specifically, an entrepreneur can hire a freelancer provided that the latter has bidden on a project and is not currently working on another project; that is, a freelancer is required to complete the project they are currently assigned to before being hired for another project.

Before hiring a bidder, an entrepreneur can visit the former's profile page to analyse their ratings, reviews, previous projects worked on, skills, education, experience and portfolio to ensure that the best-qualified freelancer amongst those who have bidden is chosen for a specific project. After being hired, freelancers shall receive a notification that they have been hired and shall be able to view the details of the current project assigned.

However, analysing each bidder's profile for hiring purposes is tiring and time-consuming, especially when the number of freelancers increases as the workforce gradually expands. To resolve this issue, through the Machine Learning technique, we provide entrepreneurs with the option to view a shortlist of the 3 best-qualified freelancers for a particular project with the precondition that the latter have bidden on that specific project and are not currently taken up with another project. An entrepreneur can then hire one or more freelancers featured on the shortlist.

To generate a shortlist of the 3 most suitable bidders to work on a particular project, we utilised

Machine Learning technique and adopted the following core steps:

1. Prepare a simulated dataset
2. Create and save a Machine Learning model for predicting the most suitable bidders for each project
3. Load and consume the saved model to generate a shortlist of the 3 best-qualified bidders whereby the freelancer appearing first on this list is the most suitable one for each specific project

We prepared a simulated dataset of 110 records programmatically in a comma-separated values(CSV) file. The dependent variable, y , is the value indicating a bidder's suitability for a specific project, and the independent variables are:

1. x_1 : number of years of experience of the freelancer
2. x_2 : this value is 1 if the freelancer has added a bid sample file; else it is 0
3. x_3 : average rating of the freelancer
4. x_4 : total number of projects which the freelancer has completed
5. x_5 : degree of text similarities, generated by spaCy Natural Language Processing framework, between data of a particular project and data of the freelancer whereby the project data constitutes of the project title and description, and the freelancer's data comprises his or her biography, skills, qualification title, portfolio title and description, job title and bid proposal.

Taking into account the linear relationship between the dependent and independent variables, we created and saved a multivariate regression model to predict best-qualified bidders for each project. The multivariate regression model takes the form $y = a + 2x_1 + 4x_2 + 5x_3 + 6x_4 + 3x_5$ whereby a , the intercept is assumed to be 0.

We made the required modifications in the main configuration file of the Apache webserver to be able to run Python files in WampServer, and we implemented an API in Python to load and consume the saved Machine Learning model. When an entrepreneur requests for the shortlist of best-qualified freelancers for a particular project, data of bidders who are not currently working on a project is sent to the API in JSON format. Consecutively, the API sends back as response a JSON string of 3 top

bidders' ID and a decimal number which is sorted by the highest value indicating a freelancer's suitability for the particular project.

E. Messaging and File-Sharing

A project supervisor, that is, an entrepreneur supervising a project, can create a new group conversation, and add freelancers working on the same project to it to provide instructions about the project, discuss progress on the project and send messages and files to one another.

F. Deliverable Submission, Review and Payment

After completing work on a project, a freelancer is required to submit a deliverable, after which the project supervisor can rate and review the work, and pay the freelancer. However, if the deliverable requires amendments, the freelancer can resubmit another one.

As soon as a freelancer submits or resubmits a deliverable, each entrepreneur shall receive a notification. This notification is sent to all entrepreneurs rather than solely to the project supervisor since if the latter is unavailable, another entrepreneur can view the notification to assess the deliverable, review it and make payment by simply adding the amount to be paid in United States Dollar (USD) after which an invoice will be automatically generated. USD is used as the standard currency on the system because freelancers can be all over the globe. PayPal Payouts API was used to make payments through the freelancer's PayPal email address.

For an entrepreneur to proceed with reviewing and making payment for a deliverable, a freelancer should have added a PayPal email address. The entrepreneur can communicate with the freelancer via chat and ask the latter to set a PayPal email address to receive the payment if they have not inserted one yet.

After being paid, a freelancer shall receive a notification on the FMS along with an email that has an invoice as attachment and instructions to claim the payment on PayPal.

G. Notifications

Notifications on the system are displayed in real-time while each notification time depends on the

user's timezone as determined by the IP Geolocation API. Each time an entrepreneur or a freelancer receives a new notification, they are sent an email. The purpose of this email is to inform users about a new notification so as to log in to the website, and view the new notification if they were not online.

Results and Discussion

In various existing systems, as the number of freelancers increases, administrative tasks such as hiring and paying freelancers turn arduous. This paper has been able to resolve these issues by dispensing a shortlist of the most suitable freelancers to work on a particular project, and by generating automated invoice and payment after that an entrepreneur has supplied a monetary figure when approving the deliverable of a project.

Furthermore, given the time differences amongst foreign freelancers, specific working hours may not be adhered to. The software of this paper thus counters this drawback by requiring freelancers to sign a service level agreement in the contract to ensure a standard online meeting time, especially when working in a team. Besides, freelancers might have to sign contracts by using another application or manually. To cease this inconvenience, this software enables freelancers to sign contracts electronically on the system itself to adhere to the business terms.

Even though few latest FMSs now support e-signature and automated payment, to hire freelancers, entrepreneurs still have to undergo the lengthy process of analysing the former's details such as reviews, previous projects worked on, skills and experience to determine their suitability for a project. The website implemented for this paper lessens this setback by dispensing intelligent hiring, automated invoice and payment, and e-signature features together on the same platform.

Certain existing applications still rely on other applications to share messages or files. This application hence incorporates a chat feature enabling users to send messages and files in groups. It also provides a searchable directory of freelancers since in certain similar software, it is difficult to keep track of each freelancer's rating, work experience, skills or previous projects worked on as the workforce enlarges.

To evaluate the performance of the regression model implemented, we calculated the coefficient of determination (R^2) which is 0.9993 (to 4 significant figures), thus indicating that the model works satisfactorily by representing a small difference between the observed data and the fitted values. This paper is also in line with literature utilising multivariate regression for decision making in the context of Human Resource and recruitment. For instance, Vedapradha et al. (2019) used the multivariate regression equation $y = 1.505 + 0.084x_1 + 0.116x_2 - 0.065x_3 + 0.045x_4 - 0.037x_5$ and predicted the performance of employees with a R^2 of 0.365.

Conclusions

This research has been able to solve the issues of existing FMSs by generating a list of 3 best-qualified freelancers for each project, by automating invoice and payment after that the amount to be paid has been confirmed, and by enabling freelancers to electronically sign contracts to abide by the business regulations on a single platform contrary to existing FMSs which do not provide these 3 features together on one application.

The software of this paper has limitations that can be resolved in future works. Though users receive an instant email when they receive a new notification or message, a mobile application to provide more convenient push notifications for new notifications, messages or projects posted can be implemented. The security vulnerabilities of the website can be further mitigated, for instance, by adding a combination of signatures, heuristics and Machine Learning detection methods to multi-scan files. Video calling and screen sharing features can also be supported. Personalised projects can additionally be recommended to freelancers by using collaborative filtering with Machine Learning. An e-Kanban board feature can be implemented as well for clear and quick visualisation of project progress, along with an ad-hoc report to inform project supervisors about delays in projects.

On the other hand, due to time limitations, preparing a larger dataset was beyond the scope of this paper. The larger the dataset, the better the prediction for the most suitable freelancers for a

project will be. A dataset of more records can thus be prepared to rank freelancers' suitability for projects more accurately.

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