Development of a Web-Based Knowledge Management Framework for Public-Private Partnership Projects in Nigeria

Akinbo Tomisin Faith(✉), Fagbenle Olabosipo, and Amusan Lekan

Department of Building Technology, Covenant University, Ota, Nigeria
tomisin.akinbo@covenantuniversity.edu.ng

Abstract. Public-private partnership (PPP) is a system implemented to improve the economic value of infrastructure outputs for the citizen of a country. Knowledge management (KM) has been seen as a way to develop successful and sustainable PPPs through constant learning and continuously improving the implementation of PPP processes. However, the presence of KM can hardly be seen on PPP project websites operated in Nigeria. The study developed a web-based knowledge management framework for PPP projects in Nigeria. The study examined existing PPP websites in Nigeria and noted that they do not have knowledge management frameworks. The system design was achieved using a use case diagram, system block diagram, and activity diagram. The web-based system is designed for the general public to access PPP project details and documents to aid accountability and transparency and help plan future PPP projects in Nigeria. The ICRC Admin, contractor's firm, and consultants on PPP projects are to populate the PPP data on the web-based knowledge management platform. The web-based knowledge management platform has six (6) primary interfaces. The essential interface is the knowledge management interface that archives the PPP project documents and is made available to users of the platform.

Keywords: Construction industry · Document control · Knowledge management · Public-private partnership (PPP) · Web-based systems

1 Introduction

Nigeria has a population of over 200 million people. This population size continues to put pressure on the provision of necessary infrastructure. Coupled with the lack of maintenance, the infrastructure gap continues to increase. Previous research works have shown evidence of infrastructural gap as witnessed in the housing deficit [1, 2], bad road rural road network [3], poor healthcare facilities [4], and so on. Currently, Nigeria needs an average of 100 billion dollars (One hundred billion dollars) annually to plug the infrastructural deficit in the country. This assertion was made by the President of the African Development Bank (AfDB). To achieve this mandate of delivering the required infrastructure to the Nigerian citizen, the government has embarked on numerous Public-private partnership (PPP) projects.

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O. Gervasi et al. (Eds.): ICCSA 2022 Workshops, LNCS 13381, pp. 411–421, 2022.
https://doi.org/10.1007/978-3-031-10548-7_30

There are many completed, ongoing, and proposed Public-private partnership (PPP) projects in Nigeria [5, 6]. One complex trait that cuts across these PPP projects is that it is difficult to access information on the cost, project documents, contractors, consultants, time of completion, or other contract details. These pieces of information are crucial to determining the accountability and transparency of PPP projects to the general public. The world in recent times is known as a global village characterized by the transfer of fast information via the internet across large geographic areas. At the same time, this PPP project information should be made accessible online, which could be helpful for citizen engagement, transparency, potential investors, and valuable for evaluating future Public-private partnership (PPP) projects.

Public-private partnership (PPP) is a system implemented to improve the economic value of infrastructure outputs, and it includes a large scale of public sector facilities broadly. Previous researchers have examined the utilization of PPP to enhance the effectiveness of infrastructure project delivery [7, 8]. PPP is used worldwide to deliver successfully various infrastructural projects. According to Li *et al.* [7], the PPP approach economically grows the value of infrastructure outputs. It enables the general development of facilities and infrastructure, including transportation facilities, sports infrastructure, airports, seaports, and so on. Despite the importance of this procurement system, there is still a lack of depth in the meaning of the concept of the public-private partnership (PPP) system [9].

Since the PPP system is a viable solution for providing the necessary infrastructure needed by the citizens of a country, there is a need to curate each project's knowledge. In PPP projects, Wojewnik-Filipkowska and Wegrzyn [10] and Ojelabi *et al.* [11] opined that vast amounts of information are generated from the public and private sector stakeholders within the project itself. Therefore, it is essential to manage this information appropriately to ensure the preservation, storage, and replication for project management in future PPP projects. This is the place knowledge management on PPP projects can help fill. According to Robinson *et al.* [12] and Boyer [13], knowledge management is critical to developing successful and sustainable PPPs through constant learning and continuously improving the implementation of PPP processes. Therefore, to enhance the performance of PPP projects in Nigeria, there is the need to integrate efficient knowledge management.

The study by Robinson *et al.* [12] supported the notion that knowledge management is crucial in PPP projects in countries such as Nigeria, where there are constraints in the public sector budgets and the necessity to increase public service delivery. Essentially, the knowledge created in any of the project phases during a PPP project will take a different shape due to the technical development of the project work from one stage to another. Moreover, when the project is not tracked during its construction process development, it will lose its context and intensely decrease the usefulness of the knowledge generated during the project [12]. There is a need to develop a framework for knowledge transfer on PPP projects tailored to the peculiar Nigerian building and construction industry. When this knowledge is available to PPP project stakeholders to use and reuse in subsequent public-private partnership projects, it can help address some challenges faced in some failed public-private partnership projects. The stakeholder can learn from the attributes of successful PPP projects. In this light, this study intends to develop a web-based

knowledge management framework for public-private partnership projects in Nigeria. This study is motivated by the little or no information regarding plans, bill of quantities, pictures, and schedule of works of major PPP projects in Nigeria. The layout of this article presents the review of related literature, system design, system implementation, and the conclusion.

2 Review of Related Literature

According to Tupenaite *et al.* [14], different knowledge management (KM) models have been developed. The models usually revolve around four main components in the KM activity process [15, 16]. Tupenaite *et al.* [14] noted that most of these KM models are activity-oriented and are mostly not adapted for the construction industry. Nonoka and Takeuchi [15] and Davenport and Prusak [16] identified the four components: knowledge creation, diffusion, knowledge transfer, and knowledge inventory. This study evaluated past knowledge management models that have been created and used for knowledge creation and transfer. The survey by Maqsood et al. [17] developed a system that integrated knowledge management, organizational learning, and innovation. The system developed explained how an organization transforms over time through organizational learning. The study showed three phases in the organization's transformation: the pre-transformation stage, the transformation stage, and the ideal transformed stage. The system developed by Maqsood *et al*. [17] measured the knowledge that existed within the organization in the pre-transformation stage, then measured the organization's knowledge after being exposed to a particular learning-transformation stage. Finally, the knowledge in the organization was measured after exposure to more learning. These stages are a continuous process.

The study by Korsvold and Russak [18] developed a generic model that identified three main themes - collective knowing, relational knowledge, and knowing how. When applied, the interaction of these three main themes creates organizational innovation within the firm. The study showed the internal and external processes between tacit and encultured knowledge. Teerajetgul and Charoenngam [19] developed a model applied to the construction industry in Thailand. Their study examined the relationship between knowledge factors and the process of creating knowledge. The knowledge creation process comprises socialization, externalization, combination, and internalization. A framework was developed to test the relationship between these concepts, as identified in Teerajetgul and Charoenngam [19]. The framework in Teerajetgul and Charoenngam [19] showed that knowledge factors such as information technology (IT), incentives, and individual competency could influence creating knowledge. The success of the study in Teerajetgul and Charoenngam [19] emphasized the importance of IT in the knowledge management of construction projects.

Information technology (IT) has long been recognized as a critical success factor for knowledge management. Information technology is possibly a legacy of knowledge-based systems (KBS) growth in the eighties and early nineties. It has led to too much of the early work on knowledge management, focusing on delivering technological solutions [20]. While it is now recognized that good knowledge management does not result from the implementation of information systems alone [21], the role of IT as a critical

enabler remains undiminished [20, 22]. The study by Tupenaite *et al.* [14] is an excellent example of an IT system developed for knowledge management. Their study developed a computerized knowledge-based decision support system for Construction Projects (DSS-CP). The automated system comprises the database management system, model-base, model-base management system, and a user interface. The user in the DSS-CP is allowed to input information on the building process' functional state; the building envelope's physical shape; the volume of work to be done; rationalize the energy consumption of the building; propose the required measures to increase the quality of air and indoor environment and analyze the construction processes scenarios by taking into account the system of criteria. According to Tupenaite *et al*. [14], a module base allows the DSS-CP's user to select the most suitable construction alternatives by comparing the measures that promote the most significant value to all interested bodies and organizations.

3 System Design

Existing websites capture project details of ongoing and completed PPP projects in Nigeria. Three (3) organizations mainly manage this: Infrastructure Concession Regulatory Commission (ICRC), the World Bank, and the Lagos State PPP Office. For instance, Fig. 1 shows ICRC's web page, which led project details of some PPP projects. It showed the project name, sector, state, project stage, sponsoring agency, and project value. It did not capture the knowledge generated on the projects in terms of project documents such as architectural, structural drawings, M&E drawings, the scope of work, bills of quantities, site meeting reports, progress reports, progress pictures, or other details that could be useful for future projects or potential investors to replicate the success of such PPP projects. Figure 2 shows the World Bank website, replicating the ICRC website and providing more minor details such as project name, sector, financial closure year, and the PPP project's investment cost. As this study posits, there is the need to implement knowledge management models on these web pages, whereby project documents regarding PPP projects can be accessed.

The system design explained the use case diagram, system block diagram, and system architecture of the proposed web-based knowledge management platform for PPP projects in Nigeria. Previous studies that have used this approach can be found in Afolabi et al. [23] and Afolabi et al. [24]. The use case diagram is designed mainly for the general public to access the contract information and project documents. However, the ICRC administrator and the contracting parties, such as the contractor and consultants, need to input the project documents and details on the website. Figure 3 shows the use case diagram of the web-based knowledge management platform for PPP projects in Nigeria.

Figure 4 shows the system block diagram for the web-based knowledge management platform for PPP projects in Nigeria. The Infrastructure Concession Regulatory Commission (ICRC) is in charge of collating PPP project information, as shown in Fig. 1. The ICRC was established to regulate the Public-Private Partnership (PPP) endeavors of the Federal government to address Nigeria's physical infrastructure deficit, hampers economic development. However, Fig. 4 proposes the integration of the contractor's firm and the different consultants' firms to input project documents in the web-based knowledge management system database.

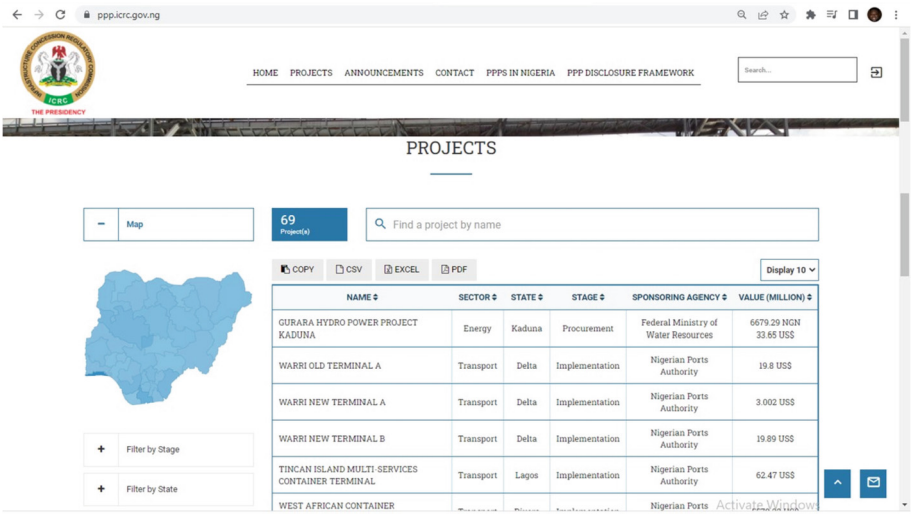

Fig. 1. Screenshot of ICRC website on PPP projects in Nigeria

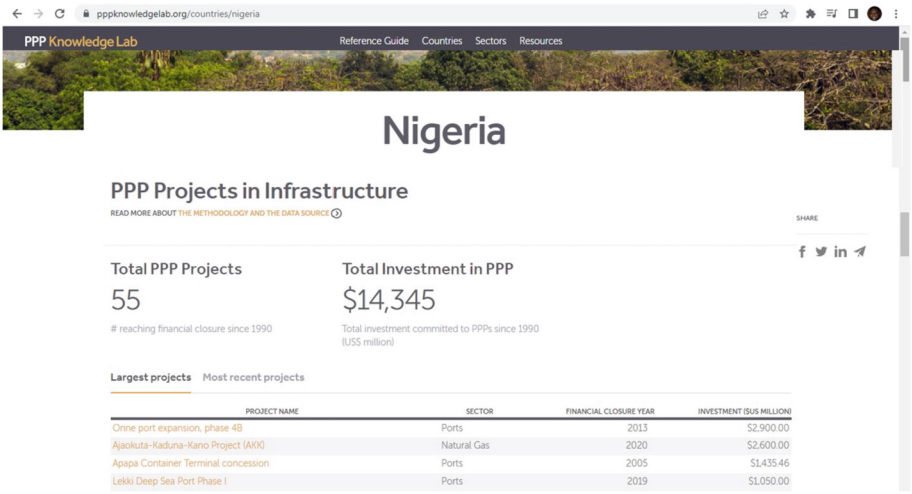

Fig. 2. Screenshot of World Bank website on PPP projects in Nigeria

Figure 5 shows the system architecture of the web-based knowledge management platform for PPP projects in Nigeria. In Fig. 5, the users can access the web-based system through the online URL through a browser. The database must be up-to-date by the ICRC Admin, Contractor's firm, and the PPP project Consultants. The general public can access the home page about Nigeria's PPP projects, PPP projects in Nigeria, Announcements from ICRC, a gallery, and a Contact Us interface. The primary interface is the PPP projects in Nigeria which shows states in Nigeria where PPP projects are situated. The user can view completed, ongoing, proposed, and future PPP projects by clicking on

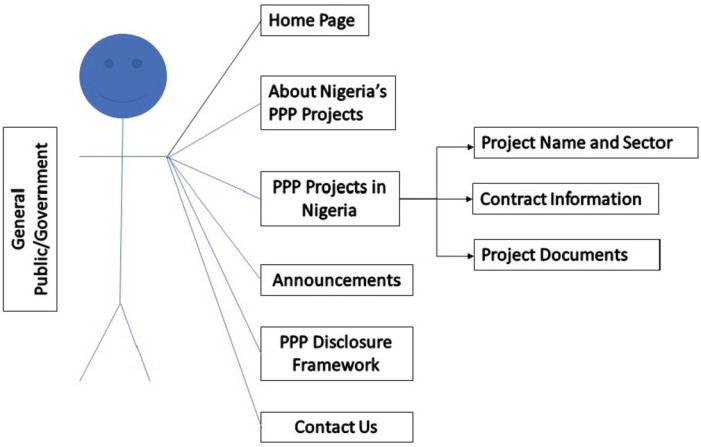

Fig. 3. Use case diagram for a web-based knowledge management platform for PPP projects in Nigeria.

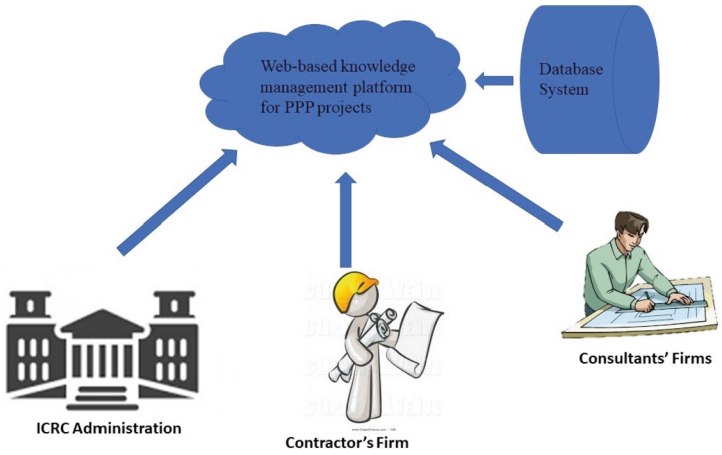

Fig. 4. System block diagram for the web-based knowledge management platform for PPP projects in Nigeria.

each state. This study's knowledge management aspect entails the user accessing the list of stakeholders and PPP documents. The list of stakeholders should show the public agencies involved in the project and the list of private participants, including contractors, financiers, consultants, and concessionaires. The PPP project documents that the users can view should include the contract description, drawings, working bills of quantities, a program of work, site reports, progress reports, pictures, and so on.

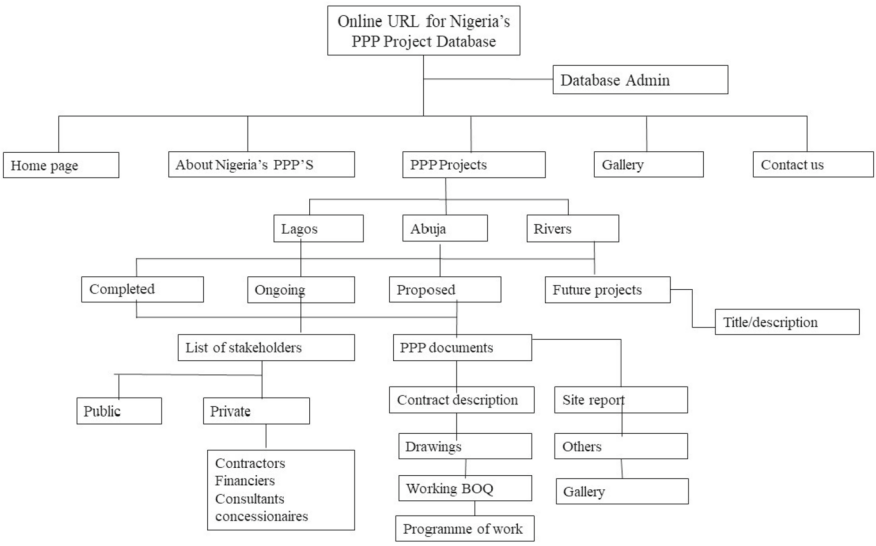

Fig. 5. System architecture of the web-based knowledge management platform for PPP projects in Nigeria

4 System Implementation

The web-based knowledge management platform for PPP projects in Nigeria was designed using Hyper Text Mark-up Language (HTML) to develop the web interfaces. In contrast, Cascading Style Sheet (CSS) was used to style the HTML tags. Most importantly, the knowledge management system required a database system designed using MySQL (Structured Query Language). PPP project documents can be stored on the database system in the web-based system. The study used C-Sharp (#) programming language. C# programming language can maximize possible performance and enable direct access to the underlying computer system parts. The system implementation for the web-based knowledge management platform for PPP projects in Nigeria is presented via a screenshot of some interfaces, as shown in Figs. 6, 7, 8 and 9. Once the user logs into the URL of the web-based knowledge management platform for PPP projects in Nigeria, the user enters the home page, as shown in Fig. 6. There is no requirement for providing login details such as username and password. This encourages the general public to access the PPP knowledge management documents.

Figure 7 shows the PPP project interface, which presents an interactive map of Nigeria with the states. Each location shows how many PPP projects are within the state. The page also showed the total number of PPP projects in Nigeria and a breakdown of the sectors. A click on each state takes the user to a new interface that lists the PPP projects within the state, as shown in Fig. 8. The user can click on any PPP project within the state. For example, the screenshot in Fig. 8 shows a list of some PPP projects in Lagos State. A click on any of the projects takes the user to the knowledge management section of the web-based system, as shown in Fig. 9. Figure 9 shows the screenshot of the knowledge management interface in the web-based knowledge management platform for

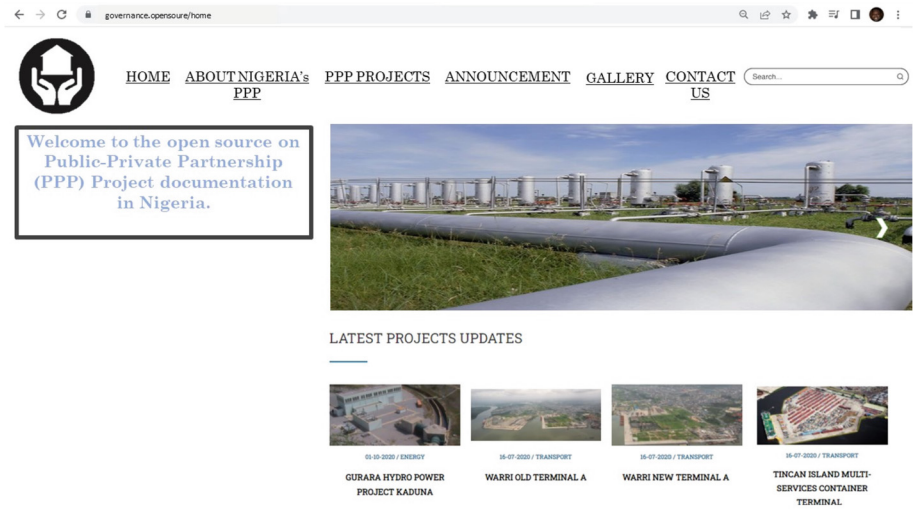

Fig. 6. Screenshot of the home page for the web-based knowledge management platform for PPP projects in Nigeria

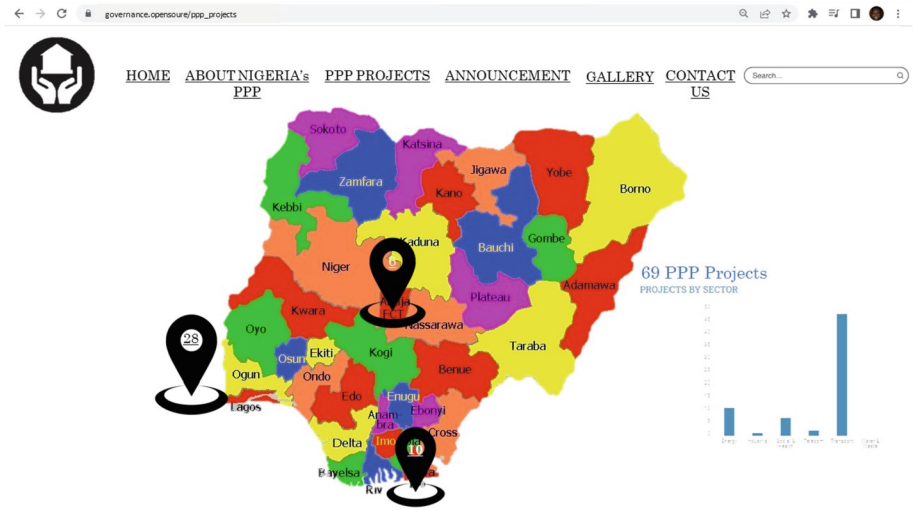

Fig. 7. Screenshot of the PPP project's page for the web-based knowledge management platform for PPP projects in Nigeria

PPP projects in Nigeria. The knowledge management details shown on the interface in Fig. 9 are the project description, type of PPP model, PPP parties, the value of the project, and the PPP project documents. Project documents such as the contract description, drawings (Architectural, Structural, M&E), bill of quantities, a program of work, site reports, and progress pictures (in gallery) are shown in Fig. 9. The significant difference between the ICRC and World Bank PPP websites is shown in Figs. 1 and 2. This study

posits the need to integrate knowledge management into existing PPP project websites to curate and transfer project information for future projects and access to the general public.

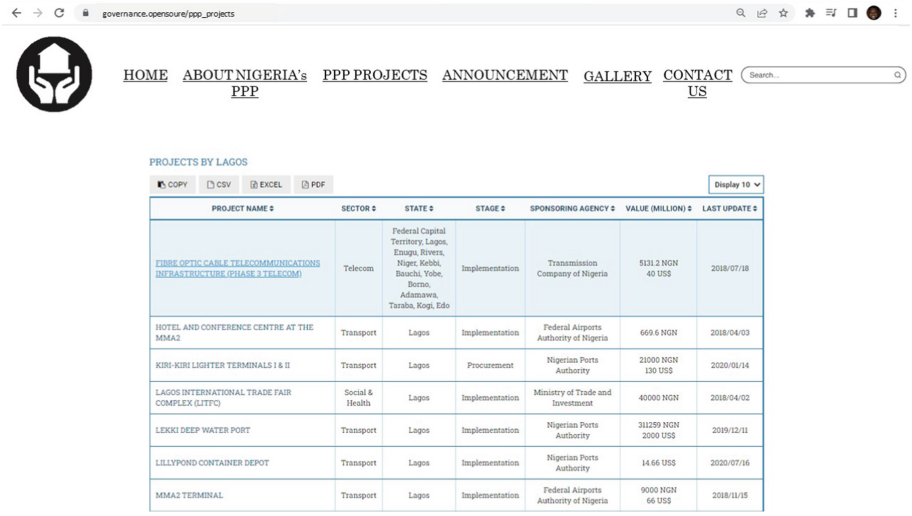

Fig. 8. Screenshot of the list of PPP projects in Lagos State interface for the web-based knowledge management platform for PPP projects in Nigeria

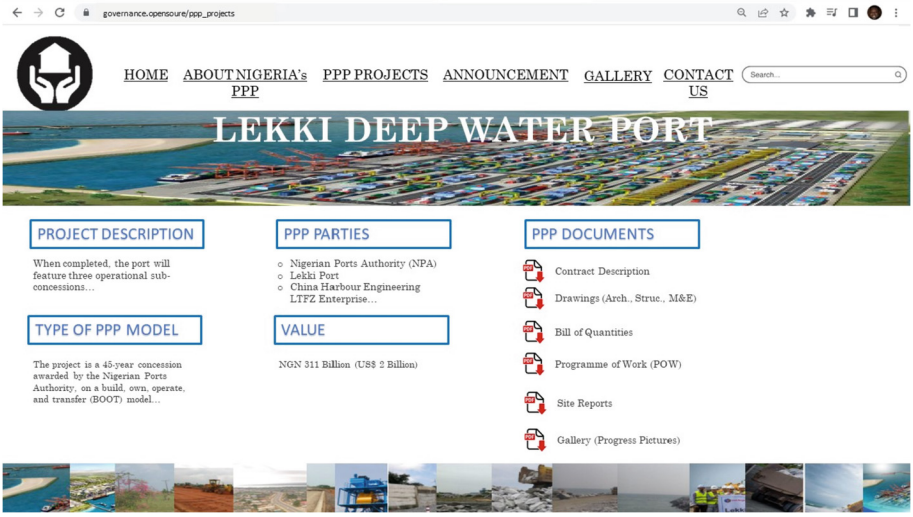

Fig. 9. Screenshot of knowledge management interface in the web-based knowledge management platform for PPP projects in Nigeria

5 Conclusion

The study developed a web-based knowledge management framework for PPP projects in Nigeria. The study examined existing PPP websites in Nigeria and noted that they do not have knowledge management frameworks. The system design was achieved using a use case diagram, system block diagram, and system architecture. The web-based system is designed for the general public to access PPP project details and documents to aid accountability and transparency and help plan future PPP projects in Nigeria. The ICRC Admin, contractor's firm, and consultants on PPP projects are to populate the PPP data on the web-based knowledge management platform. The study used HTML, CSS, C#, and MySQL to develop the web-based system. The web-based knowledge management platform has six (6) primary interfaces. The most crucial interface is the knowledge management interface that archives the PPP project documents and is made available to users of the platform. It is vital to examine why PPP project documents are not stored on existing PPP project websites for future studies.

Acknowledgment. The authors appreciate the kind efforts of Covenant University through its Centre for Research, Innovation, and Discovery in paying for the article processing charge of this article.

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