

A review and compilation of critical success factors for the implementation of maintenance at Nigerian public universities

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Abstract

Purpose – This paper aims to discuss the existing literature on critical success factors (CSFs) for maintenance implementation in Nigerian universities and compile them in a single format to determine if gaps may exist.

Design/methodology/approach – Many relevant articles were searched using keywords extracted from a preliminary literature review. The second round of articles abstract study resulted in 40 articles been selected for this compilation. Inductive coding technique and content analysis methodology were used to identify the constructs of the CSFs. Subsequently, a critical analysis of the reviewed literature identified some gaps in the literature studied.

Findings – This literature review reveals that lack of maintenance policy, maintenance culture, shortage of building facilities and overpopulation in Nigerian universities are the major problems affecting maintenance implementation success. Additionally, most researchers concentrate on the identification of CSFs without providing the strategies for implementing them.

Research limitations/implications – More in-depth research must be carried out on the study of CSFs to implement maintenance policy and culture in Nigerian universities. Duplication in the frequency analysis of the success factors is a significant limitation in this research work and is attributed to the secondary search used as the primary methodology for many articles cited.

Originality/value – This paper provides an in-depth compilation and analysis of all previously identified success factors for maintenance implementation in Nigerian universities using a structured methodological approach.

Keywords Success factors, Critical success factors, Nigerian universities, Maintenance management, Maintenance implementation, University facilities

Paper type Literature review



Introduction

The maintenance of infrastructures is an integral part of property sustainability development and management. Anybody putting up a structure without making provisions for its effective maintenance has destroyed that structure upfront without realising it. But unfortunately, maintenance culture is an attitude that has been handled with levity in Nigeria (Jones Fuanekwu and Eniola, 2017). One of the significant ways to achieve sustainability is the maintenance of the existing infrastructural facilities. However, in Nigeria, building neglect and deterioration has been recognised as a severe and long-lasting

problem besetting both the government and the people (Olatunji *et al.*, 2016). Many dilapidated facilities in deficiency of regular maintenance will cause potential safety and health hazard to the occupants or passers-by (Chan, 2019). Some of these buildings spanning more than three decades are more likely to deteriorate with their increasing building age. But despite all these problems and the need for careful maintenance management, the allocation for the maintenance work in Nigerian public universities has been reduced over time while the buildings are ageing (Ugwu *et al.*, 2018).

CSFs for maintenance are therefore recommendations on how to upgrade the maintenance management system practised. The CSFs are developed from the organisation's goals and objectives to meet specific criteria (Dahlan and Zainuddin, 2018). CSFs are those conditions and processes essential in the organisation for achieving breakthrough performance with quality assurance control throughout the maintenance implementation (Tucker *et al.*, 2014). Often, most managers mistake not aligning measurement to strategy when implementing performance measurement; they usually failed to identify those processes necessary for driving up performance. In other words, they could not identify those activities that must be performed exceptionally well for the organisation to achieve its objectives (Mukhtar *et al.*, 2017).

Therefore, in an effort to solve university buildings' maintenance problems in Nigeria, there has been an increasing demand to critically review and compile critical success factors (CSFs) to implement maintenance in the universities. CSFs are indicators of achieving the organisation's aims and objectives with a rational and achievable target. It relies not only on the process or system used but also on the end-user feedback (Kalumbu *et al.*, 2016).

According to Afolabi (2019), CSFs play an essential role in many systems' success. Therefore, it is vital to continually investigate CSFs from time to time to measure productivity and performance. For maintenance management systems to be assumed successful, the CSFs must have been tested and established. CSFs are defined in this context as creating a central point of reference in measuring the success or failure in the maintenance management implementation (Olanrewaju *et al.*, 2019).

In Rockhart's (1979) seminal research work about CSFs, he discovered that distinguishing the CSFs helps ensure that those factors received the critical attention they deserved. He further postulates that the process allows for a vivid explanation of the information needed and avoids building a system around a fragmented approach. Rockhart sees CSFs as unique areas that an organisation needed to "put right" for the business to flourish continuously. In respect of maintenance management implementation, the CSFs are those areas that must be met exceptionally well for the performance of maintenance to happen successfully.

University buildings in Nigeria constitute a significant part of the nation's assets. Future leaders, captains of industry, entrepreneurs, professionals and scientists are produced through the university buildings. Still, unfortunately, universities in Nigeria are faced with immediate pressure to preserve the existing building facilities within the campuses and enhance their higher education system's capacity to address the growing demands of an increasing influx of students and academic activities (Blessing *et al.*, 2015). Maintenance management of university buildings is also one of the most complex maintenance issues because it is multifaceted (Amankwah *et al.*, 2017). Contributing to this is the incredible complexity of university infrastructure, the high criticality of university buildings, mechanical and electrical systems and the shortage of maintenance budgets. Therefore, CSFs for maintenance must be continually investigated and applied so that Nigeria's university buildings will always perform their required functions (Ugwu *et al.*, 2018).

However, public universities' maintenance in Nigeria is associated with considerable expenditure, but intuition remains the order-of-the-day (Ighravwe and Oke, 2019). Many studies conducted previously indicated that many factors' performance and maintenance are influenced by many factors, including the building's age, frequent use, activities they accommodate, labour resources and building type (Shohet, 2016).

Therefore, immediately after the building is completed, systemic maintenance management must be carried out to address this problem. By identifying the possible maintenance problem that may occur and estimating each part's possible maintenance cost, it is possible to establish proactive maintenance measures before the maintenance related issues arise (Kwon *et al.*, 2020).

Research conducted by Chidi *et al.* (2017) indicated that buildings' maintenance problems could be prevented or minimised by optimising design processes, using tested materials and quality supervision. By adequately harmonising these components at the design and planning stage, maintenance-related problems can be minimised.

The main reasons for maintaining a building, according to Magutu and Kamweru (2015), are as follows:

- retaining the value of the structure;
- maintaining the building in a condition in which it fulfils the functions it was designed to perform;
- maintaining the aesthetic value of the building;
- reducing the continued cost of building operation;
- maintaining the usefulness of the structure to perform its required functions;
- maintaining the necessary health and safety level; and
- ensuring continuous adherence to the building regulations.

CSFs are indicators of achieving the organisation's aims and objectives with a rational and achievable target. It not only relies on the process or system used but also reflects on the end-users feedback (Zulkarnain *et al.*, 2011). CSFs are therefore recommendations to upgrade the maintenance management system practised.

Whilst research on CSFs for maintenance management in universities have been investigated in countries like the UK, USA, Australia and Canada, the maintenance management of university infrastructure is yet to receive the much-needed empirical study in Nigeria. Current studies of university infrastructure have only focused on the facilities' construction and safety aspect, but the maintenance management related aspect has been conspicuously neglected (Olanrewaju *et al.*, 2019). Against this background, there is the need to critically investigate and compile CSFs to implement maintenance in Nigerian universities from the existing literature available in the face of vast incidences of the prevalence of severe maintenance problems. CSFs are defined as "the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation" (Rockart, 1979). Consequently, Rockart (1979) stresses that any organisation should constantly and carefully manage these particular activity areas.

Other problems identified in the maintenance of Nigerian universities include the shortage of skilled personnel with knowledge of facilities management at the maintenance department (Donalek *et al.*, 2018). Most personnel at the maintenance department are not trained professionals. Whenever a maintenance-related activity occurs, they only resort to traditional maintenance methods previously without deploying the current maintenance

work methods. They also do not attend training and workshops to advance their knowledge of building maintenance management.

Further research by [Chidi *et al.* \(2017\)](#) also revealed that most Nigerian public universities are still using the traditional maintenance management method without using the modern information technology computerised maintenance management system (CMMS). CMMS is a type of maintenance used to improve building maintenance operation processes in cost savings, labour resources, storage of maintenance procedures and technical documentation.

Problem statement

The university system is the apex body of the educational system in Nigeria, where Nigeria has a total of 162 universities. A total of 92 are public-owned universities totalling about 57%, whereas 70 are privately owned, amounting to 43% (NUC, 2019). The validated available evidence proved that maintenance neglect is primarily found at the public universities, which both the Federal and State Governments manage, rather than private universities, which are privately owned ([Donalek *et al.*, 2018](#)). The building maintenance culture at private universities is adjudged to be significantly satisfactory. Thus, this study's results have important implications for public university building maintenance in Nigeria.

Current studies on the maintenance implementation at Nigerian public universities indicated that many building facilities are inadequately maintained. The few maintained are allowed to dilapidate completely without any sustainable maintenance plan before maintenance is carried out ([Ugwu *et al.*, 2018](#)). Consequently, many infrastructures at public universities in Nigeria are fast losing their economic value and, at the same time, putting the life of the occupants in danger ([Donalek *et al.*, 2018](#)). In most Nigerian universities, there seems to be no infrastructural maintenance plan. Existing buildings have been dilapidating rapidly because of the growing number of students using the facilities daily without a good maintenance policy. If no building maintenance scheme or plan is developed and implemented, the universities will soon suffer severe disastrous infrastructural damage ([Ugwu *et al.*, 2018](#)).

From the result of this compilation, it was discovered that there are so many studies on maintenance. Still, not much was discussed on CSFs for the implementation of maintenance at the Nigerian public universities. Most of the researchers previously studied the success factors for maintenance in other public places like hospitals and other government establishments. Still, little research was done on CSFs to maintain university infrastructure. For instance, [Afolabi *et al.* \(2019\)](#) studied CSFs for e-procurement adoption in the Nigerian construction industry. [Mukhtar *et al.* \(2017\)](#) looked at CSFs for public housing projects in developing countries. [Olanrewaju *et al.* \(2015\)](#) studied the challenges of building maintenance in Nigeria, [Ugwu *et al.* \(2018\)](#) reviewed the assessment of building maintenance in Nigeria, [Akasah *et al.* \(2011\)](#) studied maintenance management success factors for heritage building, whereas [Olanrewaju *et al.* \(2019\)](#) emphasised on CSFs for maintenance of hospital buildings. [Eti *et al.* \(2006\)](#) discussed strategic maintenance management in Nigerian industries. [Alshehri *et al.* \(2015\)](#) examined the common problems facing building maintenance departments. [Uzoamaka and Emoh \(2018\)](#) evaluated the challenges of maintaining commercial buildings in Akwa, Anambra State, Nigeria, while (2018) discussed maintaining Tertiary institution buildings in Ondo state Nigeria and prospects. But no empirical research on CSFs for maintenance implementation in Nigerian universities was carried out.

The above problems suggest that rather than investing, collecting, monitoring and improving one or two less critical and even unnecessary areas, identifying the

comprehensive CSFs for maintenance should be conducted. Another crucial aspect of the CSF is the ranking and criticality among the CSF. It is paramount to provide the maintenance team with a structured or structured relationship in implementing the CSF for maintenance. The “structural” is defined as “relating to the arrangement and relationship between parts or elements (Pearsall and Hanks, 1998).” Structural relationship or “what factor led to what factor,” as simplified by [Deshmukh \(2010\)](#) and [Singh \(2011\)](#), can help the maintenance manager in implementing the CSF for maintenance in sequence. All these will save a lot of time and cost and provide a higher quality of service.

The above direction of the study and compilation of CSF for maintenance is aimed to prevent the problems and ensure successful implementation of building maintenance is also supported by previous CSF studies. Most of the research on CSF, irrespective of the industry type, also focused on identifying the CSF and ranking criticality level ([Ab Wahid and Corner, 2009](#); [Achanga et al., 2006](#); [Fotopoulos and Promas, 2010](#); [Khanna et al., 2011](#); [Singh, 2011](#); [Singh et al., 2007](#)).

This compilation, therefore, seeks to bring a new order for additional research on CSFs for maintenance implementation in the Nigerian public universities and to discover a good understanding of the tactical and strategic aspects of some widely cited success factors. In the coming sections, the research methodology chosen in the compilation of the CSFs will be discussed. It will be followed by summarising the CSF categories and concepts and the literary analysis of CSFs for maintenance.

Objectives of the research

- To identify the CSFs for the implementation of maintenance in Nigerian public universities; and
- to rank the CSFs for the implementation of building maintenance in Nigerian universities.

Scope of the research

The scope of this study will only focus on CSFs for building maintenance towards a sustainable university system in Nigeria. There are many reasons why building maintenance has been selected as a case study towards a sustainable university in Nigeria. Firstly, universities in Nigeria have many buildings that require regular maintenance ranging from classrooms, lecture halls, offices, hostels, laboratories, staff quarters, clinics, libraries, shops, restaurants, offices, sports centres and other buildings for day-to-day activities. All these buildings require regular maintenance for their optimal performance, but the allocation for maintenance in Nigerian public universities is continuously declining while the buildings are ageing. Thus, identifying those CSFs for building maintenance will help to plan practical maintenance work in the University properly.

Significance of the study

- The result of this research work will contribute to the academic world in terms of the compilation of CSF for building maintenance work in Nigerian universities. It will also provide a new area of research in understanding the relationship among the various success factors.
- This study will also contribute to the knowledge and theory of sustainable maintenance of university infrastructure in Nigeria.
- Findings from this research work will provide solutions to factors that negatively affect Nigerian public universities’ maintenance implementation.

- The result of this study will also assist Nigerian universities and Tertiary Education Trust Fund in knowing the current situation of buildings at the universities and planning proper maintenance work in Nigerian public universities.
- The CSFs ranking will provide a comprehensive relationship among the success factors to the maintenance management team in deciding the priority for building maintenance work.

Research methodology and critical success factor compilation. A comprehensive literature review was conducted using a conceptual analysis approach which involved thorough note-taking that has highlighted all possible references to CSFs. As mentioned earlier, CSF is defined as a “limited number of areas in which if results are satisfactory, will ensure successful competitive performance for the organisation” (Rockart, 1979). All journals that contain a reference to CSFs for maintenance implementations were then analysed extensively for coding the identified constructs. Here, the analysis includes combining and differentiating the data collected (Miles and Huberman, 1994). Special consideration was given to the meaning of the words but not the words themselves. However, all the success factors, irrespective of their description, were noted. The sorting stage would place all the CSFs in like categories. This process involves an inductive coding technique.

An open coding system was chosen because it is the part of the analysis about the categorisation and naming of phenomena through close monitoring of data. All data obtained at the open coding process are carefully examined, broken down into discrete parts and compared for similarities and differences. Questions were then asked about the phenomena reflected in the data (Strauss and Corbin, 1990, p. 64).

Finney and Corbett (2007) also described this methodology and suggested preparing qualitative data category cards. Coded constructs were recorded as they appeared in the journal articles using a bibliographic software program; each identified construct was then placed on a spreadsheet file that recorded the frequencies of each.

As this research work aims to obtain a clear understanding of different CSFs already discovered by other researchers, content analysis was seen as the most appropriate analysis approach, as Silverman (2000) suggested, who described it as the most common analysis technique of texts. He also highlighted a very significant aspect of one’s approach while coding; he says, “every way of seeing is also a way of not seeing” (p. 147). Silverman further suggests that “a good coding scheme will reflect a search for uncategorised activities so that they can be accounted for, in a way similar to searching for deviant cases” (p. 147). Based on the reasons mentioned above, the analysis also searched for references to “success factors” that might not be identified as such. That is why some of the search terms used to select the journals did not necessarily include “critical success factors,” “success factors,” etc.

Procedure for data collection. Carley (1992) provided an eight-step coding system used as a data collection procedure in this research work.

Step 1: Deciding the level of analysis. At this stage, it was decided either to search for a single word or a phrase. The first step is to determine whether the unit analysis will be counted and the sample will be chosen in the content analysis. For this research work, the entire journal articles are involved in the unit analysis.

An extensive search of many prominent journals was used in the data collection phase of the literature reviewed as listed in the following:

- *International Journal of Project Management*;
- *International Journal of Engineering*;
- *Journal of Facilities Management*;

- *Journal of Construction Management;*
- *Journal of Technology;*
- *Journal of Earth and Environmental Science;*
- *Industrial Engineering Management;*
- *Cleaner Production;*
- *Automation in Construction;*
- *IEEE journals;*
- *Global Journal of Engineering, Design and Technology;*
- *Journal of Design and Built Environment;*
- *International Journal of Architecture and Environmental Engineering;*
- *International Journal of Sustainable Construction Engineering and Technology;*
- *Social and Behavioural Science;*
- *International Journal of Economics, Commerce and Management;*
- *International Journal of Innovation, Leadership and Technology;*
- *Business Process Management;*
- *Quality in Maintenance Engineering;*
- *International Journal of Sociology and Anthropology;* and
- *Building and Environment.*

After the journals, the following database was also searched.

- Web of Science;
- Scopus;
- Goggle scholar;
- Emerald;
- SpringerLink;
- JSTOR;
- Science direct;
- One Petro;
- Academic Search Premier;
- ASME Digital Library;
- Lexis Malaysia, Reaxys;
- Engineering and Applied Science; and
- IEEEExplore Digital Library.

The above databases involve thousands of articles that are categorised as belonging to the maintenance management practice. All relevant journals were selected from the search results that matched the condition and terms outlined in [Table 1](#) above.

All the keywords used in the search were obtained from the ones used by the authors discovered in the preliminary literature review.

Finally, all the searches were limited to only the articles that were peer-reviewed or scholarly. After reading all the articles abstract, title and conclusion, selecting a theme for

Table 1.

Search terms: journal
and database

Searched: abstract, title and citation Individual journal	Database searches
CSFs for maintenance implementation	CSFs and university
CSFs for maintenance	CSFs and maintenance
Success factors for maintenance	Maintenance and success
CSFs for maintenance in university	Maintenance and management
Success factors for maintenance in university	Maintenance implementation
CSFs for maintenance in Nigerian universities	Maintenance in a university
Maintenance implementation	Success factors in maintenance
Maintenance implementation in a university	Maintenance culture and success
Maintenance implementation in a Nigerian university	Maintenance planning and success
Maintenance success	Maintenance systems and success
Maintenance success in a university	Maintenance software and success
Maintenance success in a Nigerian university	Maintenance
Maintenance strategies	

inclusion and compilation in this review were based on the researcher's information, either relevant for collection. If the information gathered is relevant to maintenance implementation success factors, the article will be selected.

Step 2: Deciding how many steps to code. Here, it was decided either to code for a specific set of concepts or to allow for a more interactive approach. An inductive approach was chosen to allow for absolute inclusion.

From all the identified CSFs, [Berg \(2004\)](#) states that theoretical classes are those that "emerge in the analysis of data" (p. 277). Therefore, the lessons to emerge in this research work include CSFs as they appear in the literature.

Step 3: Deciding whether to code for frequency or existence of a concept. [Carley \(1992\)](#) suggested coding for the frequency of concepts and not their existence to understand each factor's relevance at this stage of the coding process.

Step 4: Deciding on how to distinguish among the concepts. In Step 4, the researcher decided how to differentiate between concepts because it is always good to choose to record the concepts as they appear or if they should be recorded in an altered or collapse form. This stage is called the "level of generalisation of terms." However, all words with the same meaning were categorised under the same construct for this research work. For example, "project categorisation" and "project characteristic" have similar meanings and were placed under the same category.

Step 5: Deciding on rules for coding the texts. At this stage, rules were developed for coding the texts. A set of translation rules was established through the coding process to have consistency and validity while coding. The following translation rules were developed and used:

- While reading all the relevant journals for the first time, special consideration was given for nothing the references to possible "success factors." Therefore, all identified concepts were recorded in the bibliography program. No categories were determined at this point regarding "success factors" and how they are defined.

[Williams and Ramaprasad \(1996\)](#) stated four degrees of criticality. They are as follows:

- factors sufficient and necessary for success;
- factors associated with success by a known mechanism;

- factors associated with success; and
- factors necessary for success.

Although this review involves those factors considered associated and necessary for success, the compilation was not limited to only factors that have been proven to produce success. Additionally, this stage of the data collection involved making a note of the chosen methodology:

- Second reading of all the notes was conducted to discover similarities in the concepts. All similar concepts were then placed in “like categories.”
- At this stage, each category is cross-examined. Simultaneously, all the concepts are reviewed to determine the possibility of collapsing or sub-dividing the concepts to establish more categories.
- Finally, categories are determined while concepts are reviewed again to discover the construct terms.

Step 6: Deciding on what to do with “irrelevant coded” information. Here, the researcher decided on what to do with irrelevant information in the text that was not coded. And as this literature review is concerned with the compilation of all concepts considered success factors in the maintenance implementation of the university sector in Nigeria, the content analysis includes the entire articles with the coding of only those aspects considered to have success factors. Therefore, the question of what to do with irrelevant coded information does not become a problem.

Step 7: Coding the texts. Using a manual technique and translation rules stated in Step 5, the actual coding process was conducted. All names attached to each category are usually those that seem more logically related to data it represents and should be graphic enough to remind us quickly of its referent, as [Strauss and Corbin \(1990a, p. 67\)](#) stated.

Step 8: Analysis of results. Analysis of the results involves cross-examining all the constructs regarding critical evaluation and frequency of the CSFs approach. The result will be reviewed in the subsequent section.

Literature compilation of critical success factors for maintenance

Determining categories. Out of the 50 journals reviewed, 40 are considered to have “success factors” related to this research work and are subsequently chosen for analysis. Like concepts are grouped into “like” categories, all “success factors” that appear to refer to the same phenomenon are grouped. A total of 47 possible “success factors” categories were determined, but subsequent analysis of all the concepts resulted in merging several categories to produce 22 categories.

Choosing names for the categories. [Strauss and Corbin \(1990a\)](#) have warned on the dangers of using a borrowed term and emphasised the need to be more precise about the meaning of the terms. The researcher tried to make the chosen names graphic enough to allow the reader to determine their referent. The selected names were borrowed from technical terminology frequently used in the literature and more abstract than their concepts.

[Pearce \(2004\)](#) suggests the grouping of factors as tactical and strategic because strategic factors represent the larger picture while tactical factors represent the skilful methods and details. But both ways address the various elements that can lead to the achievement of maintenance implementation goals.

The final 22 categories of CSFs for maintenance implementation in Nigerian public universities are tabulated in [Table 2](#) below.

Understanding the critical success factors categories and their concepts. Each identified construct from the literature reviewed is outlined below with a description of the concepts it represents. The constructs are derived from the literature during the compilation process and are presented to understand how they can influence maintenance success if implemented.

Below are the final 22 CSFs for maintenance implementation in Nigerian universities after the initial 47 categories were collapsed because of similarity in meaning and functions.

Maintenance policy: Maintenance policy is a determinant factor that influences maintenance culture and development in the university. They are a set of rules and regulation governing the conduct of maintenance in the institution. They may include: mission statement, policy guidelines and must be used to promote communication, exhibitions and other important messages to every university member ([Sani et al., 2012](#)). The policy statement explains all regulations that must be complied with while carrying out maintenance work by all maintenance staff. The maintenance policy should be a simple statement that gives a clear and distinct explanation of the core values and beliefs on common goals that want to be achieved in the maintenance work ([Sani et al., 2012](#)).

Maintenance culture: Maintenance culture is the established rules and regulation governing infrastructure in the university. It is essential because it influences individuals' conduct in maintenance-related activities. After all, individuals' attitude towards the maintenance of public facilities in Nigerian universities is rather regrettable. According to [Ebi \(2014\)](#), most Nigerian students and staff consider public facilities as government property; therefore, they are careless about their sustainability.

Additional infrastructure: Another area of interest in Nigerian public universities' maintenance management is the urgent need to provide additional infrastructure to accommodate the growing demand. Nigerian universities are currently accommodating three times the number of students they are supposed to accommodate (NBS, 2018). Given the lack of opportunities to study locally because of insufficient infrastructures, many Nigerians opt for a foreign degree to provide a more conducive learning environment and graduate with an edge academically. But in a country where the minimum wage is only \$57 per month, many cannot afford to go for expensive foreign degrees. Online degrees from

Strategic success factors	Tactical success factors
Maintenance policy	Teamwork, involvement, participation and autonomy
Maintenance culture	Education and training
Additional infrastructure	Reward, recognition and motivation
Availability of funds	Performance measurement
Top management support	Communication
Strategy and work planning	e-maintenance
Client knowledge and experience	Benchmarking
Maintenance managers competence	
Contractors related factors	
Project team's competence	
External factors	
Internal factors	
Contractual aspects	
Organisational structure	
Stakeholders related factors	

Table 2. Strategic and tactical CSFs for maintenance implementation

foreign universities are not an option either because in 2018 National universities Commission said online degrees from all foreign universities are no longer acceptable. Therefore, additional infrastructure will undoubtedly decongest the existing infrastructure and reduce the amount of maintenance work to be carried out.

Availability of funds: No matter how immediate and urgent the need for maintenance is, it always requires funds for its execution. [Mohd-Noor *et al.* \(2011\)](#) emphasised that the maintenance budget should not be tampered with at all times because it may be quickly needed without notice, especially in the case of emergency maintenance. And according to [Blessing *et al.* \(2015\)](#), it is always a headache to estimate building maintenance cost assessment in current maintenance work practices in Nigerian universities. Because maintenance work is not carried out according to actual need, it is based on the allocated budget without carefully evaluating its exact needs. The budget should be determined based on the type and implementation strategy of maintenance work. A maintenance budget should identify the quantum of funding a department requires to adequately address its facilities' critical maintenance needs to continue to support the delivery of services necessary to an acceptable standard identified in the organisation's maintenance policy ([Mohd-Noor *et al.*, 2011](#)). The maintenance budget should be based on maintenance needs.

Strategy and work planning: Strategy and work planning are essential in maintaining university infrastructure as it gives direction, work schedule and timeframe to accomplish every activity during the maintenance operation. [Eti *et al.* \(2006\)](#) outline how each task can be achieved and how to achieve it with the resources available. From the design stage to completing maintenance work, all maintenance work should be strategised and planned according to the maintenance budget for timely completion and optimal performance ([Cauchi *et al.*, 2017](#)).

External factors: According to [Ng *et al.* \(2011\)](#), external factors are not within the management's control. Although they do not depend on the maintenance performance, they can directly affect the maintenance's success or even its survival. Some of these external factors could be initiated by society. Their influence may vary from time to time depending upon the public interest change like market fluctuation, government policies, etc. The maintenance management project can be influenced by political, legal, social, economic, technological, physical, ecological and cultural factors ([Kiani Mavi and Standing, 2018](#)). The economic factors are taxes, competitiveness, credits, interest rate, inflation, etc. The social and environmental factors are factors such as the condition in which people live and work, which also significantly influences maintenance work effectiveness. All these factors influence the success of the maintenance project. [Kiani Mavi and Standing \(2018\)](#) include other factors such as demographics, ethnic hostility, religious and social values. Cultural values such as norms, attitudes and behaviour can affect stakeholder's requirement, while technological development can enable more efficient management of projects. The legal, political, physical and natural environment can also influence the maintenance projects. Change in law, ownership, restriction on imports, natural disaster, weather, pollution and supply of raw materials can affect the maintenance project implementation.

Client knowledge and experience. [Tan *et al.* \(2014\)](#) identified client knowledge and experience as very important for the success of maintenance project. Nature of finance, organisational size, emphasis on costs, quality and time, ability to brief, decision-making, roles and contribution, expectations and commitment, involvement and influence, etc. All these will ultimately influence the success of maintenance work.

Top management support: Top management support was discussed by [Kiani Mavi and Standing \(2018\)](#) as a crucial maintenance management factor. It gives support and encouragement to the project head, supports the organisation's critical activities,

understands project difficulty and influences stakeholders' influence on the project. Top management can influence maintenance staff to work excellently by giving them moral support and encouragement to discharge their duties.

Maintenance managers competency: Maintenance managers competence is crucial in terms of experience in management, organising, motivating, coordinating, leading, communication skills and feedback (Gajzler, 2013). A good maintenance manager must have the ability to resolve conflict within the organisation because it is essential for a maintenance project's success. Also, he must have the ability to take decisive action based on his previous project experience, he can act quickly to prevent a problem from occurring (Kwon *et al.*, 2011).

Contractual aspects: Mohamed *et al.* (2015) discussed contractual aspects to consist of the type of project to be carried out, tendering procedures, selection of contractor, procurement process, etc. All these are very important in the implementation of successful maintenance work.

Project team competence: According to Tsiga *et al.* (2019), a good project team must consist of team members with vast experience in planning skills, organising skills, technical skills, good working relationship with subordinates, committed to the maintenance work, ability to change quickly, attend training workshop regularly, good decision-making technique and very effective in the execution of maintenance work. All these skills are essential in the implementation of maintenance work.

Internal factors: These are factors within the control of the organisation's management. Such factors can be decided within the organisation and explain the organisation's present status and performance capability on the maintenance project to be carried out (Zulkarnain *et al.*, 2011).

Contractor related factors: These factors are concerned with the contractor's expertise on the project to be carried out so that the maintenance work will not suffer unnecessary delay from the contractor. Li *et al.* (2019) explained that a contractor's duties with experience are essential, especially when the project is complex or a complication in design. Experience contractor can use their expertise to solve so many problems without unnecessary delays.

Stakeholders related factors: Antwi-Afari *et al.* (2018) advocated the importance of project stakeholders. They described them as anybody who has a particular interest in the maintenance project's success and the project's environment. Many stakeholders actively participate during the implementation process of the maintenance project. They include but not limited to project initiators, designers, planners, contractors, clients, project managers and the university itself. The maintenance management team needs to identify those stakeholders who can affect the project implementation and manage their different vested interest before the maintenance work commences (Amankwah *et al.*, 2017).

Organisational structure: Organisational structure involves a framework of rules and power relations that exist formally to control and coordinate human action and motivate individuals to achieve the organisation's goals (Rocha and Rodrigues, 2017). Sani *et al.* (2012) explain that the organisational structure is typically hierarchical. An organisation arranges its authority and communications lines and allocates rights and duties as illustrated in the organisational chart. It can be used as a guideline to clarify responsibilities and activities for every member within the organisation. Another function of organisational structure is to serve as an advisory body is controlling and administering all the maintenance work activities.

Teamwork, involvement, participation and autonomy: According to Li *et al.* (2019), teamwork means working together to achieve a goal, while involvement in maintenance implementation is a process that requires the collective worker's participation in the

execution of maintenance work. [Gajzler \(2013\)](#) discussed the importance of the involvement of all personnel in maintenance project implementation. In his research, he explained the importance of empowering employees to create commitment in their minds. To this end, the management should engage all employees in defining the work objectives, explaining how to achieve them and setting ambitious targets. [Eti et al. \(2006\)](#) emphasised that workers participation is significant and must be highly valued, while autonomy should be a core concept of empowerment, the management should always retain control of the maintenance work throughout the execution period.

Education and training: [Ng et al. \(2011\)](#) explained that a significant amount of skill could be achieved quickly through formal training and should not be limited to transferring technical skills and knowledge. But it should also include problem-solving techniques, team dynamics and facilitation skills. [Sani et al. \(2012\)](#) advocated that the organisation's ideas should be communicated to all workers through education and training; every staff should understand what these ideas are and why they are essential for maintenance implementation.

Rewards, recognition and motivation: Reward is given to an employee as an incentive for a job well done, while recognition is defined by [Sani et al. \(2012\)](#) as some public recognition for excellent performance in the discharge of their duties. Rewards are benefits such as gifts, bonuses and promotions owing to individual performance and salary increase. On the other hand, motivation is described by [Donalek et al. \(2018\)](#) as encouragement for the development of a maintenance culture; it encourages employees to act accordingly and improve productivity. It can be given in recognition for excellent performance, reward system and support by the management. It can also be provided in terms of training and education, encouragement and support. It creates a conducive working environment filled with passion where members will be happy with every task given to them by the management.

Performance measurement: According to [Mohd-Noor et al. \(2011\)](#), performance measurement is the organisation's ability to continuously monitor work progress and ensure that the maintenance work is planned. Progress of work is measured according to work schedule to see if the maintenance work is going according to plan. It is imperative because it prevents unnecessary delays in maintenance implementation.

Communication: Communication is a vital instrument in an organisation. It gives the management information down to the labourer on what is needed and how best to do it ([Zwikael and Globerson, 2006](#)). In an environment that stresses all and sundry participation like the university, communication from the top management is essential as it encourages and makes available the necessary instrument that will help improve maintenance work. [Eti et al. \(2006\)](#) discussed that every complaint or inquiry by the employees should be considered an opportunity to improve its maintenance operation.

Benchmarking: Benchmarks are a stable reference point for improvement in the execution of maintenance work. It is a logic that promotes quality, productivity and efficiency in the maintenance implementation. [Eti et al. \(2006\)](#) maintained that benchmarking is a targeted point where a certain amount of work needs to be carried out within a specific period; they identified so many activities that need benchmarking to execute maintenance work introduced new processes and systems in achieving them. Benchmarking is a central point of reference in measuring the progress of the maintenance work.

E-maintenance: e-maintenance is a modern technology system used to optimise the inspection and make decisions that can affect the performance operations ([Blessing et al., 2015](#)). It captured good and quality data using a computerised system to execute maintenance work and monitor maintenance work progress by giving the maintenance

manager feedback. Au-Yong *et al.* (2019) explain that the relevance of data availability to maintenance managers is expanding rapidly in maintenance-related activities (Table 3).

Analysis of maintenance implementation literature. The above analysis and compilation of CSFs have provided a basis for identifying the CSFs for maintenance implementation at Nigerian universities. From the results obtained, 22 success factors were determined to achieve objective number one. Also, the number of times the success factors are cited in the literature reviewed and their frequency help achieved our objective number two. However, another analysis was conducted to discover if there is any available gap in the literature reviewed. The most apparent gap noticed during the compilation and analysis is the lack of depth in the coverage of CSFs for maintenance.

Furthermore, another observation noticed during the collection and analysis was the researchers' inability to identify the shortage of building facilities, the effects of overpopulation and the misuse of building facilities by the occupants of Nigerian universities as a significant concern. Finally, lack of maintenance culture, the joint-second most frequently cited success factor, appeared to have varied definitions. There was little explanation on the specific tactics to be used in implementing it.

Different scholars on CSFs have often focused on some specific aspects of CSF's implementation process for maintenance. Consequently, no comprehensive research documented all the success factors for implementing maintenance at the Nigerian University. For example, *Zawawi et al.* (2011) recognised the importance of students and staff's attitude to maintenance implementation success. *Tsiga et al.* (2019) discussed the importance of organisational structure as a factor and discovered the relationship between organisational structure and maintenance project success. Research carried out by *Magutu and Kamweru* (2015) discussed culture as a factor that negates implementation success in Nigerian universities. Other scholars consider other aspects: *Mohd-Noor et al.* (2011) looked at the need for sufficient funds before the commencement of maintenance work.

CSF category	No. of times cited in the literature
Lack of maintenance policy	27
Lack of maintenance culture	25
Additional infrastructure	25
Availability of funds	23
Top management support	21
Strategy and work planning	21
Client knowledge and experience	20
Maintenance managers competency	18
Contractors related factors	18
Project team's competence	17
External factors	16
Internal factors	15
Contractual aspect	15
Organisational structure	15
Stakeholders related factors	15
Teamwork, involvement, participation and autonomy	15
Education and training	14
Reward, recognition and motivation	13
Performance measurement	12
Communication	11
Benchmarking	10
e-maintenance	9

Table 3.
Frequency analysis
of CSFs in the
literature

Ugwu *et al.* (2018) spoke about the need for additional buildings in Nigerian universities; Kalumbu *et al.* (2016) highlighted strategies and work planning in maintenance implementation success, whereas Kiani Mavi and Standing (2018) discussed the relevance of external factors in the successful implementation of maintenance work.

Tan *et al.* (2014) discussed the importance of management, knowledge and experience, whereas Mukhtar *et al.* (2017) spoke about issues to do with the local authorities in all maintenance-related activities. However, in his analysis of top management support's relevance and importance, Kiani Mavi and Standing (2018) focused on top management support to maintain work success. Similarly, Sani *et al.* (2012) and Kiani Mavi and Standing (2018) explained in details the importance of discussing the project characteristics, which include the size, nature, type and requirement of the project with the contractor at the early stage of the project and also the relevance of project managers competence in respect of the maintenance work to be undertaken.

As project organisation, contractual aspects and the competency of the project team are key to the successful implementation of maintenance work, Tsiga *et al.* (2019) and Sani *et al.* (2012), in their different researches, highlighted the importance of both success factors to the maintenance implementation success. Project risk management and requirement management are discussed by Ahmadabadi *et al.* (2019). At the same time, Boynton *et al.* (1984) and Tsiga *et al.* (2019), in their independent researches, discovered internal factors and requirement management as success factors of a maintenance project implementation. Li *et al.* (2019) found related contractual factors and stakeholders' interest as key factors in implementing maintenance. However, Antwi-Afari *et al.* (2018) discussed further the relevance of harmonising all relevant stakeholders in the implementation of maintenance work.

The organisational structure is also fundamental as it indicates the hierarchical structure of the organisation. According to research conducted by Binti Rusli *et al.* (2014) and Sani *et al.* (2012), they highlighted the importance of communication through proper channels within the organisation to receive information from a single source to avoid having conflicting directives from different sources. Other support systems like additional information on recent technological advancement and machinery are discussed by Eti *et al.* (2006). While Gajzler (2013) focused on building maintenance in technical maintenance, he addressed the participation and autonomy of groups and individuals in the maintenance operation.

So many other researchers examined comprehensively other CSFs in a different way. Prefer *et al.* (2018) discussed the management function in the discharge of maintenance work extensively. Ng *et al.* (2011) focused on CSFs of total productive maintenance implementation where they examined education and training as factors that can bring about maintenance success.

Mohd-Noor *et al.* (2011) identified performance measurement as a CSF in a research work title "building maintenance budget determination." They discovered that in the improvement of maintenance success, work progress is measured continuously at regular intervals. Zwikael and Globerson (2006) explained the importance of good communication during maintenance work to understand the work's direction and concept. Donalek *et al.* (2018) examined the importance of staff motivation, whereas Suffian (2013) emphasised the importance of e-maintenance to maintenance implementation success. In another research work conducted by Li *et al.* (2019) and Sani *et al.* (2012), they discussed the importance of rewarding individuals or groups for exceptional performance to motivate them to do more as another CSF.

Although this review of CSFs highlighted several success factors, there is no indication of the transparent methodology used in arriving at some of the success factors outlined by some researchers. To this end, it was discovered that there is limited research that attempted to produce a comprehensive collection of CSFs on the maintenance implementation at Nigerian public universities.

Conclusion and direction for future research. This research work can be a valuable step towards enhancing the chances of implementing successful maintenance at Nigerian public universities. A critical review and compilation of the maintenance management success factors reveal that so many success factors are presented in the literature based on an existing assessment. Therefore, the major limitation of this compilation is duplication in the frequency analysis of the CSFs. Consequently, when some researchers attempted to discover the CSFs from their empirical research, they usually concentrate on a specific aspect of maintenance implementation or a particular CSF type. Hence, no research encompasses all CSFs for the implementation of maintenance at Nigerian public universities. Previous studies on CSFs for maintenance are also similar to the fragmented approach used for maintenance implementation projects.

Because of these problems on identification and implementation of CSFs, there is an attempt by [Zwikael and Globerson \(2006\)](#) to convert “critical success factors to critical success process” because even though CSFs are well-known, the rate of failed maintenance project is in the increase. However, this may be because the current CSFs are too general and did not contain enough distinct explanation to support project managers’ discharge of their duties. They discovered the importance of the planning process on project success and identified the critical success process CSP that project success heavily relied on. Their findings were based on a field study that involved 282 project managers. Their results reveal that the most critical planning process that has the most significant impact on project success is the “definition of activities” followed by scheduled development, communication and planning, staff management, organisational planning and project plan development. They also discovered that project managers do not divide their time effectively within the different work processes. However, [Wood and Caldas \(2001\)](#) argued that the implementation process is the most crucial and complex and recommended that future research emphasise the implementation process from a broader perspective.

Another study conducted by [Chiekezie et al. \(2017\)](#); [Ebi \(2014\)](#), [Jones Fuanekwu and Eniola \(2017\)](#); [Olatunji et al. \(2016\)](#); [Tijani et al. \(2016\)](#); [Magutu and Kamweru \(2015\)](#); [Olufunke \(2011\)](#); and [Donalek et al. \(2018\)](#) discussed in details about the need for a good and sustainable maintenance culture in Nigerian universities. Whereas [Alejo \(2018\)](#), [Ugwu et al. \(2018\)](#); [Amankwah et al. \(2017\)](#); [Kalumbu et al., \(2016\)](#); [Mohd-Noor et al. \(2011\)](#); and [Eti et al. \(2006\)](#) examined the need for a maintenance policy so that all maintenance-related activities can be scheduled, programmed and planned according to the maintenance need of the organisation.

Finally, based on those mentioned above, there is the need to conduct more thorough research into the need for a maintenance policy in Nigerian universities. The establishment of maintenance culture in the institutions so that both the students and staff can adapt gradually to the established standards governing their conduct regarding maintenance-related activities in the university. However, all of the maintenance CSFs listed in this research work are important in implementing maintenance work. Still, the need to provide a maintenance policy in this rapidly developing society becomes necessary so that Nigerian universities can compete favourably with other universities across the world.

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