JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DEVELOPMENT OF MAINTENANCE MANAGEMENT SYSTEM FOR CONSERVATION OF HISTORICAL SITES

A CASE OF KIMBIJI AND MBUAMAJI, KIGAMBONI

J.H. Mbellah (B. Arch), [1] J.N. Mkilania, [2] Dr. E.A. Nyari [3]
Architect [1], Senior Lecturer [2], Senior Lecture [3]
Division of infrastructure, Rural and Urban Development [1], Dar es Salaam, Tanzania

ABSTRACT

Preserving historical sites is essential for safeguarding cultural heritage and promoting tourism. This research focuses on developing maintenance management system for the conservation of historical sites, with Kimbiji and Mbuamaji in Kigamboni as case studies. The objective is to address maintenance and preservation challenges in the region.

A mixed-method approach is employed, combining qualitative and quantitative data collection techniques. Interviews, questionnaire and on-site assessments gathered insights from stakeholders, experts, and local communities. The aim of this research was to develop maintenance management system for the conservation of Kimbiji and Mbuamaji historical sites. Factors affecting maintenance effectiveness were identified, maintenance management model and maintenance management system was developed based on findings, integrating modern technologies, best practices, and community involvement for sustainable preservation.

The developed maintenance management system (MMS) aims to conserve Kimbiji and Mbuamaji historical sites and serve as a model for others. This research supports policymakers, heritage managers, and communities in safeguarding cultural heritage, fostering responsible tourism, and promoting socio-economic growth.

Key words: maintenance system, conservation of historical sites, maintenance

1.0 Introduction

Mbuamaji and Kimbiji historical sites, located in Kigamboni, are two examples of historical sites that require conservation and maintenance. These sites are known for their cultural, historical and natural significance, attracting many local and international tourists. However, these sites face challenges in terms of inadequate resources, infrastructure and maintenance management.

To address these challenges, it is better to develop maintenance management system (MMS). This is a tool for managing and monitoring maintenance activities, tracking repairs, and ensuring the efficient use of resources. It is critical to the sustainability and longevity of historical sites. Developing and implementing an MMS will ensure their preservation and sustainability.

Several references have demonstrated the use of MMS for the conservation and maintenance of historical sites (Kumar et al., 2020; Milani et al., 2019). These studies suggest that the implementation of an MMS can improve the efficiency and effectiveness of maintenance activities and can ensure the longevity of historical sites.

In conclusion, the development of MMS for the conservation of historical sites is critical to their preservation and sustainability. This research will contribute to the body of knowledge regarding maintenance management systems and their application to historical site conservation.

1.1. Statement of the problem

The conservation and maintenance of historical sites are critical for their preservation and to ensure they can continue to provide educational, cultural, and economic benefits. However, many historical sites in Tanzania face significant challenges in terms of inadequate resources, infrastructure, and maintenance management. Mbuamaji and Kimbiji in Kigamboni, Tanzania, are two examples of historical sites that require conservation and maintenance. These sites are known for their cultural, historical, and natural significance, attracting many local and international tourists. However, these sites face challenges in terms of limited financial resources, inadequate infrastructure, and lack of qualified personnel.

Therefore, there is the need of developing maintenance management system for conservation of historical site so as to enhance social economic activities such as tourism in Dar es salaam city and Tanzania at large.

1.2. Objectives

The General objective of this study is to develop the maintenance management system for conservation of historical site of Mbuamaji and Kimbiji.

1.2 .1 Specific objectives are as follows

i. To identify factors affecting maintenance effectiveness of historical sites at Mbuamaji and Kimbiji.
ii. To develop maintenance management model for conservation of Mbuamaji and Kimbiji historical sites.
iii. To develop maintenance management system for conservation of Mbuamaji and Kimbiji historical site.

2.0 Literature review

The literature review for this study will be structured to address the specific objectives outlined in the research proposal, namely: the identification of factors affecting maintenance effectiveness at historical sites in Mbuamaji and Kimbiji, the development of a maintenance management model for the conservation of these historical sites, and the establishment of a maintenance management system. This review is conducted with the aim of addressing challenges such as inadequate funding, insufficient expertise, and environmental degradation, all of which hinder the effective preservation and maintenance of cultural heritage sites, ultimately leading to their gradual deterioration (Deacon, 2018).

2.1 Maintenance Management system

The basic components of maintenance management system developed includes development of performance standards, determination of work load, budgeting, scheduling of activities within the budgeted program to utilize resources in the most efficient manner and establishment of management information system which provides the basic knowledge required by managers for decision making (Kishk, 2013). Refer to Figure 2.1 and 2.2.

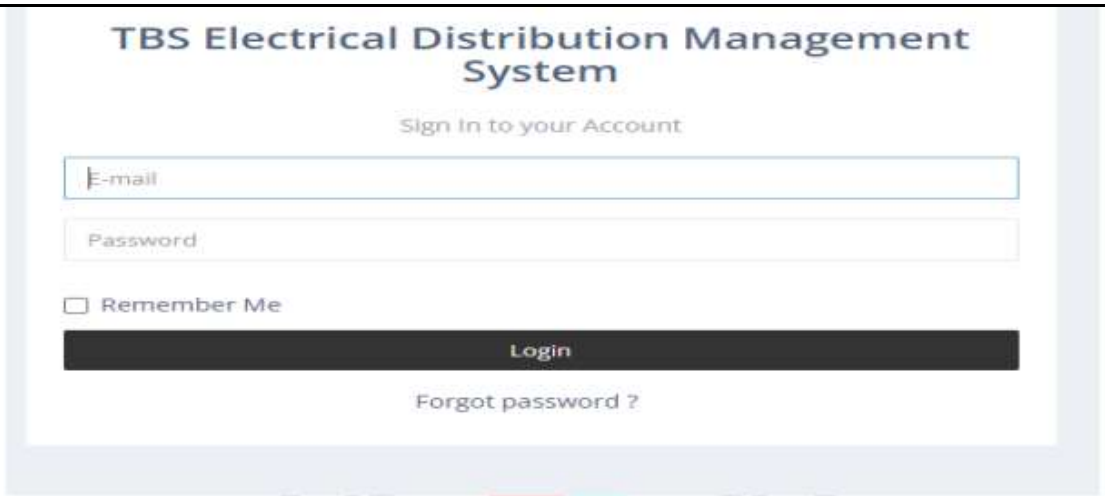

Figure 15 maintenance management system

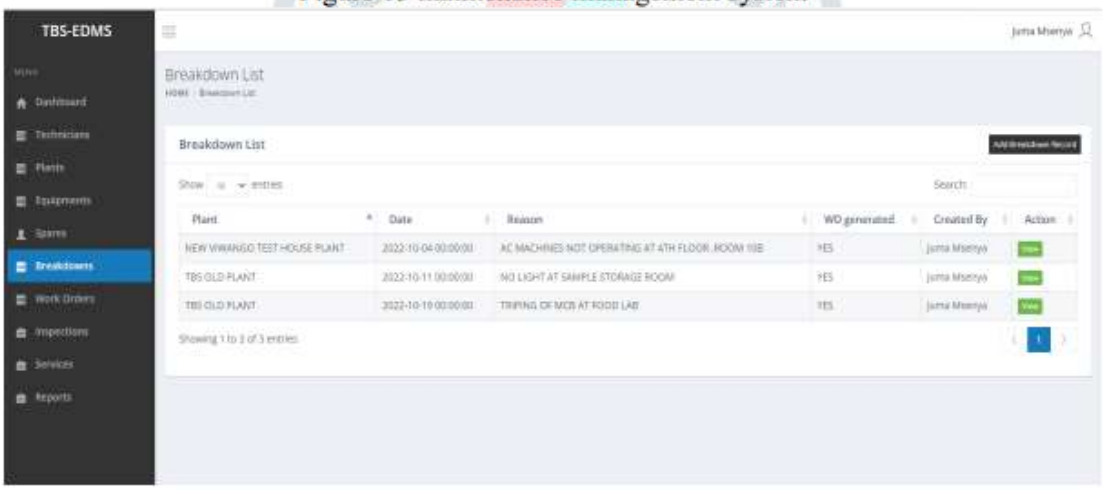

Figure 2.1: Example of maintenance management system (Msenya,2014)

Figure 2.2: Example of maintenance management system (Msenya,2014)

2.2 Multiple regression Model

Multiple regressions are the progression of a regression model with two or more independent variables. They are methods of studying the effect and magnitude of more than one independent variable into dependent variable by using correlation and regression (Kothari, 2005; Saunders *et el*., 2007).

The formulation leads to derivation of the equation between independent and dependent variables. Each independent variable has its own coefficient and the dependent variable is predicted from a combination of all the variables multiplied by their corresponding coefficients plus a residual term (Field, 2000). A generic equation of this multiple regression model is given (Field, 2000) as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 ..... + \beta_n X_n + \varepsilon_i \quad (1.1)$$

Where:

Y is the outcome variable

β_0 is the constant (y intercept)

β_1 is the coefficient of the first predictor

β_2 is the coefficient of the second predictor

β_n is the coefficient of the n[th] predictor and ε_i is the different between the predicted and observed value of Y for the i[th] Subject.

2.3 Factors affecting maintenance effectiveness for historical sites

Factors affecting maintenance effectiveness of Kimbiji and Mbuamaji historical sites have been identified with the light of literature review and are categorised into three groups as shown in Figure 1.1 and Figure 1.2 .

=

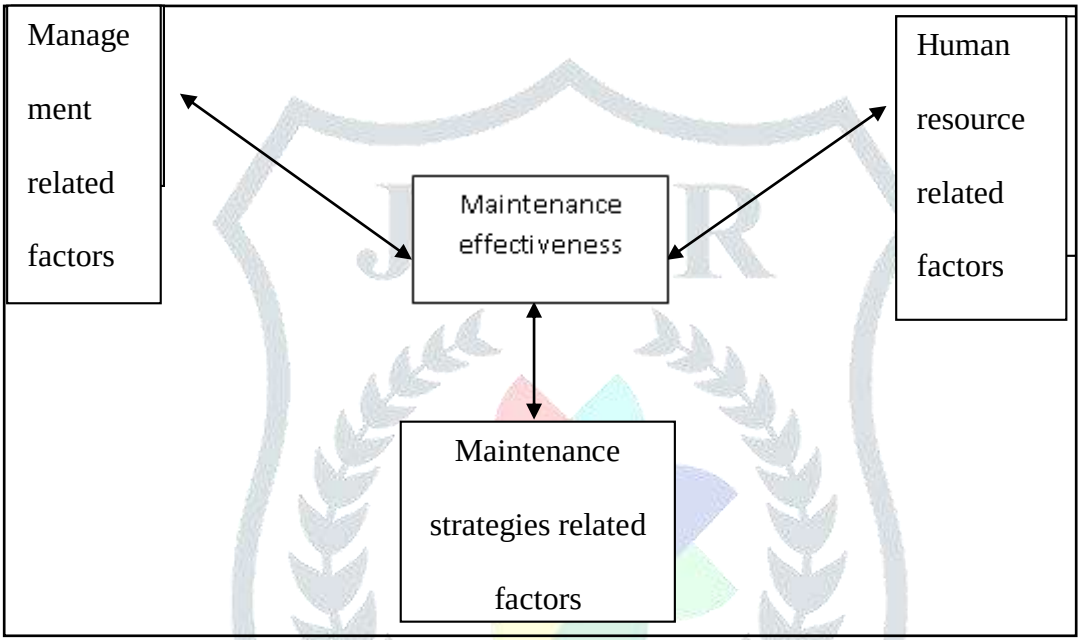

Figure 2.3: Factors affecting maintenance effectiveness (Munuo, 2016)

Factors affecting maintenance effectiveness	**Author's name & year published**
Maintenance strategies related factors	Kelly (1997); Pintelon et al (2006)
Maintenance action type	Coetzee (2000)
Maintenance resource allocation	Al-Habi et al (1999)
Human resources related factors	Cholasuke et al (2004); Gonzales et al (2007
Wages of maintenance personnel	Raaum et al. (2008)
Experience of maintenance personnel	Mjema et al (2008); Kelly (2001);
Management related factors	Marquez (2007) ; Dhillon (2002) ;
Awareness of maintenance	Bavu et al (1997) ; Liyanage et al (2003)
Maintenance Policy	Dhillon (2002)

Figure 2.4: Factors affecting maintenance effectiveness (Munuo, 2016)

3.0 Methodology

The methodology used to attain the study objectives was through literature review, questionnaire, survey and on-site assessments to observe the physical condition at Kimbiji and Mbuamaji historical sites. Most of the data have been collected from National Museum of Tanzania (NMT) and Kigamboni municipal Council (KGMC). The data collection tools were Microsoft excel and computer. Moreover, the analysis tools were descriptive statistics by using statistical package for social science (SPSS) version 26.

4.0 Data collection and Analysis

The data collected were presented according to the research objectives. The tools used were structured questionnaires, archival research and visual observation then being analyzed in tables. The data analysis was in qualitative and quantitative methods and analyzed using SPSS version 26.0. Then analysis data interpreted in terms of percentage as responded by respondents as shown in Figure 4.1 and Figure 4.2.

Table 4. 1: Guide to degree of significance

Degree of significance	**Rating**
Most significant	0.76 -Above.
Significant	0.67-0.75
Less significant	0.45-0.67
Not significant	0.44 -Below.

Table 4.2: Factors affecting maintenance effectiveness and ranking by using RII

Factors	**RII**	**Rank**	**Rating**
Building maintenance strategies	0.883	1	Most significant
Skilled maintenance personnel	0.878	2	Most significant
Fund to maintain historical sites	0.850	3	Most significant
Maintenance culture	0.839	4	Most significant
Institutional and training facilities	0.750	5	Significant
Lack of understanding the importance of maintenance works	0.717	6	Significant
Management to maintenance culture	0.694	7	Significant
Building policy	0.628	8	Less significant
Low concern to maintenance culture	0.583	9	Less significant

5.0 Development of Maintenance Management Model for Conservation of Kimbiji and Mbuamaji historical sites

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.869	6	5.165	4.823	.000[b]
	Residual	41.114	33	.900		
	Total	64.583	39			

a. Dependent Variable: Improvement of maintenance effectiveness

b. Predictors: (Constant), Lack of Institutional and training facilities, Lack of building maintenance strategies, there is no maintenance culture, Insufficient fund to maintain the buildings, Unavailability of skilled maintenance personnel, Lack of building maintenance standard

ANOVA, the significance value (P value) is 0.000 which is less than 0.05. Therefore, this implies that the hypotheses of this study are positively correlated since at 5% level of significant and 95% confident level, the significant value (P value) in the ANOVA and coefficient regression lie between values of P < 0.000- 0.05

Table: Regression equation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	0.001	.0005		7.207	.000
1	Building maintenance strategies	.014	.012	.023	0.540	.031
2	Maintenance personnel	.012	.009	.021	0.684	.089
3	Maintenance Fund	.007	.002	.004	1.144	.048
4	Maintenance culture	.009	.271	.015	.041	.767
5	Maintenance standard	.014	.290	.0.12	0.952	.199
6	Institutional and training facilities	.013	.063	.029	1.277	.018

a. Dependent Variable: Improvement of maintenance effectiveness

Model summary:

ME=0.001+0.01(MS)+0.012(MP)+0.007(MF) +0.009(MC) + 0.014(MS) +0.013(TF)

X_1 = Maintenance strategies (MS), X_2= Maintenance personnel (MP), X_3= Maintenance fund (MF), X_4= Maintenance culture (MC), X_5= Maintenance standard (MS), X_6= Training facilities (TF), Y= Maintenance effectiveness to improve the conservation of historical sites

6.0. Historical Site Maintenance Management System (HSMMS) Dashboard

The variance component of this program supports the maintenance planning tasks. The system's dash board is made up of the Dashboard component, Historical site identification, Documentation and records, the User, Survey building, survey and investigation, materials test, implementation and evaluation and reports. Figure 6.1: HSMS dashboard

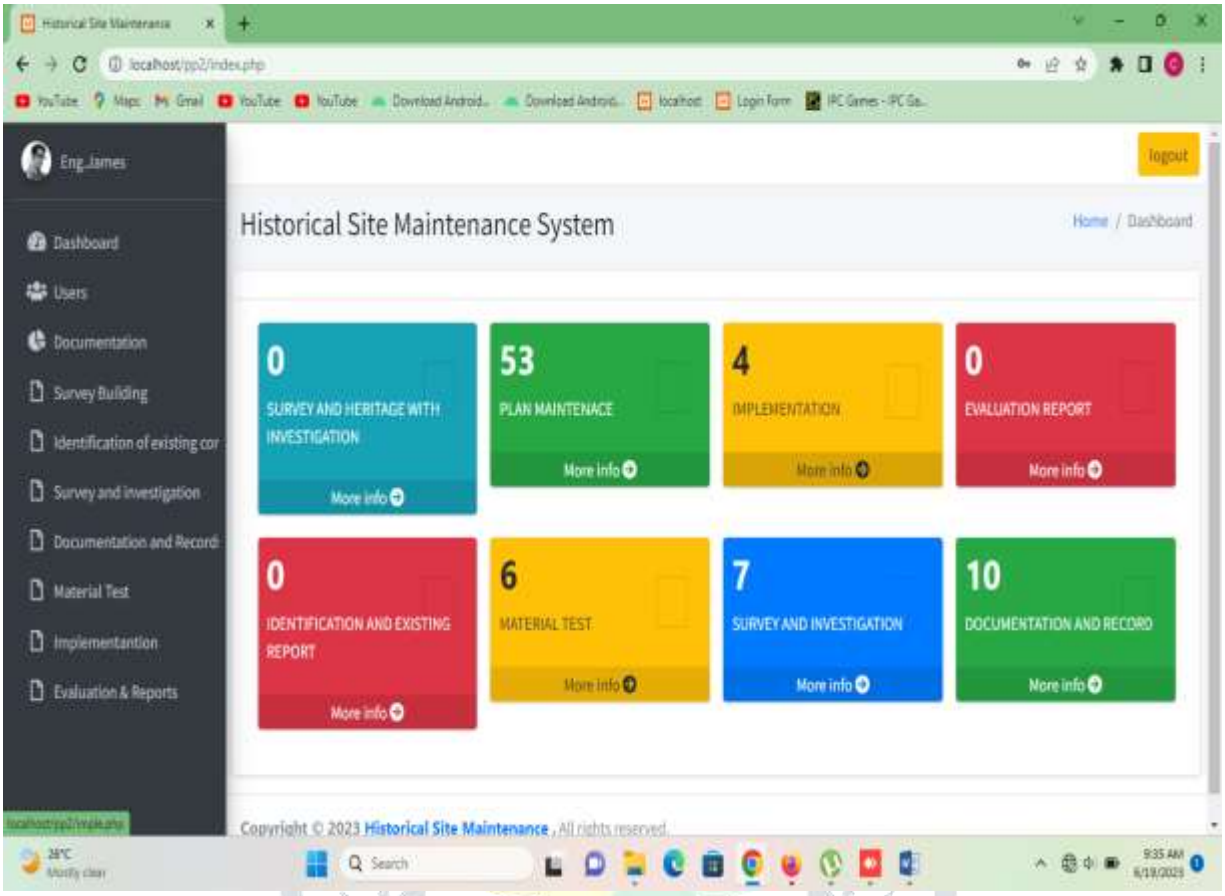

Figure 6.1: Example of Historical Site Maintenance Management System

7.0 Conclusions and Recommendations

Conclusions

The main objective of this project was to develop a maintenance management system that would increase maintenance efficiency for the conservation of historical sites at Kimbiji and Mbuamaji historical sites. The study achieved three specific objectives, which were to identify factors affecting the maintenance effectiveness of historical sites at Mbuamaji and Kimbiji, to develop a maintenance management model for the conservation of historical sites, and to develop a maintenance management system for the conservation of Mbuamaji and Kimbiji historical site.

According to the study, various elements such as maintenance strategies, personnel, funding, standards, culture, and training facilities can influence the effectiveness of maintenance. To tackle these issues, a maintenance model was developed to optimize the

conservation of historical sites. Among the strategies developed to lessen frequent historical site failure were a schedule and plan for attending equipment preventive maintenance, effective communication between maintenance personnel and the user operational department, supervision of maintenance practices for monitoring and controlling work, and monitoring of equipment age for controlling life span.

Additionally, based on the coefficients of the parameter, maintenance strategies (0.01), maintenance personnel (0.012), maintenance fund (0.007), maintenance culture (0.009), maintenance standard (0.014), and training facilities (0.013), a mathematical model based on seven key factors that significantly affect the maintenance effectiveness of a refrigeration system was developed. The factors of the independent variable account for 98%

of the variation in the dependent variable, which was modeled using quantitative data on the aforementioned components that was processed using SPSS.

Recommendations

- Methodology Utilization: To increase maintenance effectiveness, the historical sites should employ established methodologies to monitor and manage maintenance policies and strategies. This allows for thorough historical data recording on a regular basis (daily, weekly, and monthly) for scheduling and reviewing maintenance plans.
- Develop Sustainable Funding Mechanisms: To ensure the long-term sustainability of the maintenance strategies, it is recommended to explore various funding mechanisms. These may include public-private partnerships, heritage grants, and tourism revenue reinvestment. A diversified funding approach can help secure the necessary resources for ongoing preservation efforts Training: Management should develop strategies to provide regular maintenance training to the maintenance crew in their respective areas of specialization. On-the-job training at all levels, from operators to the maintenance management division, should be emphasized.
- Implementation of Developed Strategies: To increase upkeep effectiveness and extend the lifespan of historical sites, the management of Kimbiji, Mbuamaji, and Kigamboni is advised to put the developed strategies into practice.
- Future Research: Given that the study focused on factors affecting current maintenance procedures for historical sites, it is recommended that further research be conducted to explore additional improvements in maintenance effectiveness.

The developed maintenance management system provides a roadmap for improving the maintenance and conservation practices of historical sites in the studied areas. They emphasize the importance of regular monitoring, training, maintenance culture, maintenance personel, sustainable funding mechanisms, and the building standard to ensure the long-term preservation of these valuable cultural assets.

ACKNOWLEDGEMENT

I am deeply grateful to the Almighty for His boundless love and blessings, for keeping me alive, healthy, and granting me the strength to pursue and accomplish this significant dream. First and foremost, I extend my heartfelt thanks and appreciation to my esteemed supervisors, Dr. E. A Nyari and Dr. J. Mkilania, for their unwavering guidance, support, and tireless efforts in assisting me throughout this research journey.

References

[1] A. K. Sahu, S. S. M., and B. K. Mahapatra 2019. Maintenance planning and scheduling: A review," Journal of Quality in Maintenance Engineering, vol. 25, no. 4, pp. 526-551, 2019.

[2] Al-Harbi, A. and Kamal, M. 1999, "Optimisation of Staff Numbers in the Process Industries: An Application of DEA". *International Jounal of Manpower Vol.21 No1.*

[3] Al-Turki, U. M. 2009. Maintenance planning and scheduling. *Handbook of Maintenance Management and Engineering.* Springer.

[4] Ashurst, J. 1988. Conservation of Building and Decorative Stone.

[5] Bavu, E., Sheya, A., Mlawa, H. and Kawambwa, S. 1997, "Culture of Maintenance for Sustainable Development in Tanzania", TechMa, and Dar es Salaam

[6] Cholasuke, C., Bhardwa, R. And Antony, J. 2004, "The Status of Maintenance Management in UK Manufacturing Organisation Result from a Pilot Survey" *Journal of Quality in Maintenance Engineering Vol.10, No.1.*

[7] Coetzee, J. 2000, "The Maintenance Strategy Gap". *Proceedings of the World Trends in Maintenance Engineering Conference*, Pretoria, South Africa

[8] Deacon, J. H .2008. African cultural heritage sites and the world heritage convention: an overview. African Yearbook of International Law, 24(1), 83-102.

[9] Dhillon B.S 2002, "Engineering Maintenance: A Modern Approach". CRC Press, Boca Raton, Florida.

Docrep. 2019. *Methods of Data Collection and Techniques* [Online]. UK. Available: http://www.fao.org/docrep/003/x2465e/x2465e09.htm [Accessed 05/01/2019 2018].

[10] Docrep. 2019. *Methods of Data Collection and Techniques.* .

[11] E ogunoh, P., Mbanusi, E. & Peter, O. U. 2018. Effective implementation of maintenance models in building maintenance process. *Journal of Engineering Research and Reports***,** 1-10.

[12] Field, A. (2000), "*Discovering Statistics using SPSS for Windows*", Sage Publication London.

[13] Fund, H. L. 1998. Conservation plans for historic places.

[14] Ghanem, J., 2019. Conceptualizing "the Tourist": A critical review of UNWTO definition.

[15] Gonzalez, M.S. and Tacoronte, D.V. (2007), "Human Resources Control Systems and Performance: the Role of Uncertainty and Risk Propensity", *International Journal of Manpower. Vol.29, No.2,*

[16] Heritage, C. C. T. P. O. T. W. C. A. N. 1975. Convention concerning the Protection of the World Cultural and Natural Heritage.

[17] I.S, M. 2007. The production and Use of Appropriate lime in the Conservation of Historic Town of Zanzibar.

[18] Karanja, J. 2016. A Guide to Research Proposal and Thesis Writing. *Available at SSRN 2746361*.

[19] Kelly, A. 1997, "Maintenance Strategy – Business-Cantered Maintenance". Oxford: Butterworth-Heinemann, Oxford

[20] Kelly, A.L. (2001). "Comparison of Moulding Machine Ages. London", Willey and Sons Inc

[21] Kerlinger, F. N. 1966. Foundations of behavioral research.

[22] Kishk, M. 2013. *Risk-based maintenance methodology for historical buildings.* .

[23] Kothari, C.R. (2004), *"Research methodology methods and Techniques"* 2nd Edition. New age international publishers.

[24] Lam, T. Y. M. 2008. The Impact of Management Measures on Performance of Outsourced Professional Housing Maintenance Services. *Journal of Property Management***,** 112-124.

[25] Lee 1976. Planned Building Maintenance, A guidance note,

Royal Institute of Chartered Surveyors, U.K.

[26] Liyanage JP and Kumar U 2003, "Towards a Value-Based View on Operations and Maintenance Performance Management". *Journal of Quality in Maintenance Engineering, pp333–350*

[27] Mjema, E.A. and Mnanu, J.P. 2008, "Factors Affecting the Quality of Maintenance of GSE- A Case Study at DAHACO", *6th International Conference on the Role of Engineers in Meeting Millennium Development Goals in Lesser Economies.* The Institution of Engineers Tanzania-Arusha

[28] Marquez, A.C. 2007, "The Maintenance Management Framework: Models and Methods for Complex Systems Maintenance". New York: Industrial Press, Inc.

[29] Morris, E. 2022. Sample size for small population.

[30] Munuo,E. 2016. Investigation of Factors Affecting Maintenance Effectiveness of Equipment and Machinery in Public Training Institutions in Tanzania

[31] Mukalula, P. M. 2007. Maintenance Policy Implementation–Prioritised Decision Making Processes. *Rcom A***,** 29.

[32] Msenya,J.A 2014.Development of Maintenance Management system for Electrical Distribution Facilities to Enhance Laboratory Availability Peformance.A case study of Tanzania Bureu of Standards Headquarters Dar es Salaam Tanzania.

[33] Mytum, H. Conservation and Management of Archaeological Sites: Principles and Practice *Book*.

[34] Pintelon, Liliane, and Srinivas Kumar Pinjala 2006, "Evaluating the Effectiveness of Maintenance Strategies", *Journal of Quality in Maintenance 12, No. 1, pp7- 20*.

[35] Ram Chandra Dahal*, K. R. D. 2020. A Review on Problems of the Historical site conservation Maintenance

[36] Raaum, O., Haegeland, T., Bratsberg, B. and Barth, E. (2008), "Who Pays for Performance?,". *International Journal for Manpower Vol. 29 No.1*.

[37] Robert Bucon, A. C. 2021. A model to support a long- term building maintanance planning for multi family housing. *Journal of Building Engineering*.

plan arbitration. *Engineering, Construction and Architectural Management*.

[38] Taha, Z., Ahmed, S,Masjuk, H. and Hassan, (2004). "TPM. In SMIs a Survey Studies in Malaysia" *Journal of Quality of Maintenance Engineering*. Vol.10 No.2