CHAPTER 1

Introduction and Literature Review

1.1. Background of study

Electricity du Laos (EDL) is the state enterprise company that created on 18th December 1961 and it is under the Ministry of Energy and Mine. EDL is the business of production, management, service and development of electrical energy for providing the electricity to domestic and nationwide.

The electrical power system is usually divided in three segments such as: generation, transmission and distribution systems. The distribution system can be divided into substation, network and user site system. The distribution system has the circuit of power supply at medium and low voltage level. The medium voltage is usually operated in voltage range of 12.7 kV to 35 kV and for the low voltage level is 0.4 kV. The medium voltage is supplying load to large consumers, it is connected to distribution transformer which are located near the customer's sites. The low voltage level is carried to energize to domestic customers such as: industries, private and governmental building, residential, etc.

The most electricity distributed energy for Vientiane Capital, which is supplied from Phontong substation as shown in Figure1.1. Phontong substation has received electricity 115 kV from central-1 grid, then step down to 22 kV for the medium voltage and 0.4 kV for low voltage. The medium voltage is supplying load to large consumers, it is connected to distribution transformer, which are located near the consumers' sites. The low voltage level is carried to energize to governmental offices, hospitals, business units, colleges and household. Phontong substation has an important role to supply the electric energy for 117,618 customers and it contains 8 feeders of 22 kV with 219 km of total length. It distributes the electric power approximately 30.3 MW, covering around 70 km^2 with insulated conductors 169 cct-km and bared conductors 50 cct-km as shown in Figure 1.2.

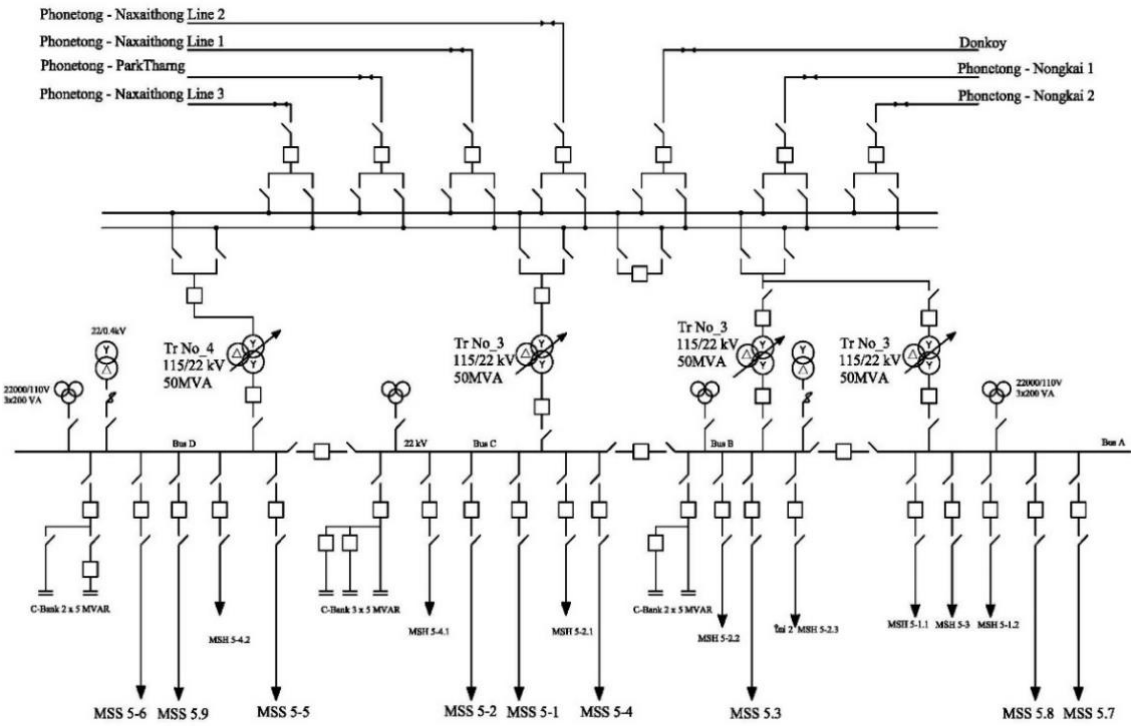

Figure 1.1 Single line diagram of Phontong substation

Figure 1.2 Distribution feeders of Phontong substation

At present, the electricity energy consumers are rapidly increasing in Vientiane Capital, meanwhile the Phontong substation has an important role to supply the electric energy. Therefore, its distribution system is expanded without proper and sufficient planning. This causes many troubles in distribution system such as: high cost of providing the service, excessive power loss and insufficient energy. Additionally, the system reliability is rather poor because there are several power interruption in some areas, which are caused by fault in electrical equipment and distribution line. Power interruption and system failure statistics are used to show the highest impact of electrical distribution system to the reliability of power supply. Therefore, Reliability Centered Maintenance (RCM) method is used for aiming to ensure the reliability improvement of distribution network system. It can be satisfied in the optimal way using the maintenance activities on the distribution system. It also focuses on existing system function, identification of critical failure in the system to find the choice possible or effective maintenance activities for system reliability.

The existing distribution network system is the vase for planning of reliability improvement. Distribution system maintenance have to ensure the sufficiency of distributed feeder in medium voltage and should be evaluated carefully all f alternatives and also including an optimal area that has many problems.

The overall problems which occurs in the system came from mostly the down tree, animal, equipment, natural disaster and other events as shown in Figure 1.3 [1].

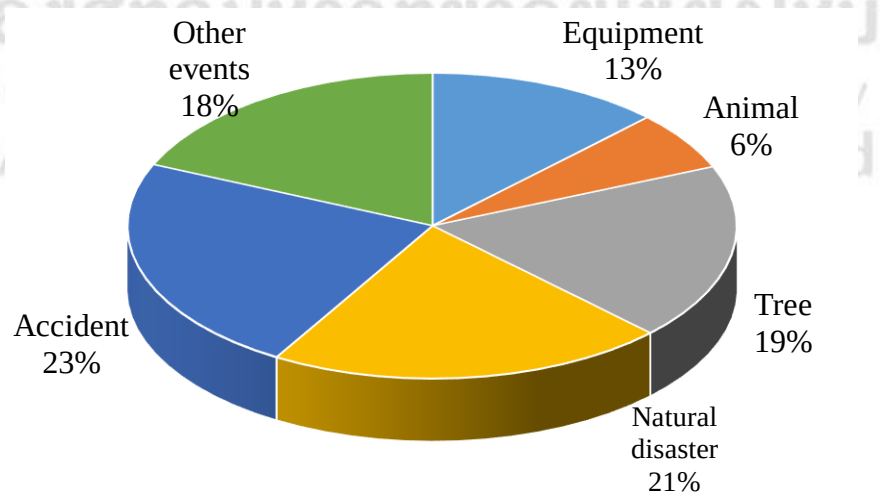

Figure 1.3 The cause of interruption events in percentage

1.2. Rationale of the study

Presently, in Vientiane Capital has grown the electrical load demand, which is quickly increasing. The most electrical power supply is provided from Phontong substation. But the distribution feeders cannot ensure the power supply with the good quality because the distribution system has no regulated the applicable maintenance so cause outage frequency, power interruption and critical failure occur in the system. Therefore, the existing distribution system should consider the optimal maintenance schedules to be increased the reliable power supply become to efficiency system that can supply continuously the electricity to customers without the power interruption and failures.

This research uses RCM method for evaluation, prediction and improvement of reliability indices of distribution system for Phontong substation. The RCM method will optimize the reliability of distribution system and optimize the properly manage maintenance activities. It can reduce the outage frequency, power interruption and failures in the system.

The damage due to the power interruption which occur in the system are affected directly to the customers. The summary of power interruption for Phontong substation in 2015 can be seen in the Table 1.1.

Table 1.1 Power interruption summary for distribution system of Phontong substation

Feeder	Number of Customers	SAIFI (time/year)	SAIDI (h/year)	Interruption		
				Outage (h/year)	Outage (time/year)	Customer (time/year)
MSS 5.1	12264	1.38	0.07	0.05	3	16890
MSS 5.2	14368	4.61	8.08	1.75	10	66300
MSS 5.3	13976	4.11	11.99	2.92	7	57470
MSS 5.4	14860	0.43	0.01	0.02	1	6412
MSS 5.5	14776	5.84	54.48	9.33	22	86275
MSS 5.6	16250	4.96	8.59	1.73	11	80531
MSS 5.7	15103	3.53	2.35	0.67	12	53244
MSS 5.8	14832	7.01	29.79	4.25	30	103950

This study is very important, it can help EDL know the problem of existing distribution network and RCM can give the role to focus the maintenance activities for finding the solution in reliability aspects and gives a framework to develop the optimal schedule for maintenance programs. EDL can also know the way how to plan the activities of system maintenance in the future. The study is concerned with the power interruption reduction, system reliability improvement for distribution system and the best way to maintain the distribution system for Phontong substation in Vientiane Capital, Lao PDR.

1.3. Objectives of study

The specific objectives of this research are as follows:

- Improving the reliability of distribution feeders for Phontong substation.
- Developing the plan and improving the maintenance programs.

1.4. Scopes of study

This study is focused in distribution system reliability of Phontong substation in Vientiane Capital that is under the responsibility of EDL to maximize the reliable power supply.

The specific scope of this study is following:

- The 22 kV distribution system of Phontong substation.
- All of technical data will be supplied and collected from EDL and electrical utility.
- This study considers only technical data of the medium voltage feeders (22 kV) on substation to distribution transformer.
- This study focuses on electrical equipment in distribution system.

1.5. Benefit of study

This study aims to give the benefits to EDL as below:

- To be able to define the guideline for the best maintenance tasks.
- To be able to plan the effective maintenance cost.
- To increase the reliability of the distribution system.
- Guideline for EDL to solve the problem and improve the reliability of the distribution system.
- Lifetime extension of equipment and system.
- Reduction of damage and impact cause critical failure in the system.

1.6. Literature review

Several research are related to this principle can have summarized as below:

T. Kasirawat and S. Titti [2] has presented the reliability improvement method including forecast and evaluation methodology for distribution system network. The power interruption, maintenance activities, system improvement budgets are used for this method. This method called RCM (Reliability Centered Maintenance) will be optimized more reliability of distribution system. Because it is very important for large city or economic, tourist area. The interruption of electricity can cause the result of high outage cost. Therefore, distribution system should have method for evaluation on reliability improvement to decrease the duration and outage frequency. RCM can help to select and control the method for the most critical problems and apply the best maintenance activities to find the solutions under budget constraint. Utility can manage the best conditions which match for maintenance activity and also can be high customer satisfaction and service quality.

S. Alshahrani and L.A Hadidi [3] have applied the RCM (Reliability Centered Maintenance) to different industries with noticeable results, this research has analyzed the power system in Saudi Arabia by putting the model into an application of real case

study conducted. The power system has referenced model which is a comprehensive model tailored.

M. Abbasghorbani and H.R. Mashhadi [4] has used Reliability Centered Maintenance (RCM) to study by focusing on the power circuit breakers maintenance planning in Khorasan province in Iran. The RCM concept strategy takes into the technical condition and importance of each circuit breaker in the network. The main idea of this study shows the method in three stage to decide the importance of each circuit breaker, evaluate the condition index of each breaker which have information provided at breaker's nameplate and consider the meteorological condition. Based on the knowledge about the condition and importance of each circuit breaker in the network, it can determine the priority of circuit breaker to perform the preventive maintenance**.**

P. Dehghanian, et al [5] have presented a practical framework with the RCM procedure, RCM can be implemented in Birka power distribution systems of Stockholm City, Sweden, and more practical aspects. The proposed algorithm consists of three stage. The first stage is the prerequisites of the analysis. Next, an approach is developed to identify the network's critical components, from the reliability point of view. Having practically modeled the components' failure rates, an efficient cost and benefit evaluation approach is then proposed to distinguish a variety of maintenance plans. The optimal set of maintenance strategies is next adopted for implementation. The algorithm is terminated in the third stage by recording both technical and economical outcomes for tuning the forward maintenance activities. The proposed methodology, although tailored to distribution networks is generic enough to be applied to other power system areas.

Jie Yu and Hao Zhao [6] have presented the principle of RCM (Reliability Centered Maintenance) strategies, which takes into consideration the condition of electrical equipment and its importance in the power network. The actual condition of electrical equipment can be identified based on various criteria and its importance in the power network shows the effect of equipment faults on power network safety and economic benefits. The RCM strategies can be adopted to find out which equipment must be maintained.