

The Framework of Capital Governance in the Electrical Energy Distribution System

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Abstract

Objectives: The sectors of distribution companies should be legislated and evaluated by the governance or sectors where performance studies should be conducted require a functional framework based on the distribution objectives. **Methods/Statistical Analysis:** This conceptual framework for power distribution companies has not been presented in any of the studies. In this paper, a new model for providing a distribution framework is presented, to this end, the governance and management of distribution companies are comprehensively possible. This model is based on the analysis of stakeholder interests and analysis of distribution capital. **Findings:** To explain the efficiency of the proposed framework to the role of the transformer in electrical distribution networks and related policies are discussed and for numerical studies on the indices presented for the Transformer Policies of Tehran Power Distribution Company located in Iran, the actual information has been studied. **Application/Improvements:** Power Distribution Companies.

Keywords: Electricity, Framework, Governance, Management, Networks, Power System

1. Introduction

Urban policies are set for welfare purposes. These policies, according to the existing constraints, regulate social variables in order to provide society satisfaction. Urban structures are determined based on urban policies. Urban structures establish the quality of urban behaviors. One of the urban behaviors is the quality of urban transactions that the sovereign and legislator should determine and monitor. Governance should provide the society goals with urban policing and planning for the implementation of the infrastructure of supply laws. Such policies have a special impact on urban indicators. Therefore, in^{1,2}, a comprehensive conceptual framework is presented to address the desired power commodity governance alongside each other and make policy simpler. Also, governance, with the management of society economics and the management of existing resources, tries to secure long-term goals. In^{2,3}, to make optimal use of resources, the dimensions of activities have been presented with different

perspectives, which have not been presented so far. Also, in order to meet the short-term goals of the city, special planning and specific laws are required by the governance. In^{4,5}, a new framework for introducing a variety of electrical services has been presented. Using modern technologies, the government tries to promote urban indicators and accelerate the achievement of goals^{6,7}. In order to utilize new technologies, we need to identify the activities of the researcher of the distribution goals in order to fully understand their implications in the framework that we will discuss in this article. Also, all urban services should be mutually reinforcing and not interrupting each other⁸. In order to coordinate electricity services with other urban services, it is essential to pay attention to the framework of distribution activities. But in this regard, several effective factors cause disturbance in the quality of services and transactions^{3,9,10}. In order to consider the effective factors, we also need to identify the framework of distribution activities that are presented in this paper. In

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addition to considering effective factors, governance should monitor the activities so that they do not reduce the quality of transactions, communications and services^{11,12}. In order to identify the dimensions of supervision, we also need to identify the framework of the activities of the researcher of the distribution objectives. To this end, before any action, we need a comprehensive framework to identify the planning activities and areas for promoting the urban indicators and reaching the main goals of society. In^{13,14}, a comprehensive framework is developed both from the point of view of governance and from the perspective of the firm, which can help legislators and electricity distribution companies understand the dimensions of profitability and society dimensions of services. Electricity is also an economic commodity, so the quality of its transactions is influenced by other urban policies and should be subject to certain rules. Distributing companies consider financial gain side by side as an increase in energy efficiency services and lower costs. This leads to risk of capital and technical stability. For this purpose, capital dominance (AG) is intended to guide AM in the distribution economic enterprises is intended to provide macroeconomic planning and regulatory activities to increase service and efficiency. The sovereignty should regulate the laws so that the goals of the distribution company and other stakeholders, including people and society, are aligned. For this purpose, governance should bring the activity framework in the eyes of the customer and returns in a clear and economical way. Economic language can be either income or fines. Governments enforce their policies by legislating and imposing fines. Restricting the inputs and financial relationships of distribution companies with the help of electricity market equilibrium and tariff regulations is another means of governance to increase the efficiency and economization of activities. Although many references have been made to the competition field, such as references^{15,16}, in a few articles such as reference¹⁷⁻²⁰, the AG has been described. However, in none of the studies, the dimensions of distribution governance have not been described. In this paper, in addition to determining the position of AG, the AG framework is reviewed and determined. In this paper, first, the relationship between power distribution and electricity distribution is described and the main goals of electricity distribution are identified. Then, the functional frameworks of the economic firms are described through the goals achieved. Then, how capital is governed and the effects of external factors are described and modeled. Finally, in order to explain the efficiency of the proposed framework, the role of the transformer in distribution networks and related policies are

discussed. For numerical studies, the indices presented for the Transformer policies of the Tehran Power Distribution Company located in Iran have been selected and the actual information has been studied.

The paper has been categorized as follows; the second section deals with the goals of the power distribution system. Description of framework of capital governance has been done in the third section. Location of transformer within the framework of the rule of capital has been presented in the fourth section. The fifth section deals with optimization of distribution processes to enhance the OF and Tn indices. Finally, a conclusion has been presented in the sixth section.

2. Goals of the Power Distribution System

Distribution companies are expected to act as economic firms. Therefore, their objectives will be tailored to the benefit of all stakeholders. The main stakeholders are the distribution of subscribers, shareholders and the community, each pursuing their goals in distribution. Through the common language of capital, the regulatory framework of the electricity distribution tariffs and the laws of the electricity market and control instruments are determined in such a way as to be easily implemented by executive activities based on the distribution management capital framework and the interests of the stakeholder's distribution. The task of the firm is to distribute the fulfillment of the obligations imposed on the part of the governance with the specific tariff of electricity. This requires the planning and management of capital (AM) in distribution. It proposes either the development of the distribution network or the use of existing capital. Governance through the use of a set of natural resources, the economy of society (financial policies of society), outsourcing of society trying to provide various goods in a stable, safe and equitable manner for the people of the society. Therefore, capital governance is indispensable for realizing the goals of governance. Indicator promotion activities are not discussed in capitalist governance, but tariffs are determined in such a way as to distribute enough incentives to increase performance indicators. Also, the expectation of providing services for their main indicators is defined and the amount of fines for distribution companies will be determined if the expectations are not met. The benefits of AMP and AGP are to assess the

impact of external factors on their distribution and measurement. Each of the external factors influences the burden, consumption, development, cost and tariff, and consequently on distribution planning. According to the presented explanations, the position of distribution companies in relation to governance and people can be summarized in Figure 1¹⁰. Based on this form, the subscriber's tariff is the standard of tariff, which is determined by the governance. The electricity purchase criterion and the costs of distribution companies are control laws governing electricity in the electricity market and other peripheral laws. On the other hand, distribution companies are required to improve the efficiency of resource utilization.

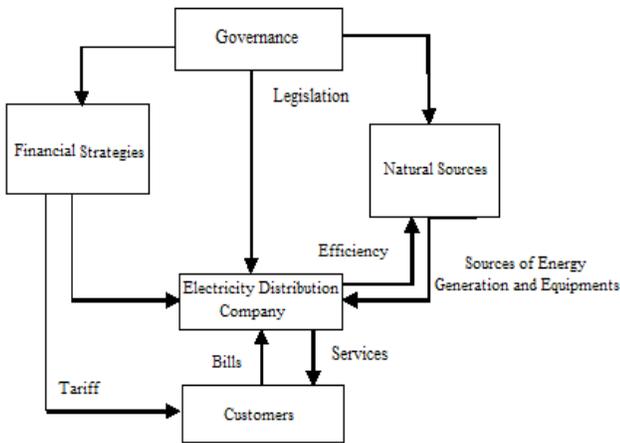


Figure 1. The position of electricity commodity relative to the sovereignty and people.

Figure 2¹⁰, according to Figure¹, addresses the relationship between AG, AM and describes the effects of AG and AM on each other and the effects of external factors on them. The AGP criterion is the government's economy, natural resources, and outcomes for the assessment of the capital of distribution companies, according to which electricity market rules, tariffs, and service control rules are determined. Distribution companies are also required to manage their distribution assets and exploit them in the electricity market environment. Capital management, with the help of DSP and DOS, should improve service and efficiency. As a result, the goals of electricity, which are the same goals of electricity distribution, can be expressed as follows:

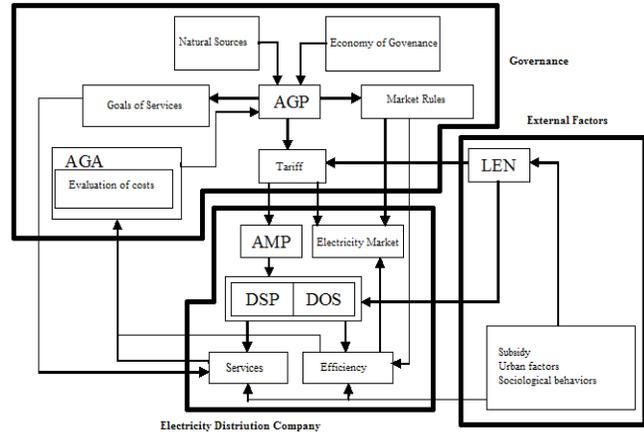


Figure 2. Describing the effects of AG and AM on each other and the effects of external factors on them.

- Improve the service
- Improved efficiency
- Restore customer rights

3. The Framework of Capital Governance

The payment of electricity tariffs by consumers is considered as a source of capital for electricity distribution companies, and capital management is one of the main responsibilities of distribution companies in order to realize distribution objectives.

Therefore, plans to realize the distribution objectives of the management framework and the distribution of capital governance. In this section, we examine the distribution goals and the management activities necessary to achieve the goals.

First objective - Improve the service

The service is divided into three main sections of the subscriber's view as shown in Figure 1¹.

A) Safety: This principle is divided into two main categories. This categorization is indicated in Figure¹. The safety of people and subscribers mainly addresses the network's immunization and addresses issues such as privacy, insecurity, and so on.

B) Quality: This term, which is known as power quality in electricity, is divided into three main categories as shown in figure¹. Transient states create a voltage flash

for critical subscribers and reduce their performance. Non-standard voltage also reduces the performance of consumer devices.

C) Continuity: This category is known as “Reliability”. The largest emphasis of distribution companies in the form of AMP and DSP reports is to provide high reliability for subscribers every year. Several contingency planning papers for distribution companies have been discussed. In most references, reliability is divided into two categories: reducing the number of offsets and reducing the time offsets. But in this paper, with a process-oriented view of distribution activities, the factors affecting continuity or reliability are divided.

This type of division has the advantage of finding and implementing solutions and improvements projects if it decides to change the reliability indicators. This type of division is given in Figure¹. The main objectives of the continuity sub-sections of reliability are shown in Table 1¹⁰.

Table 1. Objectives of the supply reliability management

Row	Management of supply reliability	Objective
1	Event Management	Error Locations Time Management
2	Waste management	Lifetime of Equipment Management
3	Network Security Management	Crisis management
4	Management of new projects	Management of new equipment and projects

4. Event Management

This section refers to a set of activities of distribution companies that should be followed after an accident or shutdown to resolve it. These activities require infrastructures that need to be built and strengthened before the accident. The set of activities after extinction can be divided into four main categories according to Table 2¹⁰. In all stages, the use of techniques and management tactics should be used to reduce definite time. Figure¹ depicts the sub-sections of this management.

Table 2. Activities after shutdown

Stage	Activities after shutdown	Infrastructure required
1	Error location separation	Creating Manipulation Points
2	Power up the maximum subscribers	Creating maneuver points
3	Troubleshooting	Management of events
4	Returns the network to its original state	-

4.1 Wastes Management

This section refers to the set of activities before the silent operation and controls the number of offsets. The set of activities in this section can be divided into two categories of network load control and physical control of the network. Network load control involves the load management of intermediate level pressure equipment, distribution and low voltage stations, and the planning of connection to ultra-distributed systems, including the request for a new medium-post-feeder or new over-distribution post and the management of the facilities protection of against load. Also, the physical control of the network can be divided into two categories of preventive maintenance activities and management of the correction of worn out networks. The set of these factors improves the management of life of the distribution equipment. Figure¹ illustrates the factors and processes of this management.

4.2 Network Security Management

The factors that cause the crisis and the security of the network can be divided into different categories, depending on the definition of the crisis.

In this paper, we consider the crisis that arises from insecurity of the network, the crises of shutdown (technical instability), or the fragility of the economic sustainability of economic distribution companies for the proper exploitation of distribution networks. Therefore, in addition to preparing the distribution to face the crisis, other infrastructures also need to be distributed in order to prevent cross-sectoral crises. The network security threats can be categorized as follows:

- Geographic and atmospheric factors such as earthquake, flood, rain, lightning etc.
- Urban factors that is most likely to arise from municipal mismatches with electricity distribution companies. Such as moving bases for building upgrades, changing utilities etc.
- Social factors: wire robbery, piracy, and so on.

Of course, the importance of network security management is higher than other management's weight in improving network reliability. Figure¹ shows the factors and processes of this management.

5. Management of Capital Projects

These projects require high investments and the introduction of new equipment into distribution networks, including the construction of LV, MV and installation of air and ground stations, or the installation of lateral equipment such as a re-closer and the like. Considering the high volume of investments in these projects, planning and prioritizing them is very important and due to the introduction of new equipment to the distribution network of equipment and quality of installation is of great importance. The shutdown management with the program and its duration during the construction of projects and connecting them to the power grid is one of the most important issues in controlling network shutdowns. The glance at the first goal is customer-centric and more oriented towards customer satisfaction. Therefore, the criterion of measurement and evaluation is done by the customers themselves. Therefore, the manner and method of measuring related indicators are defined by the rule of law and when the customer complains of the enterprises, they are responsible for answering customers. Figure¹ depicts the sub-sections of this management.

5.1 Second Objective: Improvement of Efficiency

Improving performance in this sector means optimal use of resources. These resources are the sources of governance that are distributed to the enterprise. These resources can be divided into three categories:

- Energy resources
- Equipment production resources
- Human Resources

Assuming that with the training and motivation of human resource management, we have the maximum productivity, so we focus the paper on two other sources. But for the most efficient use of equipment resources, all equipment and all distribution capacities should be used continuously.

Therefore, the goals of using resources to produce equipment to shown in Figure 3¹⁰ achieve high productivity can be divided into two categories:

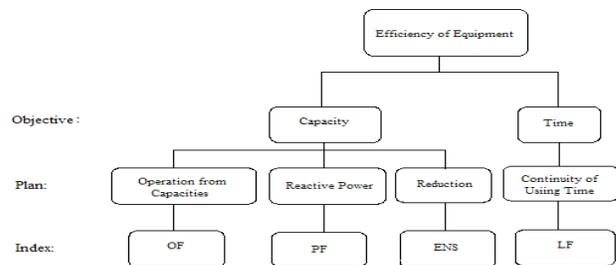


Figure 3. Efficiency of equipment production sources framework.

- ✓ Capacity: Maximum use of equipment capacity and minimum capacity against load growth.
- ✓ Time: Continuous use of equipment and maximum service time and facility utilization.

Thus, in view of the two goals mentioned above, the tree of the form (3) can be considered to ensure the high productivity of the use of production resources. Therefore, a summary of the activities of the economic firm of distribution can be summed up in order to achieve the yield performance in Table 3¹⁰.

Table 3. Increasing efficiency of resource use activities

Row	Source type	Activity
1	Energy production	Reduce casualties
2	Manufacturing equipment	Correction of LF, ENS, PF, OF
3	Human	Human resource management

Methods of improving performance indicators can be described as follows:

Loss: Losses are divided into technical and non-technical categories. Different methods for reducing the technical losses are shown in Figure 4¹⁰.

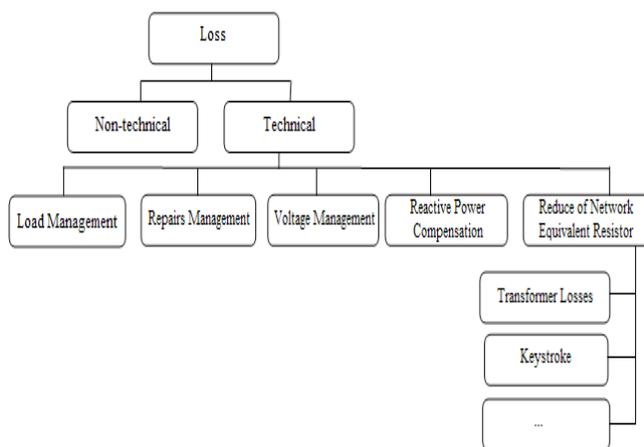


Figure 4. The framework for reducing casualties.

ENS: Distributed energy reduction methods are the same as increasing reliability.

PF: Improving PF improves the efficiency of Loss in addition to improving the return on resources, resulting in improved efficiency indirectly.

LF: All consumption management methods improve LF, which essentially changes the load factors, changes in consumption culture, changes in tariff-compliant tariff policies, and other activities that can be done by distribution to improve this index.

OF: In order to improve the OF index, load management has to be done in such a way that more than existing capacities are used to feed the load and less new capacity is set up.

5.2 Third Objective: Restoring Customer Rights

The framework for customer rights activities can be showed in Table 4¹⁰. A number of activities in the form of (5) of the third objective (CA) are functional constraints, but a number of other environmental activities, such as lighting, require cost and effect on tariffs.

Table 4. Customer Rights Framework⁴

Quality of communication	Financial interactions	Ownership	Notification and Information	Environment		
Quality of customer contact	Damage to Distributors by Subscribers	Losing assets and customer facilities	Informing customers about their legal rights	Brightness		
Legitimacy and Accuracy	The financial role of subscribers in eliminating offsets	Compliance with common ownership rights on branching	Awareness of customers about their obligations	Branching		
Ease of access to service bays	Paying damages to customers' assets		Awareness of customers about extinguishing	Voice		
Speed			Quality of awareness and information	The fit of the facility with urban furniture		
Precision			Responding	Fitness and behavior of vehicles		
Politeness and respect			Awareness of customers about the operation of distribution operations	Pollution control	Observe the rights of other living beings	
Appropriate space at the reception						Drilling management
Proper interaction at the reception site						
Interaction in the management of events						
Handling complaints						

6. Location of Transformer within the Framework of the Rule of Capital

One of the applications of the capital governance framework is the establishment of comprehensive policies and regulations for use in distribution economic companies to achieve government objectives. For this purpose, in this section, we consider the status of transformer as the most important element of the distribution network within the framework of capital governance. Transformer's role in providing the best service level is as follows:

1. **Safety:** Observing the power supply in the installation of the transformer and choosing the right place for the installation of the transformer for the safety of the subscribers.
2. **Quality:** The role of the transformer in the quality of electricity is apparent when the length of the low-voltage network is prolonged because of the improper location of the transformer and, as a result, subscribers at the end of the line suffer from a weak voltage. So there are two basic solutions to ensure the quality of the voltage:
 - ❖ Transformer capacity management to reduce the capacity of transformers.
 - ❖ Optimal transformation of transformers.
3. **Continuity:** The main role of the transformer in this section is its availability, or in other words, the damage to the transformer has been interrupted, and in addition to other costs such as unpowered energy, transformer repair, and shutdown costs are imposed on the firm.

Also, in order to achieve the best returns, five major indicators are required in accordance with Figure 4 and Table 3. The role of the transformer in the above indicators can be described as follows: (It is apparent that the transformer does not affect the type and pattern of load and consumption and consequently does not affect the PF, LF indices.)

4. **Loss:** The role of transformer in losses can be divided into two main parts of the internal losses of the transformer and the losses of the low voltage networks split from that transformer. The internal losses of the transformer are a function of its load. However, in general, the losses of the load condition of the transformers

are constant. In order to manage the losses of high-pressure networks, the same quality improvement solutions are considered.

5. **ENS:** This section is like section (c) or continuity and depends on the availability of the transformer.
6. **OF:** This indicator is the coefficient of operation of transformers, which depends on the loading rate on them. Therefore, the main factor for improvement of this indicator is the planning of distribution system development and optimal location of transformers.

In order to explain the role of the transformer in restoring the rights of subscribers, it can mainly be referred to its role in the environment. This role can include the following activities:

- * Prevent the transformers from lubricating oil in the passageways.
- * Prevent the sound of the transformers and their ventilation.
- * Perfecting Air Transformers.
- * Location of transformers with respect to urban furniture.

With regard to the above mentioned cases, one can categorize the mentioned cases into two categories: Transformer functional constraints (such as subscriber rights reinstatement, safety) and effective factors in optimizing the role of the transformer in distribution networks. The effective indicators for optimizing the role of the transformer can be summarized as follows:

1. OF or operating coefficient (to improve the efficiency of the transformer)
2. Medium capacity of transformers (to improve the quality of voltage)
3. Transformer losses (to reduce losses)
4. Tn or Transformer Loss Rate (to reduce unprotected energy and to ensure the continuity of electricity services)

But items 1, 2 and 3 all depend on the planning of the distribution system development, and with regard to the standard of losses and capacitors of the transformers, their loading rates and the determination of capacity and location for optimal loading is of particular importance. So, let's discuss the ways to upgrade OF and Tn.

7. Optimization of Distribution Processes to Enhance the OF and Tn indices

In order to improve the OF and Tn indices in order to optimize the role of the transformer in distribution networks, according to the capital governance framework, the process of entering and leaving the transformer in distribution networks is shown in Figure 5¹⁶.

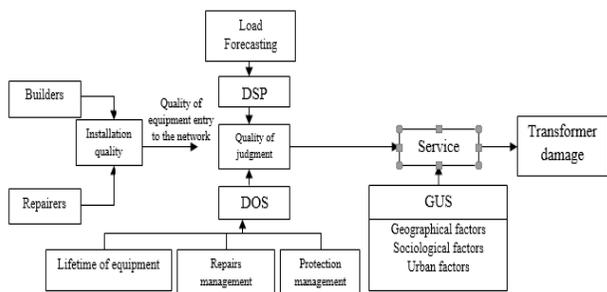


Figure 5. The process of entering and leaving the transformer in the distribution network.

We demonstrate external factors affecting the services that are out of distribution management with GUS. The GUS indicates some environmental conditions of distribution and should be included in the tariff of that area.

As shown in the Figure, the quality of the transformer into the network depends on the quality of the construction or repair and the quality of the installation of the transformer. To provide the service, each distribution management is required to implement DSP and DOS. The main DSP and DOS policies are defined by AMP. DSP predicts the load, location, capacity and load of the transformers in terms of load growth. Although DOS takes its main constraint from DSP, it also specifies DSP's feedback and policy. DOS tools are repair, maintenance of worn networks and protection of distribution networks. This repair to the transformer means a visit to its periodic service and current protection, voltage, oil temperature, etc. It is noted that the rate of transformer losses is considered as the output of the distribution processes. In the optimal mode, the inputs are configured so that the output (Tn) is zero. According to the presented form, the factors affecting the waste can be categorized as Figure 6¹⁶. In the following studies, the Tehran Distribution Company in Iran is a numerical study. To carry out numerical studies and to demonstrate how the transformers' role plays, Tehran Distribution Company, which manages distribu-

tion networks of the Iranian capital, has been selected. The firm's firmware data are listed in Table 5¹ by the end of 2008.

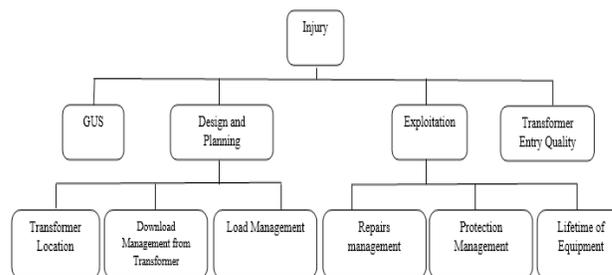


Figure 6. Tree of causation of lesions.

Table 5. Tehran Distribution Company's fixed Information in 2009

Description	Fixed information
Subscriber Number	4318347
Number of Transformers Distribution	32920
Nominal capacity (MVA)	12096.635
Area (m ²)	29741
Load	4561.6

The Tn and OF indices for the three consecutive years in this company are in the Figure 7¹⁰. The average lifetime and the average load and load capacity of the damaged transformers during the three consecutive years in this company are in the Figure 5¹⁶.

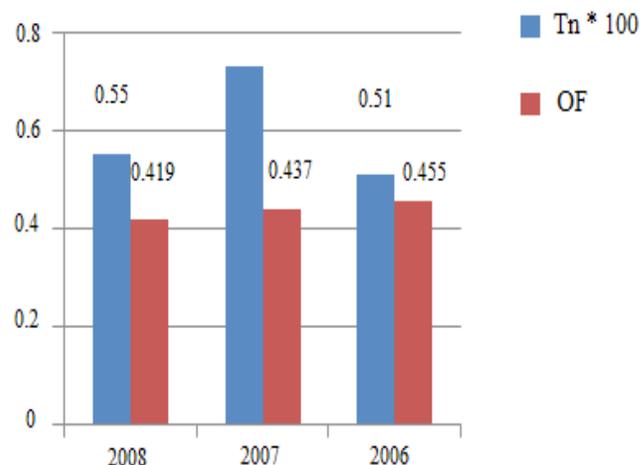


Figure 7. Operating coefficient and transformer damage rate.

It is noticeable that Tn is very high and OF is very low. This means that, despite the fact that the loading is too low. However, the transformer's losses impose a lot of

damage on the company. However, the cost of the transaction is not only the cost of transmissions, but also the cost of eliminating silence and unprocessed energy resulting from it is also added. Very Low OF is a sign of the weakness of capacity development planning. Therefore, it has a high investment and is not economical. The collection of this information and the low values of the average life of our damaged transmissions lead to disruptions in the DOS (Figure 8). To do this, in order to prove the basic problems in exploiting the distribution of the quantity amount of each cause of the lesions, it can be drawn in Figure 9¹. In this form, the protection of repairs is shown separately.

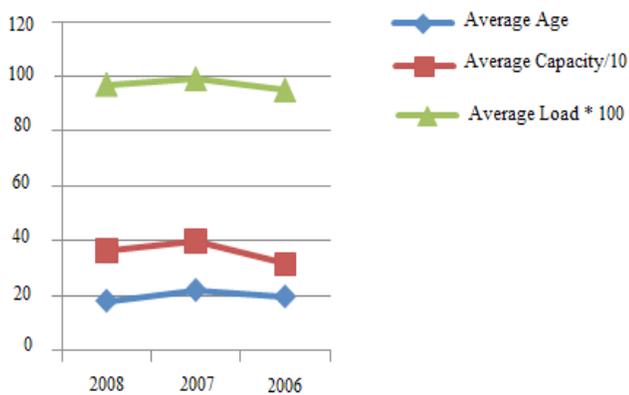


Figure 8. Indexes of damaged transformers.

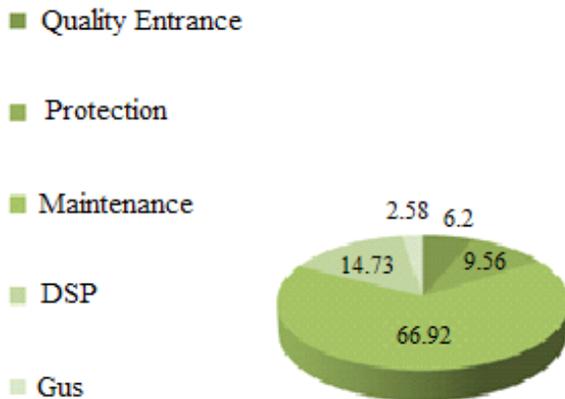


Figure 9. Damaged transformers reasoning in Tehran Distribution Company.

It is noticeable that most of the fault is caused by repairs and DOS, and after that, the forms of DSP and the quality of equipment entry and Gus account for a small percentage. This issue in terms of governance means that it should upgrade DOS infrastructure in the company by legislating and, from the company’s point of view, it means that it has to deal with solutions to such problems as planning, outsourcing, restructuring, and so on.

8. Conclusion

The distribution of electricity in the electricity industry requires planning and decision making in both the government and corporate sectors. In the governing section, economic and control laws are discussed, and in the corporate sector, the way of doing business is considered. The common language of governance is the language of capital, the main framework of which is based on the goals of the electricity distribution industry. So, with the governance and management of the capital of the electricity distribution industry, it succeeds in reaching the goals. Distribution goals are categorized into three categories of service enhancement, improved returns, and enhanced interaction with customer rights. In the meantime, the services are divided into three categories of safety, quality and continuity of electricity with a customer-centric look, and the returns to the productivity of the use of resources such as the state economy and natural and human resources. All of its’ distribution activities and control laws, including tariffs, electricity market laws, and electricity distribution services legislation will be based on the framework.

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