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Power Distribution System Regulation (A Review)

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Abstract: This article presents a framework and a comprehensive model to optimize the regulation of the electricity distribution system. The regulatory requirements of the electricity distribution system and research gaps in this field are among the important outputs of this review article. In each of the presented parts of the framework, it has reviewed, introduced and listed the regulatory studies of the electricity distribution system. In order to calculate the PDSR (regulation of power distribution system) framework, governance first presents, its goals, and its development plan in the distribution sector, and discusses the regulatory position in it. After that, in the electricity distribution system, it describes the role of the regulator in the goals and plans of the electricity distribution system, and introduces the types of regulation of the electricity distribution system, and finally, discusses about the place of data in the regulation and its requirements, and the effects of regulation in the evolution and stability of the electricity distribution system.

Key words: Electricity distribution system, regulation governance, review of studies.

1. Introduction

Electricity distribution systems are the last link in the electricity supply chain and are in direct contact with customers. These systems have an inherent monopoly and are part of public service companies such as water and gas distribution companies as well as municipalities. The electricity distribution system has two departments of asset management and electricity trading and performs two categories of service and economic activities. These systems have high complexity due to the connection with the social body as well as urban institutions and infrastructures and high impact of atmospheric factors, social factors and urban policies. The number of assets of this system is very large and scattered, and for this reason, its human resources are very large due to the high variety of activities, and practically the management of the electricity distribution system faces serious complications. Electricity distribution system management, rules and structure, expectations and goals and plans, accountability and developments, etc., all of them have undergone various transformations and challenges over time, and with numerous revisions by governments and countries, it has always been tried to give electricity distribution companies enough motivation to optimize their actions in order to gain more benefits. Despite this, due to the specific complexities of electricity distribution companies as stated above, the final management and regulatory model for electricity distribution companies is not clear. This complexity increases when we see that electricity distribution companies have a variable nature and dynamic behavior with changing conditions of economic policies and social behaviors and governance. Therefore, in this article, a comprehensive framework has been presented and reviewed in order to optimize the regulation of electricity distribution systems. After presenting each part of the final framework, the effort of this article is to state and mention the list of studies done in it, so that it can identify the research gaps in PDSR (regulation of power distribution systems) and summarize them to determine the road map of PDSR. For this purpose, in this article, by examining the steps of communication between governance and distribution activities, the distribution regulatory framework has been determined. The objectives of governance and its programs in the electricity distribution

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system have been explained and the place of electricity regulation in those programs has been determined. The regulatory views on the electricity distribution system have been investigated both in terms of the objectives of the electricity distribution system and in terms of the activities of this system. The regulatory implementation methods of indicators and programs have been packaged and explained. The role of data and information and their requirements for optimal electricity regulation have been presented. The regulatory role in the economy of the electricity distribution system and the cycle of its economic developments have been explained. Examples of implemented regulatory and distribution system developments in different countries are listed. In the end, the regulatory requirements are explained as a conclusion, and by examining the number of researches on key regulatory issues and in different years, the process of PDSR studies has been examined.

2. Regulation and Governance

The government is the main custodian of every electricity and energy industry, and like other sectors and industries, it seeks to create stability in order to maintain and survive. The sustainability of governance is one of the following three ways:

- Creating justice between the rights of the beneficiaries
- Efficiency improvement
- Maintaining and improving security

and in order to achieve these 3, the most important governance tools are economic indicators and the creation of management structures. The implementation method of optimal governance can be summarized in the following form in PDCA (Plan-Do-Check-Action) implementation in Fig. 1.

It can be seen that in all stages, the two key words of management structures and economic structures have a decisive role.

In this way, after determining the priorities and plans, the government can take action to create the market and business to achieve the goals, so that it can align the plans with the personal interests of human resources and ensure their realization.

In order to make the market and newly defined businesses current, the government should take measures to create new developments and regulations.

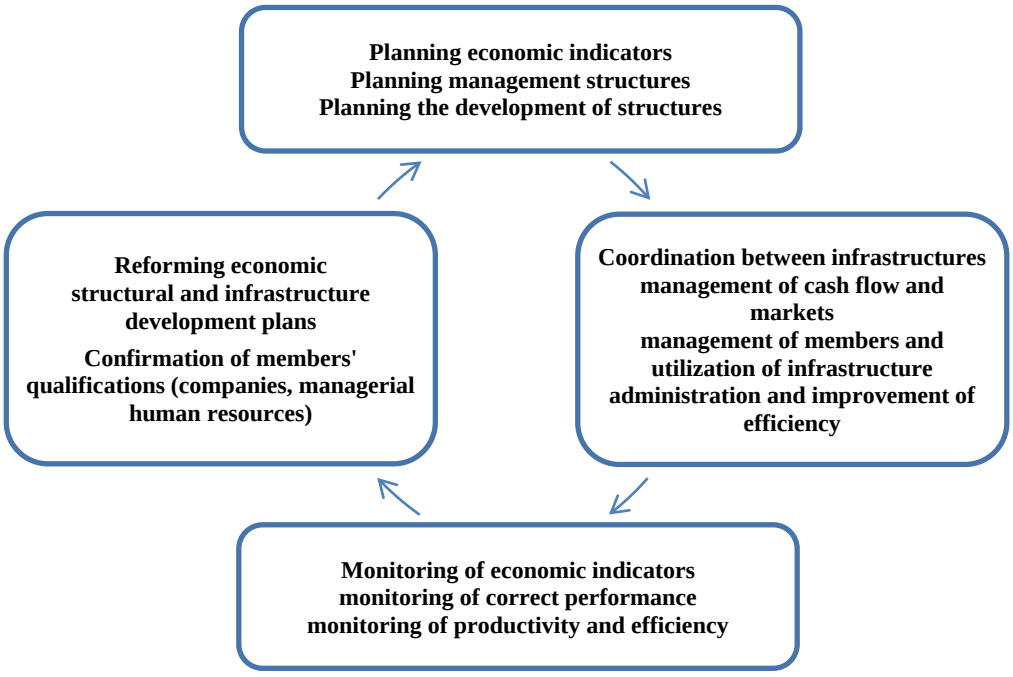

Fig. 1 PDCA implementation.

To break the previous structure and rules to update the target requirements, all these four stages prove the existential philosophy of regulation to replace the previous structure and to be in charge of regulation to achieve the government's goals. Thus, the most important work of the regulatory body is to regulate the economic indicators of markets and business in line with the goals of governance. Electricity distribution companies, as the main members in the electricity industry, also have a business space and operate as a member requesting electricity in the electricity market. Electricity distribution companies have two categories of electricity business activity and asset management, in both cases, the regulator can regulate market indicators, monitor them as well as their performance, set fines and prices, etc. in relation to the management of distribution companies to guarantee the goals of governance in electricity distribution companies. The goals of governance in electricity distribution companies can be to reduce losses in order to improve energy efficiency and increase the utilization factor in order to reduce investment in order to reduce the price of electricity, increase electricity services including reliability and availability, increase safety, and improve the load factor in order to reduce the need for investment in the field of production and network, etc. In this regard, the regulator referred to reference [1] and categorized the goals of governance.

As mentioned earlier, the regulator ensures the achievement of each system's governance goals by setting economic indicators, prices and fines, as well as monitoring and renewing the eligibility of members. Activities regulation circle can be summarized in two categories: asset management and market regulation. Regulation and economic indicators of asset management can only be defined in monopoly companies that have inherent monopoly, such as public service companies and energy companies.

In this way, the lack of regulation makes the system of fines and incentives as well as determining the final price, even though it exists, but it does not have dynamics. On the one hand, this issue can cause inflation or lack of commitment in the owners and managers of electricity distribution companies. In this way, the goals of governance are generally questioned.

Another action of the regulator is to connect technical and economic indicators in order to determine the price and fine and balance risk and profit for electricity distribution companies. Balancing risk and profit in planning distribution activities and guaranteeing profit margin as well as guaranteeing the economic stability of electricity distribution systems is vital and necessary.

The absence of an efficient, up to date and dynamic regulation causes the profit margin to disappear and, in the balance of risk and profit, actually creates losses for the consumer or the owners and managers of electricity production companies. This practically creates instability in the economic situation of electricity distribution companies. In particular, in electricity distribution companies, the lack of accurate, up-to-date and dynamic regulation makes many activities related to the network, assets or the electricity distribution system not be carried out, and development, network optimization and operation activities disrupted, the result of which can be a drop in service and its indicators such as reliability, power quality, safety, security and environment, and it can be a drop in efficiency and its indicators such as losses, load factor, utilization factor, supplied energy, property waste and productivity of human resources. Of course, in this case, the business and the balance in the interests of the beneficiaries will also be disrupted, which will actually cause dissatisfaction in many beneficiaries. According to the contents stated so far in the field of regulatory relationship with the economic tools of governance, it can be written in the form of following Table 1.

Table 1 Studies conducted in the field of regulatory economic instruments of governance.

Reform	[2]
Market	[3] [4] [5] [6]
Business	[7]
Regulation	[8]

The criterion for identifying the type of transformation in the electricity distribution industry is governance, to thereby determine the market framework and regulate the business environment in such a way that it can achieve the goals of governance as stated above. In this way, the government determines the type of regulation and its framework according to the evolution, the market and the decided business. Of course, the type of transformation is determined according to the capacities of the system and the potential of achieving goals by the transformation. The most important development today in electricity distribution systems is the launch of the retail market.

As it can be seen, most studies have been presented in the field of Market, and no study has been conducted in the field of Deregulation, which can be used as a road map in future studies.

3. Developments of Power Distribution and Regulation Power Distribution System Reform

Developments in the electricity industry have been made for a long time in such a way that they can increase the efficiency and productivity of the electricity industry.

The first transformation in the electricity industry is the vertical separation of the pillars of this industry. Therefore, in the first transformation, power plants were separated from regional electricity and distribution in an administrative, structural, legal and technical manner. The second economic transformation was defined between the pillars of the electricity market industry so that this market becomes the language of interactions and exchanges between the members of the electricity industry.

In the third transformation, the regulator was created as a representative of the government to be able to work with a balance of risk and profit for each of the pillars and members of the electricity industry in creating motivation for improvement in the pillars of the electricity industry. After that, in the fourth transformation, distribution operator and dispatching was launched in order to coordinate the distribution system with the other two pillars. In the fifth economic transformation, each of the pillars of the electricity industry, including electricity distribution companies, was commercialized so that they could operate efficiently and effectively with the prices and exchanges determined. Then, an attempt was made to make horizontal separation happen, and in the sixth transformation, the retailer was separated from the asset manager, and in some way, the electricity business was separated from the asset management administratively, legally, structurally and technically. After the sixth evolution, the role of dispatching and control centers in establishing coordination between the asset management and electricity trading departments is a key and decisive role.

In the seventh transformation, operators of measuring equipment operate in order to operate measuring equipment and resolve ambiguities and disputes between the asset manager and the retailer. In the 8th evolution of the electricity distribution system, they became intelligent and self-healing with a two-way relationship between the electricity distribution system and the subscribers so that they can operate in the most optimal possible state, and in the 9th evolution, we are leading in the search for islanding and localization of asset management. As you have seen, from the third development, regulation in the electricity industry was created. In the third transformation, the regulator played a role in coordinating production and transmission and distribution. In the fourth evolution, the regulator specifies the procedures and functions of dispatching and control centers in the electricity distribution system and their measurement criteria. In the fifth evolution, the role of the regulator is a key role, and by creating a balance between risk and profit, it acts to create the necessary legal requirements for commercialization with the help of setting prices and fines.

In the sixth and seventh transformations, the regulator also adds the retailer and MO (Meter Operator) to the set of members under adjustable rules. In the 8th and 9th developments, the regulator defines the requirements

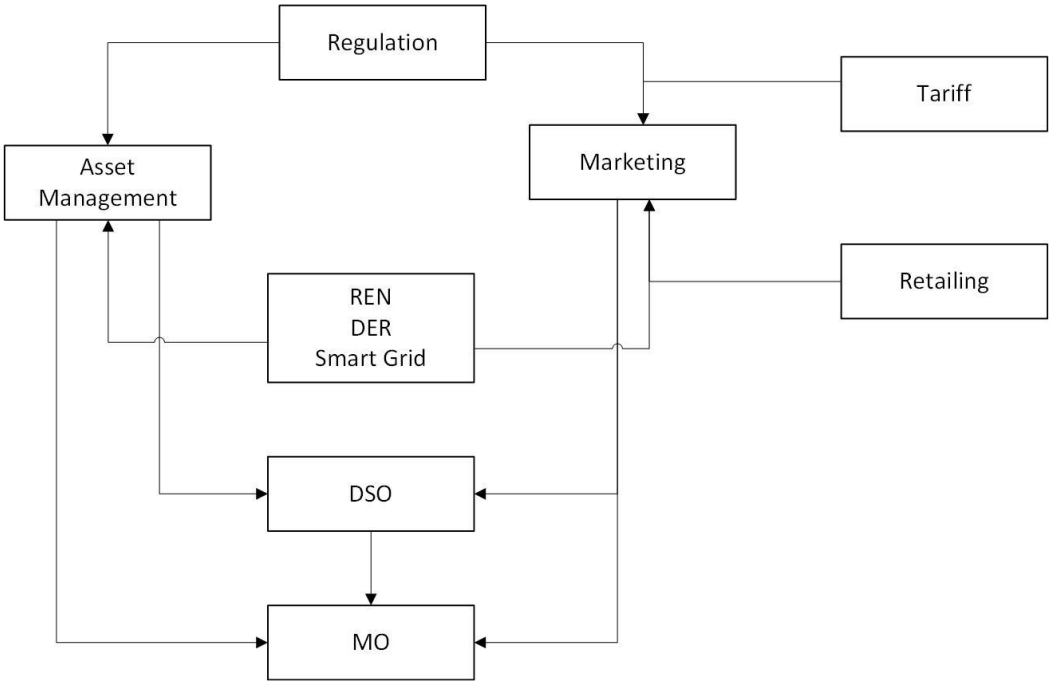

Fig. 1 Members of the modern electricity industry.

Table 2 Studies conducted in the field of regulation of each player in the electricity industry.

Distributed generation	[9] [10] [11] [12] [13] [14] [15] [16] [17] [18]
Player	[3]
Retailer regulation	[5] [6]
Renewable energy	[19] [20] [21]
Distribution system operator	[18] [22]

and predicts the repayment of facilities in order to streamline the management of the local assets of the islands. As you can see, there are many members in the reforms and changes of the electricity industry, which can be shown in Fig. 2.

Several studies have been presented for the regulation of each of the aforementioned members, which can be summarized in Table 2.

Regulation is not only applied to electricity distribution companies, but all members must be under a single and coordinated regulation to ensure the realization of governance goals. In addition to electricity distribution companies, regulation is applied to members such as scattered productions, retailers, contractors and manufacturers. Of course, members such as MO and DSO are non-private members with a specific service description whose reports are used as a criterion for judgment and regulation of the electricity distribution system and other members. Although the description of MO and DSO services is determined by the regulator, yet they have inherent monopoly and their performance is almost fixed cost. As it can be seen, the most studies are presented in the field of DG and the least studies are in the field of Player, which can be used as a roadmap in future studies.

4. Objectives and Activities under Regulation

Electricity distribution companies have two main activities. The first category is activities that have significant economic productivity, such as DR. This group of activities in electricity trading procedures will cause more profit to create the economic stability of the electricity distribution system. The second category is activities that do not have economic efficiency and are among service activities, such as repairs, troubleshooting, voltage correction, etc. This category of activities in electricity market relations does not benefit the electricity distribution company and has a small contribution to

financial, market and economic efficiency. The regulator sets and plans economic goals by adjusting and changing market indicators. By changing the price or creating a competitive environment, the regulator adjusts the business environment to improve the economic indicators.

Economic indicators in the electricity distribution system include: losses, utilization factor, power factor, load factor, unsupplied energy, waste and productivity of human resources, which all of them are adjusted and regulatable by market indicators and distribution share from the price of each kW ћ of energy sales.

In service indicators that have a small contribution to improving the financial and economic situation of the electricity market and with electricity distribution companies, the regulator adjusts fines with risk considerations.

If these activities are not carried out, the electricity distribution companies will be fined. But if the amount of the fine is high, the share of distribution per kW ћ should be increased in order to improve the indicators to a greater extent.

Otherwise, it creates unfair risks and losses for the electricity distribution system. Service indicators in the electricity distribution system include: reliability, quality of power and voltage, safety, resilience of environmental indicators, which should be regulated by setting fines and balancing risk and profit. Service indicators in the electricity distribution system include: reliability, quality of power and voltage, safety, resilience of environmental indicators, which all of them should be regulated by Calculation of fines and balancing risk and profit. In several studies, the regulation of setting the indicators of the electricity distribution system has been considered, which can be seen in Table 3.

As stated earlier, governance has two main goals: improving the economic situation and providing services. So far, there are many technical economic indicators and technical service indicators that should be regulated in order to achieve the goals of governance.

Table 3 Studies conducted in the field of regulation of electricity distribution system indicators.

Environmental	[23]
Energy efficiency	[24]
Reliability	[25] [26] [27] [28]
Social	[29]
Investment	[30] [31]
Service	[32]

Regulation of these indicators is possible through the regulation of electricity prices or fines. Among the technical and economic indicators are loss indicators, demand side management and investment, which are regulated in different ways, including the regulation of electricity prices. Also, technical service indicators include reliability, power quality and environment indicators, which are regulated in different ways, including fines calculation. As you can see, many indicators of the electricity distribution system have not been included in the regulatory studies and should be included in the future plans of the regulatory studies of the electricity distribution system so that we can achieve a comprehensive and effective regulation. As it can be seen, the most studies are presented in the field of Reliability and the least studies are in the field of Social and Environmental, which can be used as a roadmap in future studies.

The result of the regulation of the indicators of the electricity distribution system should be such that the electricity distribution company sees its economic efficiency in planning and carrying out activities to improve the indicators.

In Refs. [33] and [34], an attempt has been made to optimize the combination of index and program in order to determine the fines and incentive criteria for the regulator.

In some studies, we only improved the distribution activities with the help of the regulator, which you can see in Table 4.

Table 4 Studies conducted in the field of improving distribution activities with regulatory help.

Planning	[35] [36]
Maintenance	[37] [38]

Various activities should be done in order to improve the indicators of the electricity distribution system, which is discussed in detail in Ref. [39]. As you can see in the above table (Table 4), many activities and programs of the electricity distribution system have not been regulatory studies, which can be included in the future programs of electricity distribution regulatory studies.

5. Methods Used by the Regulator to Set Indicators

The biggest challenges in the regulation of the electricity distribution system can be summarized as follows:

(1) In order to create incentives, the regulator needs to study the indicators and programs to determine the cost of modifying each index unit in order to determine the price and fine criteria based on that.

(2) The regulator should study the framework of the community of indicators in order to be able to calculate the total cost of the electricity distribution system and not to create risks by creating heterogeneous fines in certain areas.

(3) Regulators should study the impact of various risk factors from regional and geographical conditions, cultural conditions, etc. [40] on the activities and costs and indicators affected by them, and based on that criteria, price and fines and determine the balance of risk and profit.

The above-mentioned cases are considered research gaps in the electricity distribution system and should be included in the road map of regulatory studies of the electricity distribution system. The main focus of the studies conducted so far has been on previous data, training them and estimating the amount of flow and appropriate encouragement. The difference between the studies conducted in the field of electricity distribution system regulation can be seen in mathematical methods and regulatory methods. The regulatory methods can be summarized as follows:

CBR (cost based regulation): In this method, the goal is to manage the costs of the electricity distribution system, which spends financial resources in line with the plans made.

PBR (performance based regulation): In this method, the goal is to motivate the electricity distribution company in such a way that it is encouraged and sometimes penalized by improving the indicators.

The PBR method itself can be divided into the following three categories in studies:

Price cap regulation: In this method of regulation, the main idea is to limit prices and the price cap is set for customers. The price ceiling is calculated according to its average costs and risks. In this case, the distribution company will have the right to change the tariff up to a certain ceiling, which is determined annually.

RPS (reward penalty scheme): In this method, based on the model, non-performance leads to penalty and performance leads to encouragement. The operating point of each year is estimated from previous years' studies, and the RPS model is the same for similar companies, to eliminate external factors around the operating point of each year, the dead zone is considered.

Yardstick Regulation: In this method, the performance of each company is compared with other companies or a group of them so that this comparison creates competition in reducing costs. The most important risk in this method, which is based on desirable criteria such as technical or improvement indicators, is external factors that create risk.

In most of the articles, it has been tried to determine the penalty and incentives by classifying the distribution companies in such a way that they can create a logical risk for the incentive and for not doing it. The studies conducted in each of the above methods can be summarized in Table 5.

As it can be seen, the most studies are presented in the field of Yardstick Regulation and the least studies are in the field of RPS, which can be used as a road map in future studies.

The articles of recent years have focused more on PBR in order to rationalize the risk of not doing index

Table 5 Studies conducted in the field of regulatory methods.

Articles		References
CBR		[41] [42]
PBR	Price cap regulation	[35] [43] [44] [45] [46] [47] [48] [49] [50]
	Yardstick regulation	[51] [44] [45] [46] [52] [48] [49] [50] [53] [54] [55]
	RPS	[34] [56]

improvement activities in such a way that risk and profit, be balanced. Although the presence of these methods can be effective in regulation, but without answering the first three questions posed in this section, regulatory action with any method is ineffective. implementation comprehensive regulation means the simultaneous regulation of all indicators at the same time in such a way that the impact of programs and external factors is seen in it and the total cost of improving each person calculated. Such conditions do not exist in any of the methods and studies.

6. The Role of Data in the Regulation of the Electricity Distribution System

The data framework required for the regulation of the electricity distribution system depends on the type of regulation and the method used. These data can be the technical and economic indicators of the electricity distribution system, or it can be the volume of activity or the quality of their performance. More than the required data framework, for the regulator, the accuracy of the information is important. Because the regulator is not the owner of the electricity distribution company and cannot have direct and reliable access to its data. This point raises the error of many data so high that it will not be practically usable. Of course, studies have been conducted in the field of using data for the regulation of the electricity distribution system, and in most of them, unfortunately, the condition of not owning the regulator has not been taken into account.

For this reason, they have a low performance guarantee. This category of studies has been mainly focused on smart networks and data uncertainty and can be summarized in Table 6:

Table 6 Studies conducted in the field of smart grid and data uncertainty.

Smart grid	[9]
Uncertainty	[53]
Data regulation	[57] [58]
Forecasting	[59] [60]
Estimation	[61]

The regulator has the following duties against the data of the electricity distribution system:

- Design of data monitoring systems
- Data integrity monitoring
- Determining the data flow framework between members
- Determining data sharing requirements
- Determining the reporting data to the regulator and their format

In order to perform its duties, the regulator needs data analysis, including forecasting, estimation and analysis of data components.

As can be seen, the most studies are presented in the field of Data regulation and Forecasting, and the least studies are in the field of Smart Grid, Uncertainty, and Estimation, which can be used as a roadmap in future studies.

It should be noted that the way data are handled is different between the regulator and the electricity distribution company. In distribution companies where there is legal ownership of data, the issues relate to data estimation, data uncertainty, data forecasting, data mining, etc.

But for the regulator, the lack of legal ownership of data is the main issue of data authenticity. Because the data are the criterion of competition and the criterion of penalty and encouragement and profit. The most reliable data in the regulatory sector can be divided into the following two categories:

(1) allegation and complaints of subscribers about their rights after proof

(2) Financial statements approved by tax audit

In this way, the methods of the regulator are severely limited. Maybe the smart network allows the online availability of a lot of information, but due to the lack

of legal ownership and the fact that they are in the hands of the beneficiaries, the regulator will face many errors based on them, because the design of the smart system and the preparation of its software and..., all are at the disposal of the electricity distribution company.

According to the available data for the regulator in order to adjust the indicators, it is possible to adjust the service indicators from the complaints and claims section of the subscribers, and with the help of the financial statements, the network sizes and assets and their value, and as a result, adjust the indicators acted economically. Of course, with the help of determining the relationship between costs and indicators, it is possible to reach the communication tree of activities and technical indicators and calculate the annual cost of improving each index unit and set the regulatory criteria in the coming years.

7. Economic Management of Electricity Distribution System with the Help of Its Regulator

In this section, we examine the economics of the electricity distribution system in two categories.

- Investment and cost
- Structural changes (reform)

In the investment and regulatory cost sector, it seeks to optimize costs and investments. On the other hand, the owner should be encouraged to invest more in the distribution sector. From another point of view, the costs should be done in such a way that the least losses and wastes are obtained.

In this way, with the continuity and continuation of the regulation, it is possible not only to achieve economic stability in the electricity distribution system, but also to improve the economic situation of the electricity distribution system in such a way that we can see a reduction in the tariff. A sample of the studies conducted in this section can be summarized in Table 7.

As mentioned before, the regulatory duty is the balance of risk and profit to ensure the motivation of members to move in line with the promotion and realization of goals. This issue requires economic evaluations, examination of costs and the amount of capital invested in the system by the member of the system and the owner of the electricity distribution system. In this case, the regulator can decide on setting price indices and fines by evaluating the risk and measuring the profit.

As it can be seen, the most studies are presented in the field of Investment and the least studies are in the field of Cost efficiency, which can be used as a roadmap in future studies. Of course, various and numerous studies have been conducted on each of the cases mentioned in the above table, but it is not related to the regulation of electricity distribution systems.

Certainly, the best way to create economic stability by the regulator is to calculate the cost price by improving each index and affecting its changes on the price and fines.

In the section of structural changes, it was explained in detail in sections 1 and 2 of these articles. It should be noted that any structural change requires the following steps which are shown in Fig. 3.

Although in the electricity distribution industry, different investigations are done for each development, but this circle in the studies still needs a more detailed investigation.

This has made studies unable to find the disadvantages of previous developments well. The conducted studies require a detailed evaluation of the efficiency of the developments. The list of these studies can be seen in Table 8.

As it can be seen, the most studies are presented in the field of Reform Market and the least studies are in the field of Reform planning and Reform consequences,

Table 7 Studies conducted in the field of investment and cost regulation.

Investment	[10] [11] [62]
Cost efficiency	[63] [64]
Economic assessment	[62] [65]

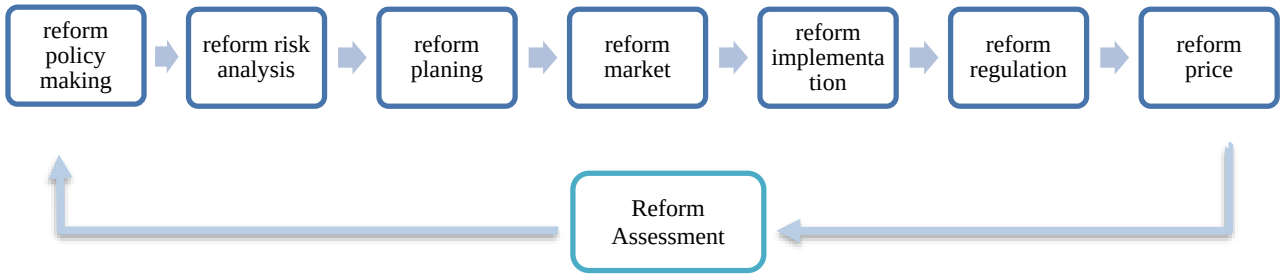

Fig. 2 Reform implementation process.

Table 8 Studies conducted in the field of structural transformation of the electricity distribution system.

Reform policy	[66]
Reform risk	[67] [68]
Reform planning	[69] [70]
Reform market	[71] [72] [73] [74]
Reform implementation	[75]
Reform regulation (& price)	[8]
Reform consequences	[76]

which can be used as a road map in future studies. Of course, various and numerous studies have been conducted on each of the cases mentioned in the above table (Table 8), but it is not related to the regulation of electricity distribution systems. It should be noted that the consequences of each change should be analyzed in the long term, because the changes in the long term show their lasting effects, especially in the prices. Although they have had positive effects in the short term, the system and actors have learned to adapt to the changes and show lasting behavior, which is the main indicator of the effects of the changes. The authors of this article have not seen a study that has compared the lasting effects of the changes.

8. Experiences Implemented in Electricity Distribution Regulation

In order to optimize the improvement of the electricity distribution system, every country has always faced many developments in the electricity industry, of course, all the developments are in line with the contents expressed in the form of this article. The studies documenting the implemented experiences of developments can be summarized in the following two sections.

- RIB (implementation of reform);
- The results of the implementation of Reform (ARB).

The studies conducted in this section can be summarized in the Table 9.

As can be seen, the most studies have been presented in China and the most studies on regulatory results are in the field of efficiency. Summarizing the results of implementation and experiences can be effective in achieving the optimal path of developments and evaluating the anticipated developments. As seen in the previous sections, in each of the stages of development, regulation is done in a way that can create sufficient motivation in electricity distribution companies in order to optimize their performance in accordance with the developments. The examples of experiences recorded in the regulation of different countries can be summarized as Table 10.

As you can see, most of the studies are done in America. The authors of this article strongly recommend that the implemented experiences should be comprehensively studied in order to develop a better standard for regulation. And it should also be seriously noted that regulation is dependent on the type of governance, economy and culture of the society, and with the change of each of these, the type of regulation faces changes in every development. This point means that each country should have its own local regulation. Copying from one country and implementing it in another country has a high probability of failure and can be accompanied by many inefficiencies.

Table 9 Studies conducted in the field of implementation of electricity distribution regulation.

	South Korea	Bangladesh	Pakistan	China	Iran	Croatia	Canada	Swiss	Egypt	Austria	India	England
RIB	[89]	[88]	[87]	[83] [84] [85] [86]	[33]	[82]	[81]	[80]	[79]	[73]	[78]	[77]
ARB	On OEM		On efficiency		On DG & load Management		On investment				On DSM	
	[95]		[93] [94]		[92]		[91]				[90]	

Table 10 Studies conducted in the field of experiences recorded in the regulation of different countries.

	Countries					
	USA	Argentina	India	China	Iran	Sweden
Benchmarking	[101] [102] [103] [43]	[100]	[99]	[98]	[97]	[96]

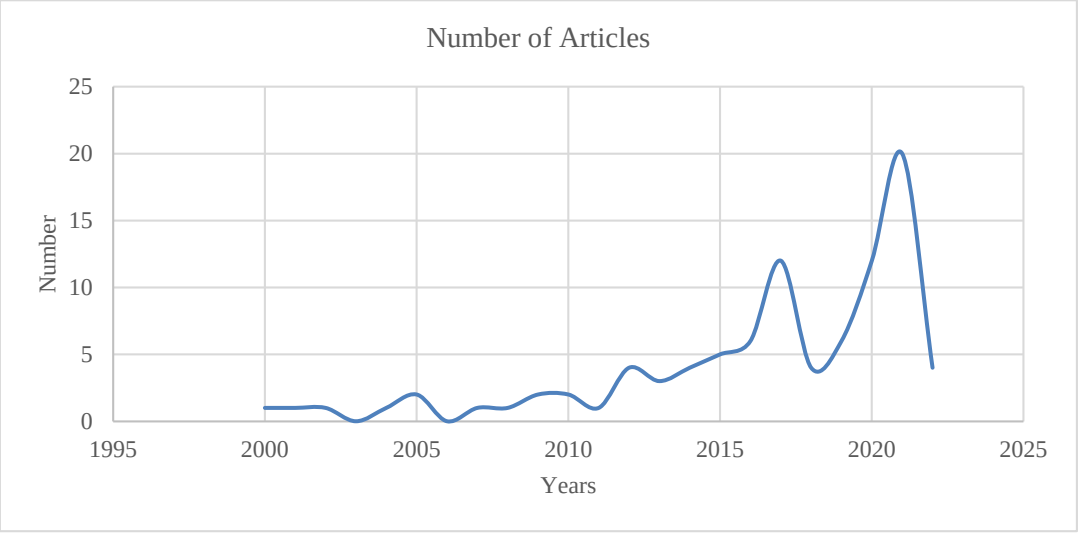

Fig. 4 Number of articles since 2000.

9. Discussion

In this article, the studies conducted in the field of PDSR have been reviewed. In order to examine the research gaps and develop a roadmap for studies related to the regulation of electricity distribution systems, a comprehensive framework of how to deal with this important issue was presented. The studies accomplished in the field of electricity distribution system regulation in each year can be drawn in the form of Fig. 4.

It can be seen that despite the fact that many questions remain in the field of electricity distribution regulation, studies in this field have declined. In terms of the distribution of the subject, by reviewing the articles and studies, we arrive at Table 11.

Table 11 Studies in various fields of electricity regulation.

Governance & regulation	9
Asset management process regulation	8
Distribution system targets regulation	9
Regulation method	40
Regulation data	15
Reform & regulation	11
Distribution system economic regulation	16

10. Conclusions

In the end, the following points are summarized from the studies conducted in the field of PDSR:

- The emphasis of the authors of the article is on the regulatory localization of the electricity distribution system in each country and geographical region.
- The best regulation happens when the cost of

improving each index in each region is calculated each year.

- The regulation of the electricity distribution system should be comprehensive and cover all target indicators and programs.
- The most appropriate method to motivate is to use the RPS and PBR method for the regulator, which must be applied to all indicators simultaneously, which have not yet been modeled simultaneously.
- Due to the lack of legal ownership of distribution data by the regulator, the only reliable sources of data are subscribers' complaints about the quality of electricity distribution services and audited financial statements.

From the research gaps presented in this article, we can draw a roadmap for PDSR studies, and in the future written programs of contract studies, we can witness more optimal developments and more suitable regulation with the goals of governance.

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