

Optimal Zoning for Distribution Sector Under Deregulated Environment: A Case Study for the State of Madhya Pradesh, India

Tripta Thakur, S.G. Deshmukh, S.C. Kaushik and S.C. Tripathi

Abstract-- The selection of the number and the location of the Distribution Companies is one of the most sensitive decisions to be made during the reforms programme as the decision is crucial for planners and experts. This paper evolves the criteria of zoning for deciding the sizes of distribution companies that would result in optimum performance in the distribution sector. The paper presents an overview of the ongoing Distribution sector reforms in India and subsequently evolves a methodology illustrated with a case study on the state of Madhya Pradesh. The work involved identification of 5 parameters viz. the consumer numbers, Energy sales, cultural affinity, area distribution and consumer categories. These parameters were used in conjunction with weightings that were obtained by employing a Delphi study to decide the optimal sizing of distribution companies. The evolved methodology is flexible and can be extended to include more parameters for application in other scenarios.

Index Terms: Delphi study, Distribution Companies, methodology, parameters, optimum performance, sector reforms, weighting.

I. INTRODUCTION

Power sector Reforms were introduced in India since 1991. Despite this the power supply position as on March 2002, indicated a peak deficit of 12.6% and energy deficit of 7.5% [1]. The Ministry of Power (MoP), India estimates that the additional capacity requirement to meet these shortages is about 10,000 MW every year. This translates into an investment of about US\$10 billion per annum [2]. The primary reason for the widening demand-supply gap lies with the distribution link. The generation companies have not found it easy to recover their dues from their biggest buyers, mainly the State Electricity Boards (SEBs). SEBs suffer huge financial losses every year due to power theft, ineffective practices of billing/collection and policies such as unmetered charges in agriculture (flat rates charged based on pump capacities), and deteriorating O & M status. The result is mounting T&D losses that have grown with time (Fig1).

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Apparently, the losses have reached an alarming Rs. 260 thousand Million (Rupees 47=US \$1) [2] per year. This has adversely affected the confidence of the private investors and the existing generation companies. Therefore privatization of distribution sector is receiving paramount attention [3]. The selection of the number and the location of the new Distribution Company (Discom) is one of the most importance and sensitive decision to be made during the reform programme. The paper endeavors to evolve the criterion for deciding the optimal size of Discom. The procedure is illustrated for a case pertaining to the state of Madhya Pradesh wherein the restructuring process has recently started. The study evolves criterion to decide upon the Optimal Discom Sizes and spells out the implications on the total Discom Numbers that are likely to result in effective distribution of power in the state.

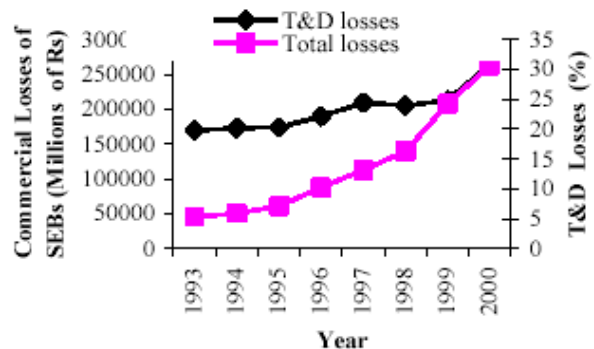


Fig.1. Performance of SEBs

II. REFORMS IN DISTRIBUTION SECTOR

The distribution system in India is characterized by inefficiency, low productivity, frequent interruption in supply and poor voltage. In addition the biggest fundamental issue hampering the viability of the Indian Power Sector is the sheer volume of T&D losses that amount to 25%, a very high level by any standard. To make the matter worse, indirect calculations show T&D losses to be much higher in the range of 40-50% [2]. Commercial losses are approximately 2/3rd of the total loss in distribution. These losses are due to rampant theft and pilferage of electricity, meter tampering, unauthorized connections and unmetered supply. Almost all commercial losses take place at 11 kV and below. This situation clearly shows that some fundamental changes are imperative in the working of the power sector entities

to realize the vision of “reliable, affordable and quality power for all by 2012” [4].

III. STATUS OF DISTRIBUTION REFORMS IN INDIA

India has 28 states and the State Electricity Boards (SEBs) are responsible for distribution of power except for a few private players who mainly operate in metropolitan cities catering the need of urban consumers. The restructuring programme of SEBs started with Orissa which was the first state not only in India but also in South Asia to implement a comprehensive power sector reforms programme in 1993. The restructuring programme had the active involvement of multilateral lending agencies like the World Bank, Department for International Development, Government of UK (DFID) and the Asian Development Bank, and several leading management consultants [5]. The experience of Orissa has been important to other states in India, which are restructuring their SEBs more or less on the lines of Orissa. Delhi is another state, which has completed one successful year under privatization. A close look at the performance of reforming states of Orissa, Andhra Pradesh, Haryana and Delhi reveals that financial performance of unbundled utilities has improved to certain extent. These states have taken up the installation of meters in a big way with the financial assistance from World Bank and Power Finance cooperation (PFC), and with these measures, the revenue collection has improved. To increase the pace of reforms further in the distribution sector, it is required to resolve the issue of liabilities faced by the distribution companies in the transition period like size of distribution companies, valuation of assets of the reforming utilities and transfer of existing liabilities.

The six main private distribution utilities in India, namely, BSES & TEC In Bombay, CESE in Calcutta, AEC in Ahmedabad, SEC in Surat and NPCL in Greater-Noida are performing better and earning profits. They are able to generate adequate internal resources and are able to plough back resources into their organizations for further growth. All these utilities are primarily catering to the urban areas, which have a large number of industrial consumers and few agricultural and rural consumers. Electricity Act 2003 introduced in June 2003 has clear-cut direction for promoting market based structure in the power sector. All the other states are in the process of initiating reforms, which will be facilitated by the Electricity Act 2003 [6].

IV. MODELS FOR RESTRUCTURING IN DISTRIBUTION SECTOR

The regrouping of distribution system of SEBs into more smaller entities has the following advantages

- It results into distribution zones of manageable sizes
- It allows for comparison of performance across the zones, and thus generates some level of competitive environment.
- Introduction of more players could facilitate enhancing level of competition in supply of electricity in the medium to long term.

- It permits application of different models of different zones - some zones may be conducive to a higher degree of private participation than others.

Depending on the environmental constraints and timetable envisaged for the process, various options/models consistent with the objectives of the state are possible, each having varying degree of private sector participation. Broadly, these models can be divided into three categories:

Category 1. Models that do not involve private participation.

- Commercialization of existing SEB's
- Distribution by municipal undertakings/local government bodies
- Distribution cooperatives (including supply cooperatives, consumer organizations, etc.)

Category 2. Models for which private sector association is limited to providing technical and managerial inputs.

- Contracting of services
- Management contract
- Leasing

Category 3. Models for which financial, technical and managerial inputs are available from private developers/promoters.

- Expanding the area under existing licensee
- Joint Venture
- Linking IPPs and Distribution circles
- Outright Sale

The above models are alternative approaches for improving the distribution system to ensure quality power supply to consumers at affordable tariffs. Application of a particular model would depend on political, economic and social constraints faced by the governments, and difficulties associated with the process of effecting transfer of control from public sector to the private sector. Any model to be adopted for private sector participation in distribution has to aim for ultimately achieving multi-buyer model [7].

V. DISTRIBUTION ZONING

Unbundling is identified as a key requirement for promoting competition in a sector that has been monolithic so far. This would necessarily require breaking distribution regions into a number of zones, each managed by an independent player, thereby introducing healthy competition while retaining the privilege of eliminating non-performing players. The structure of distribution zones can be mixed or concentrated comprising different types of consumers like industrial, domestic and agriculture. Internationally, private distribution of electricity in rural areas is not prevalent in most countries. In Australia, rural and urban zones were segregated when distribution was privatized. Similarly, in Argentina, large provincial distribution areas continued under state ownership when Buenos Aires was privatized [8]. In India there is a need to approach rural electrification in a

manner that addresses its special needs and also leverage the benefits of private and community enterprise to improve service in these areas. Internationally, supply of electricity to rural areas has not only been given special dispensation, e.g., subsidies for capital investment in network expansion, but also uses innovative institutional mechanisms. Cooperatives often provide an effective option for extending service to rural areas, especially with access to quality advice and help on technical, financial management, human resource development and other related activities.

VI. METHODOLOGY EMPLOYED

Discom similarity is one of the major criterions for selection of Discom zoning. Apart from similarity in profile of customers and losses, Discoms should also be as similar as possible in terms of other factors like size (as expressed in terms of geographical area), connected load, number of customers, energy sales, line losses, and revenues etc. In this paper the following parameters were selected for zoning:

- Size factor
- Geographical Area
- Number of Consumers
- Energy Sales
- Cultural Uniformity

Weightings for the above parameters were decided by Delphi study. In order to monitor the impacts of new technological developments in the electricity industry and to identify future prospects, Delphi has been employed in a few studies [10] [11] [12] [13]. In the present study, expert opinion was obtained through written questionnaires, thus eliminating open discussions and committee activity and thereby reducing the influence of psychological factors such as specious persuasion and unwillingness to abandon publicly expressed opinions. [9]. Questionnaires prepared for the survey covered broad area of reforms in the distribution sector. In the first round questionnaire were posted to around 50 experts and 35 people responded. After the analysis of the first round of questions, it was found that firm consensus could be concluded on 17 (out of 22) questions. Clear consensus was not obtained for five questions. Hence, five new questions focusing the points for which consensus could not be concluded during the first round, were prepared for second round. The consolidated results of the first round analysis along with the second round questionnaire were sent to all the 50 first round respondents requesting them to express their opinion. Responses were received from 32 respondents during the second round. Firm and clear consensus was arrived at all the points after the second round of the questionnaire. The end results of the survey were informed to all experts participated in the study. After the analysis the following weightings were assigned to the five important parameters as shown in the Table1. Based on the above weightages final zoning was achieved by using mathematical graphical interpolation theory.

TABLE 1
Weightings given to Parameters for Discom configuration

| S.No. | Parameter | Weightage |
|-------|---------------------|-----------|
| 1 | Size factor | 10% |
| 2 | Geographical Area | 10% |
| 3 | No. of Consumers | 30% |
| 4 | Energy Sales | 40% |
| 5 | Cultural Uniformity | 10% |

VII. MADHYA PRADESH: A CASE STUDY

The Madhya Pradesh Electricity Board was the first Electricity Board in India constituted on the 1st of April 1957. The total installed capacity in the state is 2,990 MW (as on March 31, 2003), the per capita consumption is 279 kwh. Since 1987 the power cuts have been creeping the growth, particularly after the division of M.P State. In November 2000, M.P. state was reorganized into present Madhya Pradesh and Chhattisgarh, about 33% of generation capacity went to Chhattisgarh, while 67% came to Madhya Pradesh, even though Chhattisgarh had only 21% share in total power consumption. The bifurcation of the state severely affected the demand – supply balance in Madhya Pradesh [14].

A. Current State Of Affairs In The MPSEB

The energy shortage in the state is 12.8% and peak deficit is 20.3% (up to september2002); this huge gap is affecting every section of economy adversely. The annual growth rate of demand is 7% assessed by Central Electricity Authority. To meet the demand a total investment of approximately Rupees 1200 thousand Million will be required for new plans, this clearly shows the need for the private participation because neither the state Government nor the MPSEB is in a position to mobilize such big amount. There is urgent need of capacity addition in a fixed time frame. Though doors of the power sector were opened for private participation about 10 year ago, the contribution from such participation so far has been practically negligible.

The two major deficiency of SEB were identified as the lack of Commercial Autonomy and Management Inefficiency. The core issues that compelled the State Govt. to start the restructuring process were the following:

- Policy Constraints: Since the inception of MPEB, the Govt. of M.P. has concentrated on social aspect of the organization overlooking the commercial aspects, due to which financial condition is deteriorated.
- External Interference: Lot of political interference in the day-to-day functioning of the organization affected the performance of the MPEB management.
- Indiscriminate Recruitment of Labor Force: In the absence of proper recruitment policy surplus work force present and affecting the performance.
- Excessive Size and Monopoly: Due to the high degree of vertical integration problem of centralization and excessive size suggest unbundling.

- Increased Power Demand: state is facing a serious power shortage and there is an urgent need of capacity addition.
- Poor Financial Position: SEBs required mobilizing the funds for his highly capital-intensive power sector, and this is not possible unless the private sector is inducted to the reform process.

The obvious solution for these problems is to give relief to the SEB from the existing burden of running the huge monolithic organization into which it has grown and it is finding it unable to provide the needed investments and the quality of services a consumer expects from it. This has been done by dividing it on the functional basis into:

- Madhya Pradesh Power Corporation (MPPC)
- Madhya Pradesh Transmission Corporation (MPTC)
- Madhya Pradesh Zonal Distribution Companies (MPZDC)
- The setting up of autonomous regulatory arrangements.

B. Need For Distribution Company

Private investor participation into distribution can be introduced by sectionalizing distribution sector into number of distribution companies (Discom). The entry of a number of players in the distribution sector will improve the overall performance of the sector in terms of levy of appropriate user charges, proper metering and billing of the energy sales, elimination of power thefts and energy audits and fixing accountability. Assured revenue streams from the distribution sector would facilitate adequate investments in generation and transmission projects and the investors will be more willing to put in money even without counter guarantees and escrow covers. With the local socio-economic and political realities of M.P. state present need is to continue with uniform category-wise tariffs, this implies a substantial amount of cross-subsidy from the industrial and commercial customers. Given the current non cost-reflective nature of tariffs and the high commercial losses, The robustness of Discom profitability under any proposed configuration will depend on the way in which this cross-subsidy mechanism works and its flexibility under different outcomes. Any Discom configuration proposals should therefore be tested under financial sensitivities (e.g. changes in demand growth, tariffs, and loss reductions) not forgetting likely circle-wise variations. Unfortunately some of the data necessary for this level of analysis is not available.

C. Review Of Discom Numbers

Requirements of the large investments and economics of scale indicate a preference towards larger and therefore, fewer Discoms. But the concerns about manageability, customer services, the need for regulatory comparator and a device to attract a wider range of investors might suggest just the opposite. Based on a review of international privatized Discoms in terms of customer numbers, investment size, and MKWh sales, it was concluded that the selection process should allow for

Discoms with a maximum of about 3 million customers and a minimum of about 3500 MKWh of sales per year. For Madhya Pradesh, the total numbers of consumers are 6.1 million and total sale is 13369.9 MKwh. This translate to a possible range of 2 to 4 Discom. As a larger State, M.P. has even greater scope for alternative configurations.

D. Parameters for Distribution Sector Zoning

1) Consumer Numbers:

The state of MP currently has some 6.1 million customers with close to a million pending applications for new connections. Table 2 shows the year-wise growth in the number of consumers of different categories.

TABLE 2
Number of Consumers of Various Categories (in thousands) [15]

| Year | Domestic | Non-Domestic | Industrial | Water Works | Agriculture | Street Lighting |
|----------|----------|--------------|------------|-------------|-------------|-----------------|
| 1991-92 | 4257.6 | 531.9 | 90.8 | 9.7 | 905.0 | 22.7 |
| 1992-93 | 4399.3 | 540.5 | 92.8 | 10.1 | 940.3 | 22.4 |
| 1993-94 | 4867.9 | 5692.2 | 93.7 | 10.6 | 1021.2 | 22.9 |
| 1994-95 | 5260.5 | 5860.0 | 94.8 | 11.6 | 1083.5 | 23.2 |
| 1995-96 | 5525.5 | 598.1 | 96.0 | 12.3 | 1166.5 | 22.3 |
| 1996-97 | 5707.0 | 612.5 | 98.4 | 13.4 | 1173.3 | 22.8 |
| 1998-99 | 5969.1 | 627.6 | 100.5 | 14.8 | 1242.4 | 23.8 |
| 1999-2k* | 4497.1 | 505.0 | 82.9 | 12.6 | 1173.2 | 16.5 |
| 2000-01* | 4325.3 | 533.4 | 84.9 | 13.8 | 1145.4 | 16.3 |
| 2000-01 | 5271.7 | 662.9 | 102.0 | 14.8 | 1234.7 | 22.0 |
| 2001-02 | 4528.2 | 556.2 | 86.9 | 15.0 | 1202.1 | 16.1 |
| 2002-03 | 4569.0 | 577.5 | 89.4 | 17.1 | 1128.9 | 15.4 |

*Excluding Chattisgarh

Economic growth and development is also expected to add further to the number of consumer in the State. The ideal consumer size of Discoms depends on economics of scale, manageability, existence and reliability of systems and structures, and the type of challenges facing the Discoms. As per the international experience the average is about one million customers per Discoms [8]. However, manageability and improved customer focus, some of the key rationale of reform in MP are key factors inhibiting the larger sizes. It is therefore necessary to ensure that the Discoms configuration does not result in large unwisely Discoms, which are viewed to have the same problem as MPSEB. The question of economics of scale can also be significant. It is interesting that in the U.K. with the advent of full supply competition, a number of 2 million consumers are being mentioned as the minimum necessary to achieve required economics of scale. On the balance it was concluded that Discoms should be configured with no more than 3 million. Figure 2 illustrates consumer-wise zoning of MPSEB for the state of M.P.

2) Energy Sales:

Another important indicator is the level of annual Kwh sales. The current level of sales in MP stands at about 13317.1 MKwh. Given the large customer numbers; this is on the lower side and reflects the current low levels of consumption per customer.

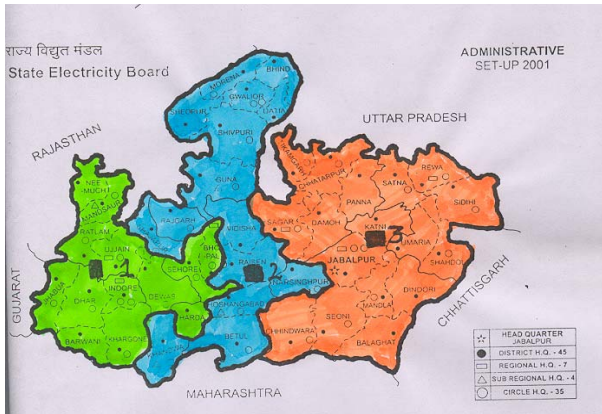


Fig 2. Consumer-wise zoning of MPSEB (Legend: No. Of Consumers: Zone1- 2.034 million, Zone2- 2.031 million, Zone3 – 2.062 million)

However, it should be noted that MP is one of the more successful states in India in terms of attracting foreign direct investment and increasing industrialization and commercialization. Therefore, future growth potential both in terms of per capita consumption as well as number of customers is relatively high. Table 3 shows power consumed by various categories of consumers (MKwh). International experience suggests that typical privatizing Discoms in the emerging markets have had less than 45000 MKwh of sales per year [16]. This led to selection of a minimum target of about 3500 MKwh of annual sales for each Discom in the present study. Figure 3 illustrates energy sales-wise zoning of MPSEB for the state of M.P.

TABLE 3

Power Consumed by various Categories of Consumers (Mkwh) [15]

| Year | Domestic | Non-Domestic | Industrial | Water Works | Agriculture | Street Lighting |
|----------|----------|--------------|------------|-------------|-------------|-----------------|
| 1991-92 | 2378.4 | 452.2 | 7836.9 | 315.5 | 2418.1 | 82.6 |
| 1992-93 | 2608.9 | 505.6 | 7836.9 | 356.5 | 3296.8 | 98.9 |
| 1993-94 | 2677.4 | 593.2 | 8278.7 | 395.9 | 5495.9 | 101.2 |
| 1994-95 | 3027.4 | 606.0 | 9843.7 | 399.9 | 6750.9 | 114.1 |
| 1995-96 | 3387.1 | 655.0 | 9683.5 | 423.1 | 7981.8 | 127.4 |
| 1996-97 | 3739.4 | 677.6 | 10172.7 | 425.1 | 8593.4 | 129.5 |
| 1998-99 | 4044.8 | 692.2 | 9910.1 | 447.0 | 9679.3 | 136.0 |
| 1999-2k* | 2622.2 | 616.0 | 5507.4 | 435.7 | 9011.9 | 120.8 |
| 2000-01* | 2911.22 | 578.8 | 56323.1 | 440.2 | 7172.8 | 126.8 |
| 1999-2k | 2622.2 | 616.0 | 5507.4 | 435.7 | 9013.9 | 120.8 |
| 2000-01 | 2720.8 | 578.1 | 5623.1 | 440.2 | 3809.5 | 126.8 |
| 2001-02 | 3210.8 | 596.8 | 6105.9 | 446.6 | 4185.4 | 124.8 |
| 2002-03 | 3230.1 | 651.6 | 5855.4 | 434.9 | 4820.5 | 121.2 |

*Excluding Chattisgarh

3) Cultural Zones:

Cultural zones are combination of circles whose customer historically shares a strong cultural affinity. Cultural zones play a pivotal role in configuring Discoms. While an agricultural consumer in one zone may agree to a higher tariff to give relief to another consumer in the same zone, he may not be willing to share the burden of another agricultural consumer in another culturally different area with whom he has no ties. It is therefore believed that, although not inviolable, much greater attention needs to be given to protecting the integrity of cultural zones while configuring Discoms. It is imperative

that before embarking on any exercise to map out the boundaries of potential Discoms, the prevailing cultural affinities, the expectation of the state government and most importantly the hopes and aspiration of the people should be clearly understood area recognized. The entire state was therefore divided into 7 culturally and historically similar areas.

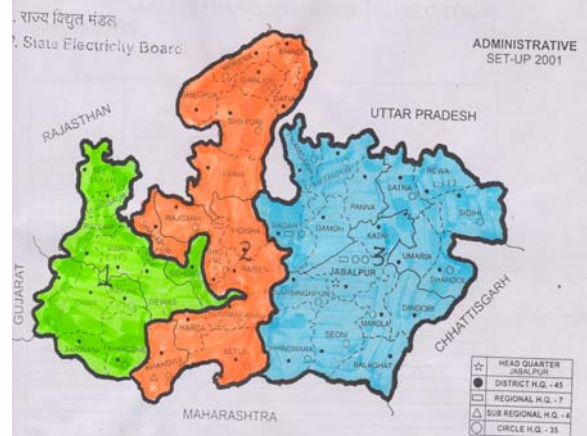


Fig.3 Energy Sale-wise Zoning of MPSEB (Legend: Zone1- 4436.113 Mkw; Zone2- 4382.087 Mkw; Zone3 -4464.236 Mkw)

4) Area Distribution:

M.P. State stretches in the area of 323.2 thousand sq.km. Here M.P. State Area was divided into three approximate equal areas.

5) Type of Consumers:

Each zone should have balanced load structure comprising the agriculture, domestic, commercial and industrial load. This is to balance the peak demands, to ensure uniform subsidy distribution in each zone and to ensure profits for every Discom. The area was hence divided into a 3 zones based on uniform distribution of various consumer types.

VIII. RESULTS AND CONCLUSIONS

Based on the Delphi survey weightages were given to the parameters and final DISCOM zoning on the basis of weightages given to the parameters was derived by using graphical mathematical interpolation theory. Figure 4 shows the final zoning. Finally three Discoms were proposed for the MPSEB on the basis of the study.

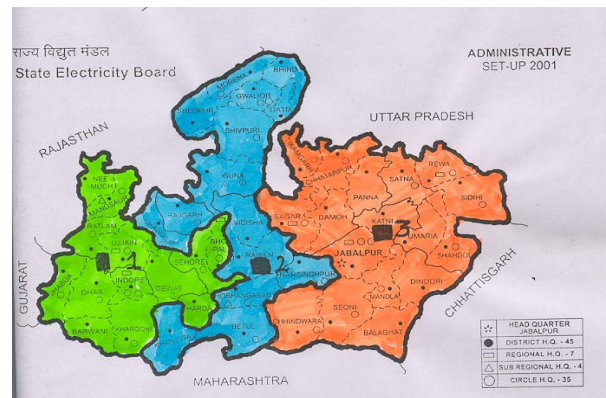


Fig 4. Final Discom Zoning on the Basis of Weightings given to Parameters

In the present work only five parameter viz. area, cultural uniformity, energy sale and no. of consumer and types of consumers were considered keeping in view the importance of these parameters and availability of data. It is possible to apply this methodology with larger number of additional parameters such as connected load, revenue, subsidizing ratio etc..

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X. BIOGRAPHIES

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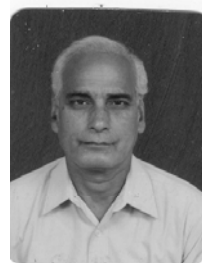
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