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Research paper

Enhancement of Electrical Distribution Networks Performance Using the Load Management Methodology

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ABSTRACT

This paper presents the importance of load management methodology (LM) and helps in clarifying the difference between load management versus demand-side management (DSM), as LM is a crucial method of controlling the loads especially in peak periods, to prevent tripping. It was found that the previous researches focused on the dual tariff meters to force and motivate the consumer to change the demand time which was a gleam in overcoming the phenomena. However, the dilemma of the DSM was relying mainly on the consumer, who has to change the time of his needs. Therefore, it is difficult to be controlled. Consequently, they cannot find effective feedback as well. On the other hand, LM relies only on the designer or service provider in re-distributing loads according to the load behavior studies (time, location, and type of user) without depending on the consumer in solving the phenomena of extreme fluctuations of loads on the electrical equipment. In this paper, the second methodology is by the service provider, it is going to be handled and discussed by Selecting medium voltage (MV) feeders, re-distribute loads equally, and variously on transformer preventing unifying load which causes overloaded transformer on one period rather than the other. Consequently, it will lead to protect electrical equipment from no-load or overload effects, selecting the exact size. That will improve the economic status and will lead to a stable, balanced system, besides reduce heat island effects and prevent load shedding caused by sudden overloading. The model was created by using DIgSILENT power factory software.

1. Introduction

Severe load fluctuation Problem all over the electrical network which, causes negative impacts on the electrical installations. Moreover, causing over or under voltage, over or under frequency, over current and instability.

Some countries use Load shedding and circuit breaker (CB) Trip protection methodology to face the force majeure of the severe overload on the electrical network installations. Although, this way of dealing with the problem was not efficient as it circumvented the problem but did not solve it (Yazdani-Asrami et al., 2013). Also, it ignores the no-load issue (Takach and Boggavarapu, 1985). The most negative impact for this method is the frequent trip which leads to customer dissatisfaction and causes financial losses. But previously it was a prevalent way of preventing damage to service provider installations and even customer electrical appliances damage (Damodhar and Krishna). Caused by severe inconstancy of voltage, ampere (A), and frequency changes Due to fluctuating load all over the day (Tamilselvan and Jayabarathi, 2016).

Other countries follow the DSM Technique which encourages the customer by reducing and changing times of his desires, requests, and needs (Jabir, 2018). This positively overcome the overload and even filling the valleys to solve the no-load issue which was not solved in the load shedding method (Tutkun et al., 2017; Gellings, 2017).

The negatives of this technique are neither effective nor guaranteed as it depends on the consumer to modify his needs on the required times. Moreover, following or monitoring these loads for consumers by service provider was difficult (Batra et al., 0000). Even there were several questions about how many consumers react and cooperate. Is it going to be effective, does the consumer all the time will follow the instructions? Consequently, if the customer is uncooperative will cause overload again so forcing the service provider to use load shedding to protect the network installations (Amoiralis et al., 2012).

On the other hand, the LM is the methodology that studies the load profile, helps in redistributing the loads on the network utilities, and overcoming the problem of random distribution

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which causes peaks and valleys. Conversely, LM is a radical solution completely by electricity companies within the network whether distribution or transmission without the need for the consumer. As, it had been studied and noted that loads can be divided into morning, afternoon, and evening periods. Which is according to their specifications, so it can be divided into at least two periodical loads and distributed according to these classifications (Wang et al., 2015). That was not focused in the previous studies. Besides, to use the proposed solution in the previous studies. DSM noted that there are loads whose time of demand cannot be changed as (refrigerators, freezer, air conditioning, and lighting) (Laicane et al., 2015). According to double tariff meter and it will continue to be a burden on the network and with time it will increase (Farhadi and Taheri, 2017). The only result will be the energy of conservation that is not guaranteed in rush hours and not effective in solving the problem of peak and no-load time.

There are loads whose demand time can be changed, such as (washing machines, pumps for water tanks in residential towers, water heaters) (Swain and De, 2017). However, it is not an effective way for reducing the peaks and not a strongly effective or radical solution. LM depends on studying the load behavior, selecting different types of loads for example selecting governmental bodies in the morning and wedding halls, cinemas in the evening to be loaded on the same feeder so that to prevent loading loads classified the same type on the same feeder. The LM has to be used in the load calculations for selecting the electrical equipment capacity. And to be included in the codes as a factor must be respected, as per demand factor (Anthony et al., 2016).

This research intends to find the best economical methodology to prevent over and no-load phenomena. Consequently, prevent over and under-voltage. Moreover, prevent over and under frequency. The target is the stability and quality in continuity and prevents any other effects such as a trip or load shedding (Omara and Nassar, 2019). Accordingly, select the optimum capacity, increase the lifetime of the electrical installations, and save the environment all of that without the return to the consumer with the most economical method.

The main contributions of this paper are as follows:

- Selecting an Unbalanced Two feeders with random load distribution on the electrical installations showing the load fluctuation.
- Installation of the new kiosk as a new customer with new loads and using it in linking between the two selected feeders to establish a new open-loop with balanced loads.
- Enhancement of Electrical Distribution Networks Performance Using Load Management Methodology on the selected feeders to balance them.
- Clarifying the positive effects of using Load Management Methodology versus other techniques DSM or load shedding.

The contents of this paper are arranged as follows. Section 2 describes the types of consumers in Egypt, consuming percentages and Loads as per consumers. Side effects of severe load fluctuation briefly described in Section 3.

In Section 4, the unbalanced selected feeders, the experimental steps to apply the Load Management Methodology. Results and discussion are given in Section 5. Interpret the merits of load management methodology in Section 6. Importance of load behavior as a part of load management methodology. Finally, Section 8 concludes the paper.

2. Types of consumers on medium and low voltage distribution network

Medium and low voltage loads are (residential, industrial and governmental) of the Egyptian network are considered the main loads in terms of about 77.3% of the total loads, besides 15.2% (commercial, agriculture and street lighting) and 7.5% (others (losses, youth clubs, Gaza) as shown in Fig. 1). The medium voltage network (6.6 kV, 11 kV, and 22 kV) of the Egyptian network are considered the main distribution networks in terms of MV. However, the transmission lines consider the (66 kV, 220 kV), beside the LV as (230V and 400V) each has its network specifications and capacities (Nassar et al., 2020).

Consequently, distributing this load on the whole day was not homogeneous. From Fig. 2, it was shown that the consuming amount and demand were not distributed homogeneously on the whole day (Nassar and Abdella, 2019). Thus, which needs to demand-side management.

Fig. 2. shows the heterogeneity of loads all over the day. In which the governmental and public services are the main load during the day. However, Residential is the main load in the Evening period. This is to clarify the four different periods of load behavior depends on the three factors (Type of Consumer, Time, and Location) in Egypt (The Arab Republic of Egypt, 2015b).

3. Severe load fluctuation side effects

Due to Severe Load Fluctuation, unstable electrical network installations and stakeholders can be affected negatively as follows:

3.1. Severe load fluctuation leads to overloads effects

- Damage caused by the adverse effect of overloading. That reduces the lifetime thus, causes losing the equipment after time, as a consequence, it is crucial to saving network electrical equipment (Said et al., 2010).
- Overloading harms the transformer. This is due to increasing the ambient temperature which leads to an increase in oil temperature accordingly causes hot-spots and Bubbles phenomenon increasing heat island Temperature and reduce the life time (Gadzhiev et al.; Godina et al., 2015).
- Moreover, the cables which were affected by the overloading, Causing elongation to cables and after the load deducted, cable returns causing the Bubbles phenomenon leads to weak points (Borisova and Osina, 2017).
- Causing more Cost for changing the damaged installations by another (Lobão et al., 2014).
- Frequent trips caused by protective relays due to overload, under frequency, and voltage protection (Al-Ali et al., 2011)

3.2. Severe load fluctuation leads to no-loads effects

- Notwithstanding it is crucial to reduce the load, the no-load also have an adverse effect such as no-load losses, selecting electrical equipment capacities with more than the required, which is wasting for investments especially for private investments.
- It causes overvoltage which leads to the industrial and other fields to completely shut down as protective action (Bhosale et al., 2018).

  From the previous Side effects of severe load fluctuation, it was found that it is not only a quality issue but it is also the most important of all the continuity which will not be applicable due to frequent trips (Mihai and Helerea, 2019).

4. Case study for implementing the LM methodology

The loop that will be select and study is supplied by an 11 kV distribution network. Moreover, the study succeeds to select two feeders with different loads of characteristics. Feeder (A) was loading 175 A at day and only 105 A in the evening and Feeder (B) was loading 155 A at day and 220 A in the evening

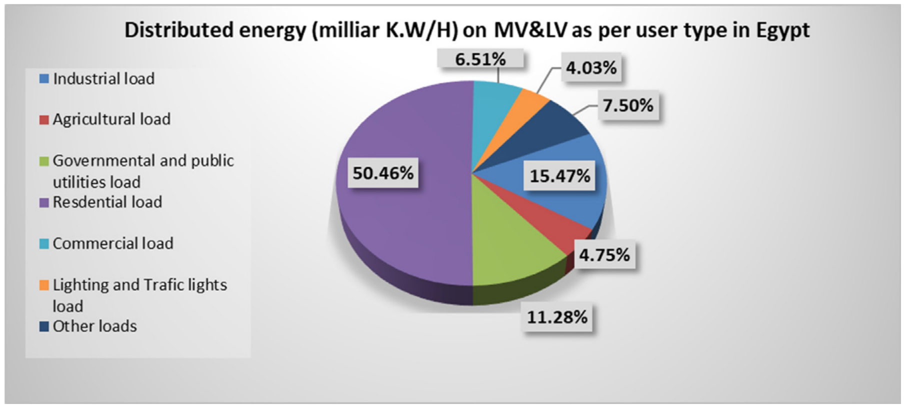

Fig. 1. Percentage of consuming in Egypt in 2017.

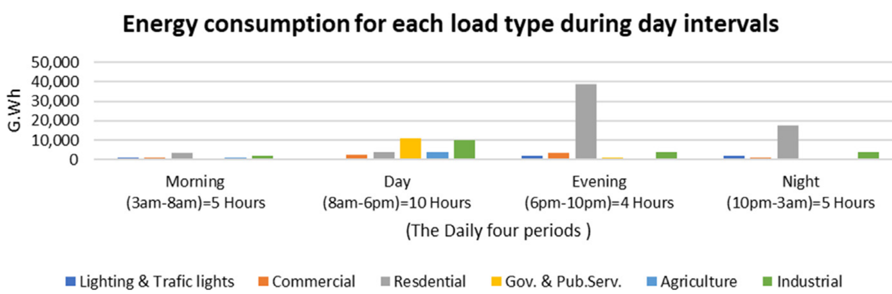

Fig. 2. The amount of consumption according to daily demand.

as indicates in Figs. 3 and 4. Although, both were not designed as per load management. Which causes overload in a specific period and minor loads on other periods on the feeders. Feeder B on some occasions or seasons will be easily overloaded in the evening leads to load shedding and protection trip so it was rechecked with DIgSILENT software, adjusted then executed on the real state.

4.1. Basic information (for selected feeders)

1- All cables are typical in the network as they are 3 × 240 mm^2 AL/XLPE/STA/PVC.
2- All transformers' power capacity and their cooling type are 1000 kVA, 50 Hz, Dyn11, ONAN respectively, 11/0.4 kV.
3- The total number of transformers is seven for each supply feeder.
4- All circuit breakers are (SF6)/630 A. with CT (100/1 A) VT (11 kV/110 V) type.

Figs. 3, 4 show the feeders selected to be studied from the MV distribution network.

This figure shows that the selected Feeder A which is loaded without Respect to Load Management Methodology causes the difference between Day and Evening Loads. The connected load to the feeder A is seven kiosks each capacity is 1000 kVA. Feeder A was planned to form a loop with another feeder X. According to security issues, it has an open switch in the Ring main unit (7) to act as a radial feeder. As per our teamwork survey, it was found that the feeder is loaded with day load more than evening load. Thus, it was planned to use this Feeder to be a host for the transferred two kiosks from the selected feeder B to be loaded in the evening period and reduce evening load on feeder B.

From Fig. 4 can be concluded the selected Feeder B which is loaded without Respect to Load Management Methodology causes the difference between Evening and Day Loads. The connected load to the feeder B is seven kiosks each capacity is 1000 kVA. Feeder B was planned to form a loop with another feeder Y. According to evening overload on both feeders (Y, B) we open switch in the Ring main unit (G) to act as a radial feeder. As per our teamwork survey, it was found that the last two kiosks (F, G) are loaded with evening load more than day load. In contrast, feeder which was suitable for us that the two feeders are going to be complementary to each other. Thus, we will use these two kiosks to be transferred to transfer the load to the other selected feeder A.

4.2. Implementation of load management methodology steps divided into three phases

The methodology was divided into three Phases as follows:

4.2.1. The first phase of the study collecting data (measurements and classifications)

This was the most crucial phase because the whole next phases from redesign to implementing and management of loads is going to depend on this data, measurements, and classification (Tsekouras et al., 2007). We use in this phase the measurement and protection instruments that are connected to the circuit breakers, taking the readings four times a day (6 am–1:30 pm–8:30 pm–1 am) (Ali, 2019). This data collected and sent to the design department, classified the loads to different four categories as per user loading demand periods to indicate and use the load to complement each other which is shown in Table 1.

4.2.2. The second phase of the study redesign and calculations of loads using the collected data

Using the collected data, measurements, and Classifications to redesign as per the LM methodology to get a homogeneous distribution of loads throughout the whole day, in which to be studied as per divided into four periods. However, this was not only an Effective factor but also there was another important

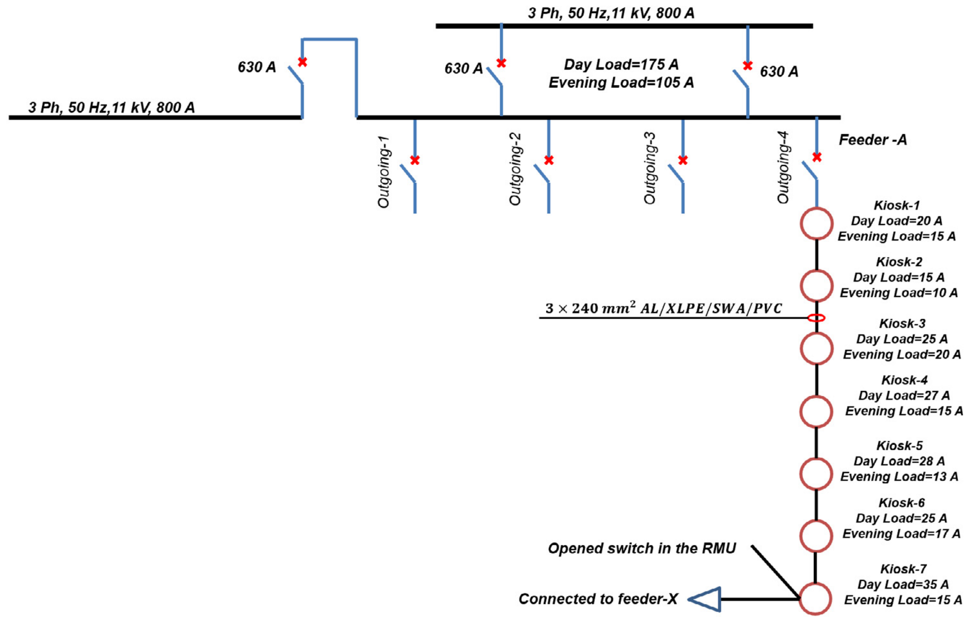

Fig. 3. Selected sample feeder A in the distribution network (day and evening) before load management.

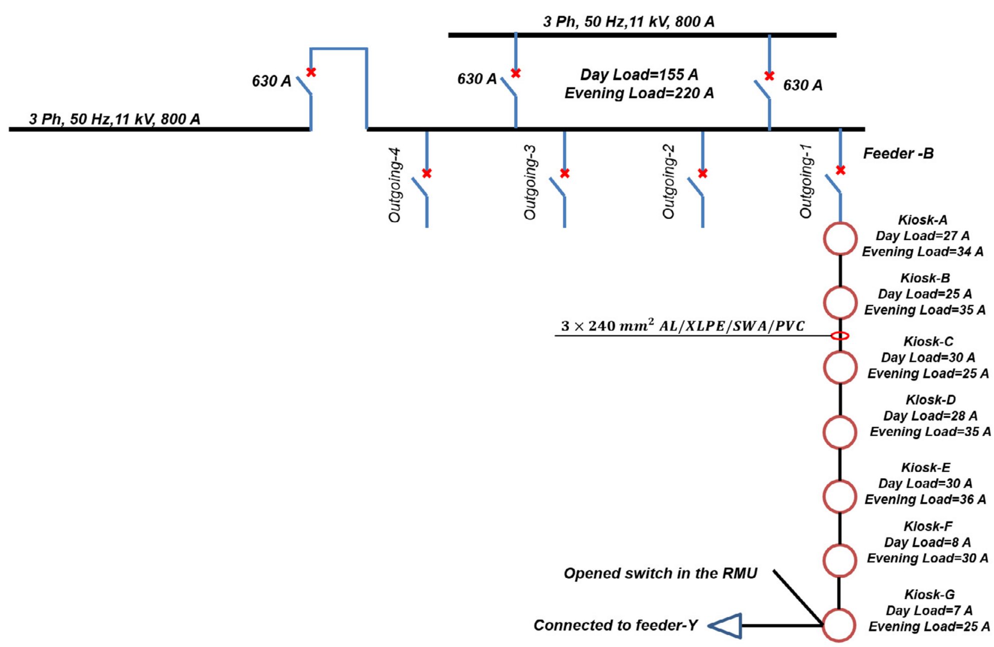

Fig. 4. Selected sample feeder B in the distribution network (day and evening) before load management.

factor which is the baseload and Peaks in which we have to respect in our design. Base loads and peaks are different in an amount as per the time, location, and type of user. Accordingly, calculations of the loads concerning mix and match the loads from different types preventing collecting the same load (with the same behavior) on the same feeder in this phase.

$$|S| = \sqrt{3}.V_L.I_L \tag{1}$$

Step 1. Calculating the load can be connected to the transformer.

However, the Connected Loads to the electrical installations must not exceed 80% of the total capacity of the installations and calculated by equation (1).

$$Max.Demand = CL \times DF \tag{2}$$

Step 2. Calculating the Demand load by equation (2).

where:

$|S|$ (VA) = capacity of the selected transformer in volt–ampere.

V_L (V) = Line voltage in volt.

I_L (A) = load current in ampere.

Max. Demand (VA) = demand load in volt–ampere.

CL (A) = Connected load current in ampere.

DF = Demand Factor (as per load type).

For our LM methodology, the total calculated load has been (focused on Day and Evening loads). Total connected load on Day must be almost equal to Evening total connected load for the same installations, in which this is the Ideal LM. The nearest to zero Difference between Day and night values after load installations the closest to the ideal LM design.

Table 1
Load divided into categories according to user type and time.

Time	Users	Common periods
3 am–8 am Morning (5 h)	–Traffic, lighting signs –Bakery ovens	
8 am–6 pm Day (7 h)	–Governmental –Official buildings –Schools & Universities	–Commercial –Industrial –Hospitals
6 pm–10 pm Evening (4 h)	–Street lighting –Residential – Clinics	
10 pm–3 am Night (5 h)	–Cinemas, Theaters –Wedding halls – Street lighting	

4.2.3. The third phase of the study redistributing the loads on feeders as per the new design

Implementing the design calculations to rearrange the loads as per LM methodology. However, this must be done using another new kiosk which is even can be a new service for new customers (double benefit) (Chen and Xu, 2018). The illustrated Fig. 5 shows the feeders before installing and connecting the recent kiosk, feeder (B) loaded with 85 A only at morning which is close to being 20% from the allowed capacity of the feeder on this period but on the other hand, it is up to 220 A at evening. On the other side, it is shown that feeder (A) loads in the morning period almost 80 A, but in the evening it reaches 175 A in this period.

Also, Fig. 5 illustrates that the load is extremely dissimilar all over the day on both feeders. Thus, this is the problem that we achieve to overcome in our study without depending on the DSM. Which, will require asking and rely on the customer to increase the demand in the morning to compensate for the power losses caused by the light loads in this period (Nnachi et al., 2018). However, the consumer reduces or increases the demand to adjust the feeder's loads will not happen exactly as planned. Therefore, it is questionable whether it is helpful, efficient, or even sufficient. However, it can be solved with LM as previously clarified and which is indicated in Fig. 6 as an LM methodology result. The two feeders become balanced and semi-Identical in loads of same periods, which is required to prove.

From Fig. 7 it can be inferred that the loads were not distributed homogeneously on the feeders which reflect on the daily report of the feeders, consequently, that was our target to redistribute the Loads on the feeders as per LM methodology to reflect all over the whole day.

Fig. 8 indicates that the interconnection between the two feeders by a new kiosk to configure a loop that helps to equalize the loads as possible between them, the advantage of linking the loop and managing load by redistribution of load and balancing the two feeders.

Fig. 8 shows that the selected Feeders A and B after Connecting with the new kiosk to help in shifting (G, F) kiosks from feeder B to A. This two shifted kiosks according to the survey were suitable as per Load Behavior and LM study for both feeders in which to be accumulative and proof the ability to shift loads whatever the type of the Load, The study shows how LM can shift the loads without depending or forcing the Consumer to shift any of his Time usage or demands.

5. Results and discussion

During the case study, the installation of a new kiosk and linkage between two feeders helped to Balance both feeders A and B. By decreasing the evening load of the Feeder B which was overload (peak period). And increasing the evening load on feeder A which was loaded only about 40% of its total loads capacity before using LM methodology. Without depending on the customer and with an efficient redistribution of load, this reveals the LM Methodology results. Moreover, the balancing of the two feeders proofing that the LM causes and affects balancing on the Substations Transformer. The new load on feeder A with an overall Number of seven original kiosks with a new kiosk for linkage process besides of also two kiosks swapped from the feeder B to be added on feeder A. So, the new total number for feeder A is ten kiosks. Fig. 9 shows that the severe load Fluctuation on feeder B in the first three periodic shapes had been decreased in the last four ones as a result of using the LM Methodology. Fig. 9 indicates that the un-balance between the two feeders in the first three periodic shapes, while using LM the next four periodic Measurements reveal the congruence between feeder A and feeder B, proving our methodology effectiveness in balancing the loads. Moreover, the customer was not requested to change any of his needs. However, feeders are changed to almost stable load after using LM methodology by redistributing and rearranging the kiosks of the Feeders and the installation of the new kiosk. The new load on feeder B will be the five remaining kiosks.

1- The results indicate the methodology success in transferring and shifting loads between the electrical installations. Which effects on the balancing of the network, consequently saving the installations and increase the lifetime. Besides, it helps in the exact selection for the suitable capacity of the installation with neither more nor less capacity. All of this without relies on the consumer to change his demand time.
2- LM Methodology was proven in the case study when we select a feeder indicates the same problem of overloading in special few hours on the whole day. Accordingly, we prove that LM Methodology can solve this problem and balance as much as it can overcome the design mistakes.
3- This Case study may reveal small Load Changes during the proof of the Methodology. However, it can be applied to major Feeders in the substations or the power plants. It was important only to prove that it is applicable to be done.
4- This methodology helps in increasing network stability, power supply continuity, and Load Balance. Consequently, Prevent over and under-voltage problems. Moreover, over and under frequency problems caused by Load Fluctuation. All of that to provide a power supply with the best quality (Tarigan and Pulungan, 2018).
5- This methodology helps in Preventing Load Shedding or trip all over the electrical installations in the network. Overcoming the problem of frequent shutdowns providing the continuity of electrical power service (Nassar et al., 2014).

6. Benefits from load management exploitation

This experiment helps in preventing the side effect of poor electrical designs. This appears clearly in both feeders the evening periods seem to be more loaded although the morning period was approximately not loaded at all since the designer did not study well the load management to arrange the loads sufficiently from the beginning.

– Consequently, the experiment also indicates how the ministry of electricity can overcome this problem even after installation by load management methodology.
– Insure and Guaranteed that the selected installations will be loaded with only the allowed capacity that is 80% from the whole size of it and on all-around the day and not in some specific short periods, which will help in selecting the exact size.

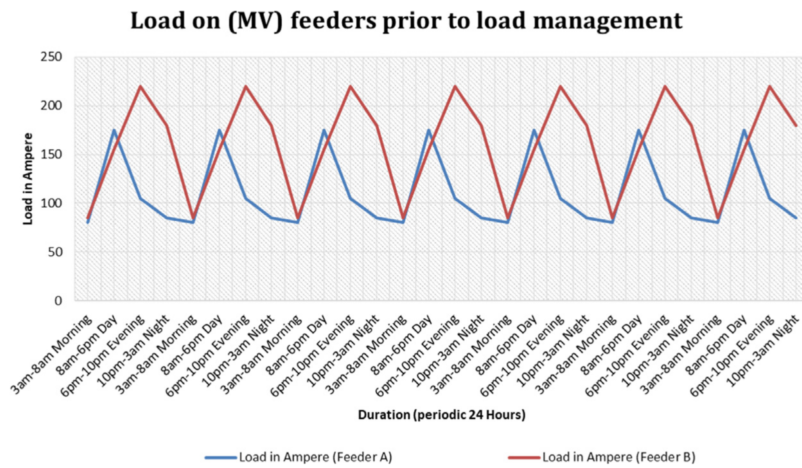

Fig. 5. Load graph for a selected sample of two feeders in the distribution network (day and evening) before load management.

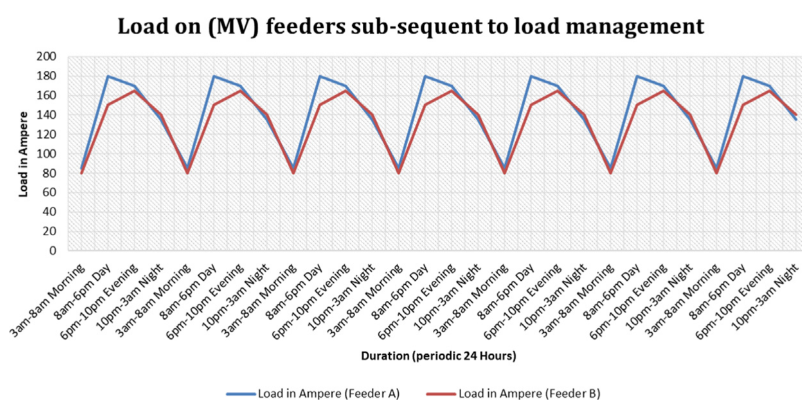

Fig. 6. Almost controlled, corresponding load graph for the two feeders in the distribution network (day and evening) after load management employment.

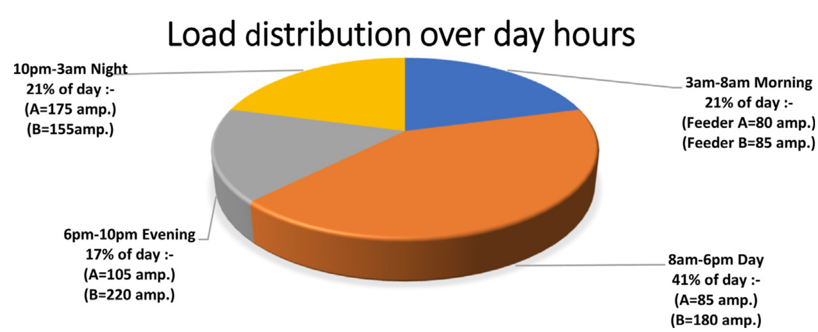

Fig. 7. Selected feeders with different loads on the same periods before applying the LM methodology.

7. Load management affected load behavior

Therefore, in our selected sample we study the loads on the installations such as the class of user and types of used loads. Which is significant in choosing the light lamp as a load with the same specifications. However, in residential buildings will differ from governmental buildings' usage time. Consequently, lighting should be turned off at night in governmental buildings following day is off, on the other side it is turned on in the Residential buildings at night. Thus, clarified in Fig. 10 the first feeder (B) at day was lesser than evening load compared with the second feeder (A) it was vice versa. This signifies clearly that there was no LM. That reflects on selecting the equipment capacity in case of the feeder (B) at Day the load is 155 A. That means in selecting cables & circuit breaker (with safety factor 25% in conformity with NEC, IEC) it will be: C.B $= 155 \times 1.25 = 193.75$ A. Consequently, for Cable $= 193.75 \times 1.25 = 242.18$ A. These calculations for sizing the installations for day loads. However, in the evening it is going to be as per measured loads. For C.B $= 220 \times 1.25 = 275$ A. Consequently, for Cable $= 343.75$ A. Therefore, (simply without demand, diversity factors) in selecting the equipment it is going to be for the max. Load, which is 343.75 A. This denotes that the selected equipment (as per the evening period) is approximately close to one and half the equipment needed for the day. Thus, this is not economically to use equipment with one and a half

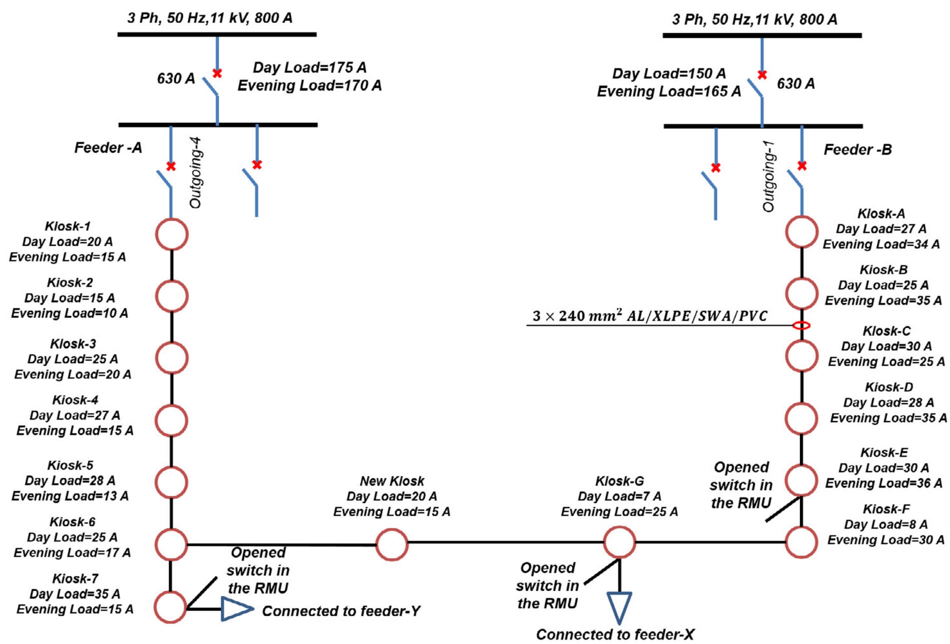

Fig. 8. The total distribution network of the selected two feeders after load management employment.

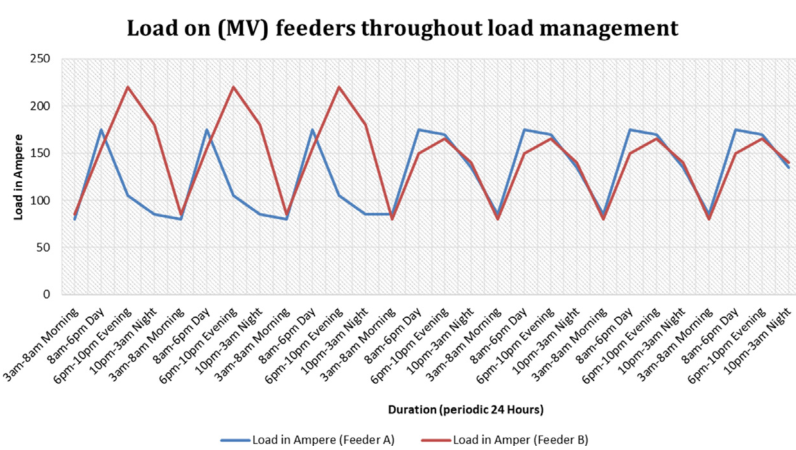

Fig. 9. Load graph for the two feeders in the distribution network (day and evening) throughout load management employment.

times the required capacity for only four hours daily Nassar et al. (2019).

In Fig. 11, after LM the day was closely equal to the evening load on both feeders, which helps in selecting the exact capacity for Cables, Circuit Breaker (C.B) used for more than half the day (as per NEC, IEC): For C.B 150 × 1.25 = 187.5 A. Therefore Cables = 234.375 A. These calculations for sizing the equipment for morning loads. However, in the evening it is going to be as per measured loads: For C.B 165 × 1.25 = 206.25 A. Therefore Cable 257.81 A. Also, the load balancing of two feeders on same bus bar prevent growing the currents in neutral. In which the selected installations will be fully used on all-over the day not only for a few hours and for the remaining hours in the day it will be only used with about 60% from its whole capacity.

8. Conclusions

This paper presents a data-driven, method for LM using load characteristics, specifications, according to the type of user, time, and location (load behavior) studies in arranging the loads to occur load balance improving the load curve all around the electrical network during the whole day. Compared to prior studies of DSM that is different in methodology depending on the customer in all solutions. The novelty presented by this work:

1- The introduced methodology clarifies how the LM can Shift or transfer the whole load from one electrical installation to another. However, the consumer did not change his time of demand.
2- The introduced methodology clarifies how LM was so effective on electrical installation which was overloaded to change its status to be within the average load, which can be used to prevent fake peaks on some areas in the network.
3- The introduced methodology clarifies how the LM can save capacity in the installations of the network, in which we distribute the loads concerning load management concepts (with studying the load behavior) to form the homogeneous distribution.

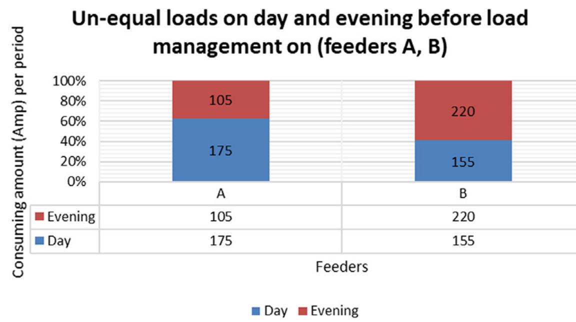

Fig. 10. Unbalanced load on two feeders (morning and evening) before load management.

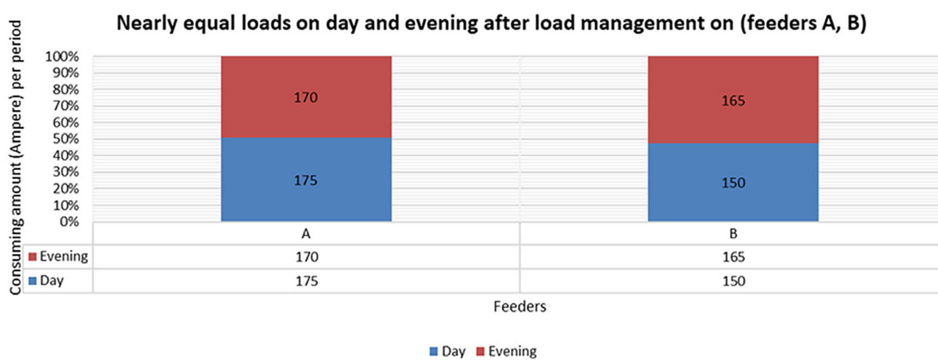

Fig. 11. Balanced load on two feeders (morning and evening) after load management employment.

Table A.1
Medium voltage network installations details.

i-MV distributor switchgear details: *SF6 incomer CB:* (Protection relay trip settings) Overcurrent 600 A at 0.5 s, Earth Fault 120 A at 0.3 s, Short Circuit Current 45 000 A, with Direction Over Current 600 A instantaneous, Direction Earth Fault 120 A Instantaneous, Circuit Breaker Rated Current, 1250 A, CT 400/5/5 A and S = 30–50 VA & class 0.5–1, VT 11 000/110 V and S = 50–100 VA & class 0.5.
SF6 outgoing CB: (Protection relay trip settings) Overcurrent 300 A at 0.3 s, Earth Fault 80 A at 0.1 s, Short Circuit Current 45 kA, 5 In, 0.05 s, Circuit Breaker Rated Current, 630 A, CT 200/5/5 A.
ii-MV cables details: M.V cables connected with incoming CB: 3C × 400 mm^2 AL/XLPE/STA/PVC-15 kV M.V cables connected with outgoing CB: 3C × 400 mm^2 AL/XLPE/STA/PVC-15 kV
iii-Kiosk details: (a) RMU 2 out of 3: with incomer switch, 400 A, Outgoing Switch 400 A, and Injection Switch 400 A, Beside the Transformer Switch 200 A with High Rupturing Capacity (HRC) Fuses 63 A for the 1000 kVA Transformer. (b) Transformer: with capacity 1000 kVA, 50 Hz, Dyn11, ONAN respectively, 11/0.4 kV.

4- Using LM does not depend on any customer for load shifting, swapping, or even monitoring.
5- This research provides a practical methodology for managing (balancing) the loads on feeders of different circumstances.
6- LM is efficient economically and easily can be done by electrical designers or by the ministry of electricity (Service Provider) even in late states after installations.
7- LM Saves equipment lifetime and reduces the need for maintenance and repair caused by temperature rise.
8- The conducted research proves the importance of studying load behavior which can be used in the future in many other security purposes as per (Time, Location, and Type of User).
9- LM reduces the heat island effect caused by ambient temperatures due to overloading.
10- LM improves the efficiency of providing the service without any more cost or shutdowns.
11- LM saves electrical installations and customer appliances from load fluctuations side effects.
12- Using LM prevents load shedding caused in case of overloading causing under-voltage and frequency.
13- This research distinguishes well between DSM and LM methodologies, previously was treated as one methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

The authors are grateful to the Egyptian Electricity Holding Company for their information.

Appendix

See Table A.1.

Abbreviations:

DIgSILENT	: Digital simulation and electrical network.
MV	: Medium Voltage
LM	: Load Management
DSM	: Demand Side Management
CB	: Circuit Breaker
SF6	: Sulfur hexafluoride
ONAN	: Oil Natural Air Natural
XLPE	: Cross-linked polyethylene
PVC	: Polyvinyl Chloride
STA	: Steel Tape Armored
CT	: Current Transformer
VT	: Voltage Transformer
HRC	: High Rupturing Capacity
kV	: kilo Volt
kVA	: Kilo Volt–Ampere

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