A Risk Based Method for Energy Management of Smart EV Parking Lot Equipped with Renewable Energies

Hamid Helmi[1], TaherAbedinzadeh[2*], Jamal Beiza[3], Sima Shahmohammadi[4], and Ali Daghigh[5]
[1,2,3,4,5]Department of Electrical Engineering, Shabestar Branch, Islamic Azad University, Shabestar, Iran
[*]Email:taherabedinzade@yahoo.com
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Abstract

The penetration of electric Vehicles (EVs) to the modern distribution system, has taken place in the last decade. Furthermore, Renewable Energies (RE) play an important role in such Micro-Grids (MG). Several Distributed Energy Resources (DER) including Distributed Generations (DGs) and Demand Response (DR) as well as EVs charge/discharge stations form a typical MG. In this paper, optimal DR-based charging and discharging strategies have been applied on the renewable-energy-based charging station of Electric Vehicles. In order to avoid profit loss due to the uncertainties of renewable energies, Peer to Peer (P2P) energy bartering between EVs charging station as prosumers is suggested in this paper. Therefore, in this paper, the management systems are developed for charge and discharge of EVs and station batteries, as well as Energy Management System (EMS) in order to do so, developed EMS was applied to the individual station in the first step. In the second step, the P2P power transaction was added to the model for the purpose of smoothening volatile uncertain load and renewables. The proposed model is a Mixed-Integer Linear Programming (MILP) and GAMS/CPLEX has been used to solve it. Numerical studies have proved deployment of aggregator is to be more beneficiary for Virtual Power Plant (VPP).

Keywords: Energy Resources, Renewable Energy, Uncertainty, Demand Response, Energy Management System, Peer to Peer

1. Introduction

1.1 Motivation

Small-scale renewable resources known as Photovoltaics (PVs) and wind had mixed the producers and consumers to form new parties named prosumers who are able to directly participate in their own energy management. These types of consumers may have been coordinated to build larger entity and consequently increase their benefits which are individually unachievable [1]. For example, although DR reduces the grid operation costs, but the incentives may not compensate the dissatisfaction of small prosumers. Besides, the amount of power that can be supplied to the energy markets is significantly larger than the single-family stations who have RE. According to [2], the minimum bid/offer size, simultaneous upwards and downwards bid and activation time are the constraints that should be mitigated as they disable the prosumers to participate in the market. For this purpose, retailers, large consumers, power plants and etc. are the energy markets parties.

The high prices in some periods are caused by the volatile energy prices. The advances in RE technology are also the motives of the aggregated virtual models. These virtual aggregated parties may help decarbonization and local environmental aims by delivering extra energy of REs to the main grid instead of power curtailment [2, 3]. The virtual models can comply national-level market constraints while locally managing prosumers [4, 5]. Therefore, prosumers can also provide opportunity for low carbon policies of current decade paradigm in the energy system, while simultaneously reducing local grid’s peak load and contributing to their economic development. So, the local residential entities will have the ability to optimize their Res and EVs as well as the other electric appliances.

A large percent of the overall electricity demand around the world is caused by Residential sector. Thereupon, the Home energy management (HEM) optimization has drawn attentions of many researchers. The changing role of the passive consumers in the electric power system into active is the key idea. Hence, the active participation of customers in energy transactions is done by manipulating the relating patterns of consumption and by optimizing available REs inside them which converts them to prosumers.

However, some reasons such as a sudden need for some appliances and frequent tracking of the order of Demand Response Programs (DRPs), can cause a phenomenon named “response fatigue” [6]. Hence, in the long-run, the return of some consumers to a default consumption pattern is expected. The dissatisfaction index is considered in the proposed Energy Management (EM) system. Which results in response fatigue avoidance.

There are lots of research works that have studied the EM by considering DR and from different points of view.

1.2 Literature review

The optimization of the energy management of a hybrid green residential complex in [7], which is composed of renewable resources, electric boiler/chiller and electrical storage is done by considering adaptive parking lots, responsive loads and home crypto miners. Since the accurate predictions are the perquisites of reliable operation of such structures, various parameters including solar radiation, local loads, arrival/departure time of vehicles, wind speed, initial charge of batteries and price of markets are modelled via scenario generation procedures firstly. Secondly, the risk analysis of decisions under the desired robustness level is done using the downside risk method.

A novel framework of energy management for HSS-based IPL is proposed in [8] which considers the risk management approach and demand response programs. The input parameters such as solar irradiation and its temperature, wind speed, energy tariff of the upper grid and IPL's demand, the uncertainties of which, are modelled using two strategies; the stochastic optimization method (SOM) and the stochastic p-robust optimization approach (SPROA). The SPROA is helpfulin modelling the risk-based form of the IPL in such a way that the total expected expenditure of the IPL and its maximum related regret (MRR) are minimized.

A MG in [9] , is formed by integration of a smart parking lot (SPL), local dispatchable generators (LDG) such as microturbines (MT) and fuel cells (FC) and renewable energy sources (RESs) such as wind turbines (WT) and (PV). Meanwhile, an energy management system considering the uncertainties of solar irradiation, wind speed and load consumption is presented in the study. In order to lower the costs, an optimal operation of the SPL serving as asource for load and energy generation of the distribution network, is done. Cost cutting measures such as time-of-use (TOU)-tariff based DRP is utilized which results in moving a part of load from on-peak to off-peak time intervals which in turn, flattens the load curve. The main purpose is the reduction of operational expenses of the upstream grid (UG), SPL and LDGs while the technical and physical constraints are present. Moreover, the uncertainty modelling method based on Hong's two-point estimate method was adopted for mitigating the uncertainties of load consumption and wind generation.

A real-time energy management strategy based on a deep reinforcement learning (DRL) model was proposed in [10], for controlling power and mass flow of ISPL according to the user's preference parameters, the retail price is set by DRLagent and a fuzzy logic controller of EVs subsystem responds to it. Furthermore, the adoption of detection load vectors which are obtained through interaction, improves the agent's perception of the real-time state of ISPL. Therefore, the system of ISPL is equipped with refined modelling, intelligent decision-making and real-time interactive perception.

The charging and discharging issue of electric vehicles in public parking lots is dealt with in [11] by maximizing the parking's benefit. An algorithm for controlled scheduling of charging/discharging is proposed. The sale (purchase) of energy from (for) electric vehicles at high (low)-price periods is guaranteed by the optimization procedure. By comparing the proposed method with two distinctive uncontrolled strategies including constant power-based scheduling and constant time-based scheduling, the efficiency of the proposed strategy can be achieved. The uncertainty of arrival and departure times and charge state of EVs is considered in the analysis approach. Furthermore, statistical methods have yielded the required data.

According to [12], a suitable model for energy management of the EVPL community is used for the operational scheduling of several PLs. besides the energy trading with each other, the PLs exchange energy with the PDGO for the purpose of maximizing their profit. The mixed-integer linear programming (MILP) problem model is solved via using stochastic programming and a simple additive weighting (SAW) method.

In [13], in order to test and approve the applicability of the proposed method in terms of simplicity, accuracy, independency preservation and not requiring any control or initial parameters, a three-area power network is chosen. The maximum yielded error in the chosen case study is 0.0009 pu. Also, voltage deviation and operation cost are the selected ~~o~~ fundamental objective functions. Their analysis is to be done both multi-objectively and solely. Moreover, distributed generators and soon-to-be-indispensable electric vehicle parking lots are also utilized. The operation cost is optimized up to 49.28% while that of voltage deviation is up to 48.99%.

The electricity fluctuation feasible region concept is suggested in [14] and the reliable evaluation of reserve declaration capacity is achieved. The feasibility of EV guidance between different PLs is considered, as well as the reserve the time scale of the market and the asynchronous problem of EV appointment interval. The effectiveness examination of the proposed model is carried out via Simulation verification, which results in the effective relieving of the congestion of PLs after introduction of the guidance model. Besides, the operation profit of PLs and the reserve declaration capacity are accordingly enhanced.

An SPL is proposed in [15] which is equipped with power and heat sources as well as storages, and includes renewable and non-renewable technologies such as micro-turbines, wind turbines, and generating facilities consisting of combined heat and power (CHP) plants which are locally installed SPL operator can supply its electricity for the power market sell and sell the heat which CHP units locally generate to this maximizes the profit. Moreover, the uncertain nature of EV arrivals and departures and the associated SOC level can be handled by the proposed model for the SPL. Wind-power output management and gauging optimal power prices can be an outcome of the proposed model too. The implementation of the hybrid robust-stochastic programming in a case study,confirms practicality and effectiveness of the model.

A transactive energy management system (EMS) for commercial parking lots is proposed in [16]. These lots possess rooftop PV system and EV charging system the objective of the optimization of the EMS is to balance the charging demand with supply. Factors such as battery degradation cost and photovoltaic levelized cost of energy are considered in order to give the EMS a more realistic look. Then, a communication is established between the EMS of each parking lot and the local trading agent. The data of energy requirement and excess energy initiate the proposed energy transaction mechanism. The flexibility of the double-sided auction bidding mechanism in terms of price and the energy requirement valuation of the parking lots are considered. Implementing the proposed scheme on a system consisting of six parking lots and 25 EVs in each of them results in cost savings in the range of 2% to 7% for different cases of feed-in tariff which is either fixed or variable. The cost savings variety from 2.41% to 12.09% and an average of 6.11% is attained by the uncertainty analysis. The case studies prove the economic benefit of the method that has been proposed.

Public transportation systems which are rail-based, have been integrated with electric vehicle (EV) parking lots in [17]. The new concept of “park and ride” strategy also includes energy production based on renewable resources. Different charging strategies supply the charging power demand of the EV parking lot in this structure. The existing unused energy infrastructure capacity and the regenerative braking energy of the railway system are considered. The design of a renewable energy production unit which is carport type and photovoltaic (PV) based, is also attained in the existing local parking area. Developing an optimal energy management system for the purpose of managing inputs in an effective way, is acquired. The pertaining uncertainties of EVs’ demand are considered too.

A real-time energy management model for an EV parking lot (EVPL) which is based on optimization, is proposed in [18]. Linear programming has been used in the proposed algorithm. A DR program which is oriented at limiting the peak load and provides operational flexibility, is offered the objective of this method is to maximize the load factor of the EVPL on a daily basis operation. The mobility of the EVs results in uncertain arrival/departure times. The generation of the state-of-energy levels upon their arrival is done through considering historical data and providing a more realistic approach.

The coupling relationship among the travel information of EVs and battery status have been considered in carrying out the intelligent grouping method proposed in [19]. The index of charging process contributes to establishing a charging/discharging priority model. At last, for the purpose of maximizing the penetration level of EVs under current conditions, a smart real-time energy management strategy is formed. The proposed strategy yields an increase in the maximum penetration level of EVs from 20% to 60%.

The operation of an integrated system which comprises an electric transportation system possessing a charging station which is battery-powered bus [electric bus (eBus)] and a PV generation based EV parking lot is proposed in [20]. The battery storage system (BSS) is used as a virtual energy hub (VEH). Furthermore, the strategy of a cooperative decision-making (CDM) is used for the VEH. A novel three-stage cooperative control system is used for the active and reactive power flows and the economic operation of the VEH.

A new algorithm based on day-ahead co-optimization is proposed in [21] which mitigates the unwanted effects that PEVs have on the power system. The minimization of cost of energy losses as well as transformer operating cost is done in this algorithm by simultaneous management of active and reactive powers. In addition, the effect of harmonics produced by the PEVs charger, is considered Furthermore, the operating cost of transformer is obtained by a method containing the transformer loss and loading cost as well as its purchase price. Power quality parameters improvement is another upside for this algorithm.

The minimization of micro-grids' operating cost and degradation cost of EV batteries, is the main aim of the proposed method in [22]. Besides, the resulting emission cost from the active and reactive power scheduling of EV parking lots containing photovoltaic (PV) systems and the optimum network configuration acquisition were the other goals. Because of some statistical assumptions, methods which relay on models are not able to appropriately consider uncertainties in EV users' behaviour. Nonetheless, data-driven methods based on generative adversarial networks (GAN) are employed in this paper for representing these uncertainties. The performance evaluation of the proposed method is done via its implementation on a real reconfigurable micro-grid.

This paper introduces an EMS model for the EVs station based on [23]. The EVs station is equipped with renewables and storage, while an aggregator is established for EVs charge/discharge station. The aggregated EMS model and P2P model result in Energy cost reduction of EVs station. Numerical studies with and without aggregator as well as P2P transactions have proved the increase in profit, especially from market balancing point of view.

1.3 Contributions

The optimal operation model of EVs station has been developed in this paper. As for the innovations, the following list is valid.

- Application of EMS for multi-EVs-stations system in order to guarantee the procumer benefits in coordinated structure.
- Development of P2P power transaction between EVs stations for uncertainty and variability management of load and renewables.

In the remainder of this paper, Section 2 expresses developed framework of energy management system problem. The coordinated model is given in Section 3. P2P power transaction between stations are expressed in Section 4. Section 5 and section 6 include the Simulation procedure and conclusions, respectively.

2. Energy Management System Framework

For the energy management system, The following decision variables are presented; the transferred power from the grid to station, $P_{\omega.t}^{G2S}$, the transferred power from the station to the grid, $P_{\omega.t}^{S2G}$, the charging and discharging powers of the EV and the station battery, $P_{\omega.t}^{S2V}$, $P_{\omega.t}^{V2S}$, $P_{\omega.t}^{S2B}$ and $P_{\omega.t}^{B2S}$, the On/Off state of controllable EVs, $x_{i.\omega.t}^{CEV}$.

$$\sum_{\omega} \mathrm{Prob}_{\omega} \sum_{t=1}^{T} \{P_{\omega.t}^{S2G}\lambda_t - P_{\omega.t}^{G2S}\lambda_t - (BAC_{t.\omega}^{B} + BAC_{t.\omega}^{EV}) + \mathrm{Inc}_t(P_{\omega.t}^{G2S} - P_{\omega.t}^{G2S.ini} + P_{\omega.t}^{S2G}) - \mathrm{Pen}_t(P_{\omega.t}^{G2S.ini} - P_{\omega.t}^{S2G} + P_{\omega.t}^{S2G,before}) - V_{\omega.t}\} \quad (1)$$

The selling income and purchasing cost of the station due to the energy trade with the grid, are respectively expressed by the first two terms. While the third term states the aging cost of the batteries due to their inherent cyclic operation. BAC_{ω}^{B} and BAC_{ω}^{EV} denote the battery costs relating to the battery and EV which are considered as wear for the mentioned modes resulting from the extra cycling nature of the batteries and are calculated by Eq. (2).

$$BAC_{t.\omega}^{X} = \alpha \cdot (r_{\omega.t}^{ch.X} + r_{\omega.t}^{dis.X}) \qquad X \in \{B.EV\} \quad (2)$$

$$\mathrm{Inct}_t(P_{\omega.t}^{G2S,after} - P_{\omega.t}^{G2S,befor} + P_{\omega.t}^{S2G})$$

presents the incentive income resulting from taking part in an incentive-based DRP. While, $\mathrm{Pen}_t(P_{\omega.t}^{G2S.Cont} - P_{\omega.t}^{S2G,after} + P_{\omega.t}^{S2G,befor})$ is the penalty cost for participation in the DRP. $P_{\omega.t}^{G2S,after} - P_{\omega.t}^{G2S,befor}$ is able to shows the energy transferred to the station when implemented tariff has a fixed-rate minus that of the applied incentive-based DRP. The term $\mathrm{Inct}_t(P_{\omega.t}^{S2G})$ is used for modelling the customer's incentive-based income (EVs in this paper) resulted from power injection back to the grid. Lastly, $V_{\omega.t}$ is a dissatisfaction modelling function for EVs owner as [23] due to variation from the initial consumption and is given by Eq. (3).

$$V_{\omega.t} = \sum_{i} v_i^{CEV} (P_{i.\omega.t}^{CEV} - P_{i.\omega.t}^{CEV.ini}) + v^{EV}[(P_{\omega.t}^{S2V} - P_{i.\omega.t}^{ini.S2V}) + (P_{i.\omega.t}^{ini.V2S} - P_{i.\omega.t}^{V2S})] \quad (3)$$

where $v_i^{CEV} > 0$ defines the load inelasticity parameter of controllable EVs [24, 25]. The amounts of v_i^{CEV} which are higher, are an indication of the operation of the ith EV at the initial time which is the most convenient time for the consumer.

The demand that contains the charging requirements of the batteries of Station (i.e. $P_{\omega.t}^{S2B}$) and EVs load is shown by Eq. (4).

This demand is either supplied by the wind and PV internal generation, or through the grid ($P_{\omega.t}^{G2S}$) or by the battery or Ev's energy.

$$P_{\omega.t}^{G2S} + P_{\omega.t}^{wind2S} + P_{\omega.t}^{PV2S} + Y_{\omega.t}^{B} P_{\omega.t}^{B2S} + \sum_{i=1}^{N_{EV}} Y_{i,\omega.t}^{EV} P_{\omega.t}^{V2S} = \sum_{i=1}^{N_{EV}} Z_{i,\omega.t}^{EV} P_{\omega.t}^{S2V} + Z_{\omega.t}^{B} P_{\omega.t}^{S2B} \quad (4)$$

$Y_{\omega.t}^{B}$ and $Z_{\omega.t}^{B}$ are the binary variables to guarantee the disability of a Station battery in simultaneous charging and discharging. Similarly, binary variables $Y_{i,\omega.t}^{EV}$ and $Z_{i,\omega.t}^{EV}$ guarantees the same for each EV as presented in Eq. (5).

$$Y_{i,\omega.t}^{X} + Z_{i,\omega.t}^{X} \leq 1 \qquad \forall t.\forall \omega, x \in \{B.EV\} \quad (5)$$

As in Eq. (6), the controllable part of Station demand is the Total consumption of controllable EVs, each of which's consumption, is considered to be equal to its nominal power. Therefore, each of the single EVs is controlled by determining the relating ON/OFF states, $x_{i.\omega.t}^{CEV}$. It should be mentioned that the EVs' operation is also considered to be a function of scenarios. Simply put, the EVs and operating the Station battery can cover the uncertainty of renewable energies.

$$P_{\omega.t}^{I/C} = \sum_{i} \{x_{i.\omega.t}^{CEV} (Y_{\omega.t}^{EV} - Z_{\omega.t}^{EV}) P_i^{Nom}\} \quad \forall t.\forall \omega \quad (6)$$

Inequality (7) states that the daily consumption of each controllable EVs is limited to the required consumption. It is noteworthy that this constraint cannot be extended for more than 24 hours, since the operation of EVs should be some times per day. Besides the considered dissatisfaction function,V_t, an operation time is considered to model the tendency of consumers for preserving the initial consumption pattern. This guarantees the charging of each controllable EVs in a given appropriate period for the inhabitants.

$$P_i^{Crit} \leq \sum_{t} \{P_{i.\omega.t}^{CEV}\} t \in T_i^{CEV}, \forall i.\forall \omega \quad (7)$$

The EMS must not switch off some EVs at working period. In other words, the operation period of each EV must be respected by the EMS system. Thereupon, Eq. (8) and Eq. (9) guarantee that all controllable EVs are continuously used in their inhabitant operation period.

$$Y_{i,\omega.t}^{EV} + \sum_{j=1}^{WC_i - 1} Z_{i,\omega.t+j}^{EV} \leq 1 \qquad \forall t.\forall i.\forall \omega \quad (8)$$

$$Z_{i,\omega.t}^{EV} - Y_{i,\omega.t}^{EV} = x_{i.\omega.t}^{CEV} - x_{i.\omega.t}^{CEV} \qquad \forall t.\forall i.\forall \omega \quad (9)$$

The model for the evaluation of the SOC variations in the station and EV batteries is described by Eq. (10).

$$SOC_{\omega.t}^{X} = SOC_{\omega.t-1}^{X} + Z_{\omega.t}^{X} \eta^{ch.X} \left(\frac{P_{\omega.t}^{S2X}}{Cap^X}\right) - Y_{\omega.t}^{X} \left(\frac{P_{\omega.t}^{X2S} + P_{\omega.t}^{X2G}}{\eta^{dis.X} Cap^X}\right) X \in \{B.EV\} \quad (10)$$

$$SOC^{min.X} \leq SOC_{\omega.t}^{X} \leq SOC^{max.X} \qquad X \in \{B.EV\} \quad (11)$$

$$r_{\omega.t}^{ch.X} = \frac{SOC_{\omega.t}^{X} - SOC_{\omega.t-1}^{X}}{\eta^{ch.X}} \qquad \forall t.\forall \omega, X \in \{B.EV\} \quad (12)$$

$$r_{\omega.t}^{dis.X} = (SOC_{\omega.t-1}^{X} - SOC_{\omega.t}^{X}) X \in \{B.EV\} \quad (13)$$

$$0 \leq r_{\omega.t}^{ch.X} \leq r^{ch.max.X} \qquad \forall t.\forall \omega, X \in \{B.EV\} \quad (14)$$

$$0 \leq r_{\omega.t}^{dis.X} \leq r^{dis.max.X} \qquad \forall t.\forall \omega, X \in \{B.EV\} \quad (15)$$

As stated by Eq. (10), the SOC at time $t - 1$, the injected energy to the battery and back to the grid and station at time t are the input variables of SOC the function of the battery at time t. in Inequality (11), the depth of discharge is limited and no overcharging of the battery is guaranteed. The constraint relating to the charging and discharging rates of Station and EV batteries are presented in Eq. (12) to Eq. (15).

As presented in Eq. (16), the power that is transferred to the grid can be achieved by addition of PV and wind generations as well as battery injections.

$$P_{\omega.t}^{S2G} = P_{\omega.t}^{wind} - P_{\omega.t}^{wind2S} + P_{\omega.t}^{PV} - P_{\omega.t}^{PV2S} + P_{\omega.t}^{B2S} + \sum_{i=1}^{N_{EV}} Y_{i,\omega.t}^{EV} P_{\omega.t}^{V2S} \quad \forall t.\forall\omega \tag{16}$$

$$Y_{\omega.t}^{S} P_{\omega.t}^{G2S} + Z_{\omega.t}^{S} P_{\omega.t}^{S2G} \le P^{C.max} \forall t.\forall\omega \tag{17}$$

$$Y_{\omega.t}^{S} + Z_{\omega.t}^{S} = 1 \qquad \forall t.\forall\omega \tag{18}$$

Eq. (17) limits the power transaction between grid and station. Also, equation Eq. (18) describes that the station may choose one direction for power transmission.

Also, in order to model the effect of uncertainty on the problem, the addition of risk index well-known as Conditional Value at Risk (CVaR) was done.

$$OF = (1-\beta) \times EQ(1) + CVaR \tag{19}$$

$$CVaR = \beta \times (£ - \frac{1}{1-\alpha} \sum_{\omega} \pi_{\omega} \times SW_{\omega} \tag{20}$$

In which α and β are the level for confidence and risk importance, respectively. Also, decision variables of CVaR, £ and SW_{ω}, are as follows:

$$£ - EQ(1)_{\omega} \le SW_{\omega} \tag{21}$$

$$SW_{\omega} \ge 0 \tag{22}$$

Nomenclature

subscribes

$after$	After DR application
B	Battery
BAC	Battery Aging Cost
$before$	Before DR application
$B2G$	Battery to grid
$B2S$	Battery to station
CEV	Controllable EV
ch	Charge
Cont	Contracted
$Crit$	Critical demand of EVs at station
dis	Discharge
EV	Electric vehicle
$G2S$	Grid to station
G2V	Grid to vehicle
I/C	Interruptible curtailable EVs
Nom	Nominal power of controllable EVs
PV	Photovoltaic
Req	Requisite power of controllable EV's
S	Station
$S2B$	Station to batteries
$S2G$	Station to grid
$S2V$	Station to vehicle
$V2G$	Vehicle to the grid
$V2S$	Vehicle to the Station

indices

i	Controllable EVs
t	Time
ω	Scenarios

Variables and parameters

Cap	Battery capacity
CW	Critical working period of the I/C
Inc	Incentive paid for demand curtailment
N	Number
P	Power
Pen	Penalty applied to demand who refuse DR adjustment
$Prob$	Probability of scenario
r	Charging/discharging rates of battery
SOC	State of charge
v	Inelasticity of demand
V	Dissatisfaction of EV consumers
WC	Working Cycle of EVs
x	Binary variable for controllable EVs
Y,Z	Binary variables for direct of transferred energy
α	Aging coefficient of battery duo to cyclic charge and discharge
η	Battery efficiency for charge and discharge
λ	Tariffs

3. Coordinated EM

The proposed EM model in the previous section can be aggregated in order to apply the proposed EM to multiple procumers. To this end, the profit of each procumers should be guaranteed in coordinated model due to uncertainty of renewable generation and load of each procumers. It is highly probable that the coordinated EM for multiple stations increases the profit of each station. The schematic of coordinated model for EM is depicted in Fig.1.

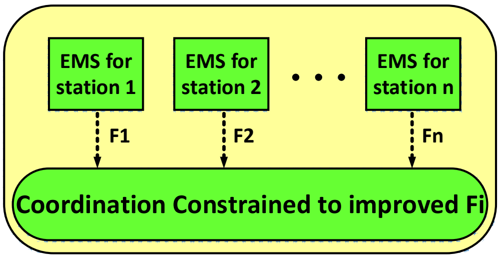


Fig .1. Coordinated EM model for Procumers

Two major matters of aggregation are as follows:

-Point 1: reduction of EVs station (as procumer) bill in coordinated model towards each of individual EMs.

- Point 2: If the summation of electric energy supply for multiple stations is set as objective function of coordinated model, some of stations are likely to experience an increase in cost and some may face a decrease.To ovoid this, minimum profit insurance as much as the profit of individually EM system application should be modelled as a constraint.

Hence, the coordinated (aggregated) model is developed as:

$$Min: \sum_{H=1}^{N_S} OF(S) \tag{23}$$

$$S.t: \tag{24}$$

$$Constraints(S)$$

$$OF(S) \le OF^{min}(S) \tag{25}$$

Where $Constraints(S)$are Eq. (2) to Eq. (22) for each station and $OF^{max}(S)$ is the optimal cost of each station in the individual EM application. Note that the added value of profit due to the aggregation is dedicated to the aggregator. Hence, the basic concept of aggregation is verified.

4. P2P Power Trading between stations

The main problem in this paper is to enhance EMS using P2P facilities. The addition of P2P energy transaction between stations to the EMS is done in this section. The traded power between the stations is as in [21]. However, other stations are as a black box from point of view of each station.

$$P_{j.k.t}^{Sout} = \sum_{l=1.l\neq j}^{N_S} P_{l.t}^{out}\ \forall j.t.k \tag{26}$$

$$P_{j.k.t}^{Sin} = \sum_{l=1.l\neq j}^{N_S} P_{l.t}^{in}\ \forall j.t.k \tag{27}$$

$$P_{j.t}^{Sout} = P_{j.t}^{in} \tag{28}$$

$$P_{j.t}^{Sin} = P_{j.t}^{out} \tag{29}$$

The power output and input summation of stations other than jth station, is determined by Eq. (26) and Eq. (27). Eq. (28) and Eq. (29) state that these summations are equal to the corresponding station (jth one) input/output, respectively. Therefore, the equation for power balance of each station after implementation of P2P transactions between MGs would be as follows:

$$P_{\omega.t}^{G2S} + P_{\omega.t}^{wind2S} + P_{\omega.t}^{PV2S} + Y_{\omega.t}^{B}P_{\omega.t}^{B2S} + \sum_{i=1}^{N_{EV}} Y_{i.\omega.t}^{EV}P_{\omega.t}^{V2S} + P_{S.\omega.t}^{in} = \sum_{i=1}^{N_{EV}} Z_{i,\omega.t}^{EV}P_{\omega.t}^{S2V} + Z_{\omega.t}^{B}P_{\omega.t}^{S2B} + P_{S.\omega.t}^{out} \tag{30}$$

5. Numerical Studies and Discussion

In order to investigate the proposed model, a Station in Italy is considered. All data for the case study is available in [25]. Two types of EVs have been considered as controllable EVs. First groups waiting capacity is three hours in morning and four hours in the evening. On the other hand, second group can wait for two hours. The departure time of these groups floats over a day.

5.1 Case-1

The first case study contains risk analysis for 10 scenarios and study of coordination of EMS considering P2P power transactions.

- Risk Analysis

Firstly, in order to validate the model and GAMS codes, the objective function has been depicted for different values of β in Fig.2.

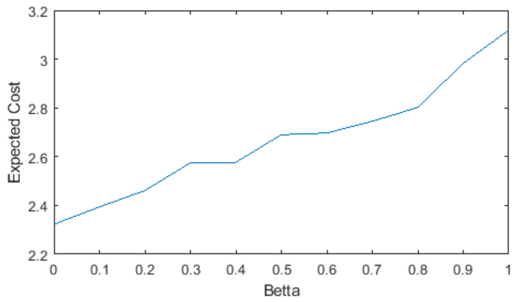
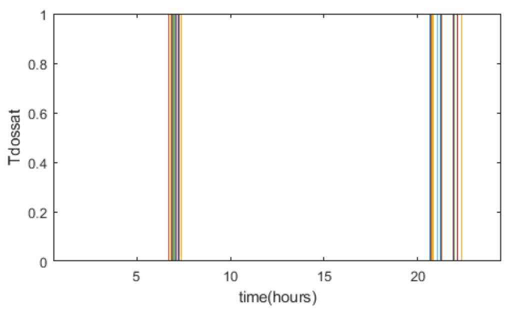
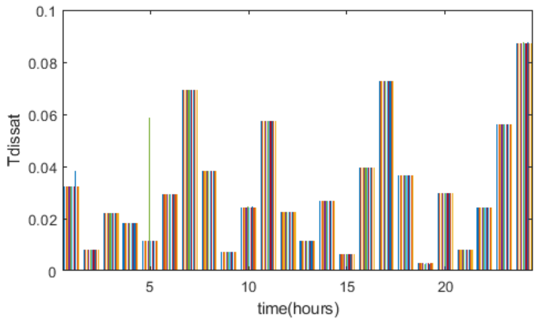


Fig.2. Expected objective VS β[23]



(a): First group of controllable EVs



(b): Second group of controllable EVs

Fig.3. Dissatisfaction time due to change in EV consumption pattern

Fig.3 shows the waiting time of station using due to participation in the load response program. Fig.3-a and Fig.3-b show this variable for the first and second group of controllable EVs, respectively. For critical EVs, this variable is equal to zero. Although the amount of penalty or inelasticity of critical EV loads is less than that of the controllable EVs, its working hours are limited and specific. Therefore, dissatisfaction cost calculation of the objective function, leads to significant difference in the amount of power consumed by the critical EV loads in case of interruption in the hours of need since its compensation is meaningless in other hours.

Another point in Fig.3 is that even though the dissatisfaction for the first EV group only exists in three hours of the day for some scenarios, its amount is 100%. For the second group of controllable EVs, while this lack of satisfaction was present at all hours and for all scenarios, its value is less than 10%. The first reason is that there are only two consumption periods considered for the first EV group during the 24 hours of the day and night (7-9 and 18-22). Therefore, it cannot be used at periods other than the above, and thereupon, it is possible to have non-zero values. Second, the changes in the common desired pattern for the first group of controllable EVs can be applied for a complete hour, therefore, the changes in its pattern is made as the changes of a complete hour at the desired consumption time. However, for the second group of controllable EVs, it is possible to be changed minutely therefore, the related values are not binary and any value between 0 and 1 is possible. The final point is that there is no difference between the scenarios for second group of controllable EVs, except for the two hours of 1 and 5, which shows the independence of the performance of this system from the change in scenarios of uncertain parameters.

- Coordination of EMS considering P2P transactions

The coordinated model verification has been done through application of coordinated EM in two cases, where first case contains three stations as an example and the large scale system as the main case study.

Case-1: three station example

Table.1 contains the comparison between the profit increments of the stations in this example.

Table 1. Profit enhancement in coordinated model

Station	Individual EM [23]	Aggregated EM	Profit Enhancement
1	2.444	2.445	0.199
2	2.692	2.716	0.024
3	2.747	2.784	0.037
Total	7.883	7.945	0.26

From table.1, it can be concluded that the coordination through aggregation by adding P2P transactions results in a more profitable EMS for consumers. Hence, the tendency of EV stations to take part in DR programs can be increased, as for the EV owners.

5.2 Case-2

In this case three scenarios based on the previous case and some modifications and extension to 30 EV stations, have been considered on a large scale system. Total wind and solar generation of stations are illustrated in Figure.4. Studied scenarios are as follows:

-Scenario 1: without EMS

-Scenario 2: with individual EMS

- Scenario 3: Coordinated EMS

The results of numerical studies consist of load profile and individual cost saving due to participation in EMS in the second and third scenarios. Figure.5 depicts load profile of three scenarios for 30 stations in three scenarios. Note that total EV load is about 3.7 MWh while total renewable generation of stations are about 0.55 MWh. However, there is a strong correlation between them. This may lead to more profitable P2P trading and no subsequent load dissatisfaction due to load shift.

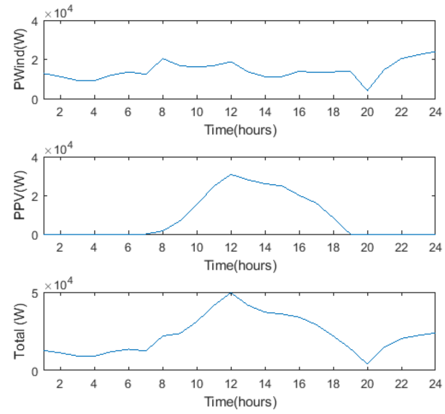


Fig.4. Wind and Solar generation

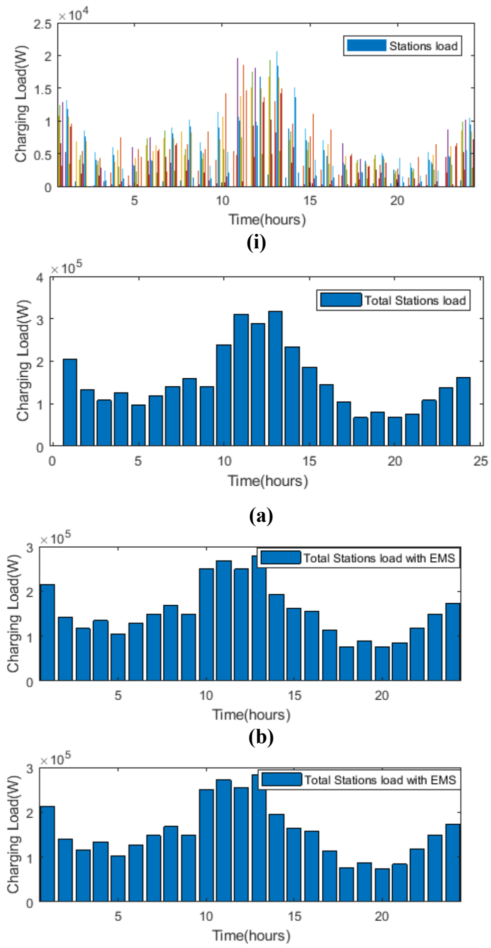


Fig.5. Charging Load in a day (i) and Load profile of three scenarios for 30 stations (a): First scenario, (b): Second scenario, (c): Third scenario

Figure.5 shows that the load in the second scenario is adapted to the electric price bought by stations with manipulated tariffs and EMS application in comparison to the scenario 1, while in third scenario P2P power trading results in more flexibility achievement by stations despite the equal price manipulation in comparison to the second scenario. It is noticeable that although there is little difference between charging load of scenario 3 and 2 (see Figure.6), valuable effect of this negligible difference will be shown in the following.

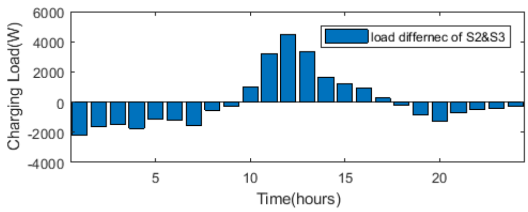


Fig.6. Difference of EV loads between scenarios 3 and 2

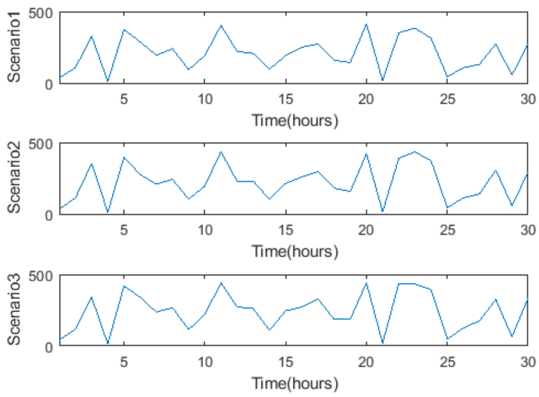


Fig.7. The comparison between income of stations in three scenarios ($)

Figure.7 depicts the comparison between incomes of stations in three scenarios. It can be concluded that the coordinated model is more profitable for entities as well as the operator of grid as it can alter the load more than individually EMS application. Total profit for three scenarios are 6216, 6523 and 7199 $.

6. Conclusion

Besides presenting the basic model of the energy management system, the cost risk modeling by CVaR as well as the coordination method modeling and methods and tools for solving, were proposed in this paper. Numerical studies for different states of the presented model including the basic verification study, increased risk as well as the coordination of the energy management system for several EV stations and studying its effect on the cost of subscribers in individual solution, have been conducted. The most significant outcomes of the paper are as follows:

• The reason that coordination results in the reduction of the supply cost of the total energy is to cover un flattens and uncertainties of the load curve and the production of renewable resources. For example, the intensity of changes in the load of the distribution network is greater than that of the transmission networks. Although the load of the transmission network is actually the sum of these highly variable loads the aggregation leads to a smoother load curve.

• Coordinated model participation will definitely be attractive for all stations due to the lower total cost ~~for~~ the station brought by this model. However, if the total cost increases by the coordinated application of the energy management system, its implementation would not be possible.

It is suggested to consider V2G in EMS in order to gain more profit in the stations and lower charging price of EVs.

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Optimal Scheduling of a Micro-grid through Hybrid Method of Nash Equilibrium –Genetic Algorithm

AmirKhanjanzadeh[1],Mohammad Hossein Salmani Yengejeh[2](Corresponding Author),MehdiRajabzadeh[3], Amir Hashempour Mafi [4],NasserMoslehi Milani [5]
[1] Department of Electrical Engineering,Chalous Branch, Islamic Azad University, Chalous, Iran
[2]Department of Mathematics, Chalous Branch, Islamic Azad University, Chalous, Iran
[3]Department of Computer Engineering, Chalous Branch, Islamic Azad University, Chalous, Iran
[4]Department of Computer Archelogy, Chalous Branch, Islamic Azad University, Chalous, Iran
[5]Department of Physics, Ahar Branch, Islamic Azad University, Ahar, Iran
Email: amirkhanjazadeh@gmail.com[1], salmani@iauc.ac.ir[2], Rajabzadeh.ad@gmail.com[3], hashempoormafi.amir@gmail.com[4]nmilani@gmail.com[5]

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Abstract

Increasing the use of fossil fuels and environmental concerns have led to the expansion of renewable resources and their replacement with conventional sources. In this paper, a robust algorithm for a micro-grid (MG) planning with the goal of maximizing profits is presented in day-ahead market. MG containing wind farms (WFs), photovoltaic (PV), fuel cell (FC), combined heat and power(CHP) units, tidal steam turbine (TST) and energy storage devices (ESDs). This algorithm is divided into two main parts:

1) *Optimal planning of each energy resource;*
2) *Using the Nash equilibrium –genetic algorithm (NE-GA) hybrid method to determine the optimal MG strategy.*

In energy resources optimal planning, using a stochastic formulation, the generation bids of each energy resource is determined in such a way that the profit of each one is maximized. Also, the constraints of renewable and load demands and selection the best method of demand response (DR) program are investigated.

Then the Nash equilibrium point is determined using the primary population produced in the previous step using the NE-GA hybrid method to determine the optimal MG strategy. Thus, using the ability of the genetic algorithm method, the Nash equilibrium point of the generation units is obtained at an acceptable time, and This means that none of the units are willing to change their strategy and that the optimal strategy is extracted. Comparison of results with previous studies shows that the expected profit in the proposed method is more than other method.

Keywords: micro-grid, Nash-Genetic hybrid method, wind farm, photovoltaic, combined heat and power, expected profit.

1. Introduction

Due to the fact that many Distribution Energy Resources, when used alone, do not have the capacity, flexibility and capability of controlling enough to carry out system management and market-oriented activities, these can be solved by forming a MG by a group of energy resources and removable loads [1-3]. In [1], Binary backtracking search algorithm optimization algorithm minimizes some objectives such as: the power generation cost, power losses, delivers reliable. In [2], fuzzy optimization is proposed to model the uncertainty in renewable energy resources. Wind power generation and market price uncertainties is modeled by using confidence bounds and scenarios, respectively in [3]. VPPs can participate in the wholesale market and collaborate on managing the transmission system. In this situation, distributed energy sources can take over the responsibility of delivering the system's protection services and play the role of centralized production [4-8]. In [8], the energy management system is considered as the heart of the virtual power plant, and the power distribution is aimed at minimizing the cost of generating electricity and final cost, reducing greenhouse gases; And to prevent loss of power generated by renewable sources, and to balance the electrical power flow, the water purifier and controllable loads have been used. In [9-11], the power plant and flexible loads have been integrated into the day-ahead electricity market in the form of a virtual power plant, and the mathematical model of these resources has been given. Flexible loads cover the uncertainty of wind power that its objective function is to maximize profits from market participation. In [12] explores the virtual power plant (VPP) management modes in providing different ancillary services such as loss reduction, voltage and frequency control, and power quality improvement. Also, load uncertainty and output power of renewable resources are considered, and wind output power and consumption forecasting error are modeled with Gaussian and normal function respectively, and the VPP is planning its distributed generation resources using the priority list. In [13], the VPP is regarded as a new solution for the management of distributed generations in the decentralized power system. It sends the quantity and price to the dispatch control center, where it predicts the load and cost of energy in each node connected to the power plant. In [14], the VPP operator will decide on the distribution of units per hour based on variable costs and repair and maintenance costs to provide electrical and thermal energy at a minimum cost. The VPP in this reference has the ability to generate heat and electricity, and its main goal is to minimize customers' electricity costs by considering network constraints. It also can exchange the electrical power with the main grid in instance price. In [15], the exploitation of the VPP is aimed at maximizing the revenue generated by the sale of power to final consumers. The reference [16] uses an optimization algorithm to reduce network congestion and imbalance between load and generation. In this algorithm, a large number of loads are combined with direct control in a MG and the load shedding is optimized over a certain control time interval. In the reference [17], the MG include a wind, solar, and gas power plant, and the plant will close profit-sharing contracts by closing bilateral contracts, and the issue is solved with integer linear planning. In reference [18], a VPP with a proposed strategy in the energy and reserve day-ahead markets has taken part that has been solved objective function consist of load and supply equilibrium constraints, distribution network security constraints and dispersed resource constraints. In reference [19], weekly scheduling includes a MG consisting of alternative renewable resources, a storage system, and a traditional power plant. The optimal distribution problem is formulated as a linear complex integer linear planning model, which maximizes the weekly earnings of a VPP with respect to long-term bilateral contracts and technical constraints. The uncertainty of wind power and solar power generation has been solved by using a pump-storage unit for flexible operation as well as having a conventional power plant as a backup production. In reference [20], the MG exchanges electricity in both day-ahead and balance markets and seeks to maximize expected profits. Uncertain parameters, including the output power of distributed generation and market price have been modeled through scenario based on Historical data. In reference [21], a probabilistic price based unit comment method has been used to model uncertainties in market prices and generation resource to propose a VPP in the day-ahead electricity market. In reference [22], a method is proposed to solve the problems of integration of large-scale distributed generation resources based on optimal power control algorithms. In [23], determining the pricing strategy of a VPP is proposed for participation in energy and reserve markets. In the reference [24] a new method for evaluating reliability has been developed and a VPP has been introduced to model MGs with renewable resources, and the reliability of the power plant has been investigated. Then, the Monte Carlo method is used to evaluate the reliability of active distribution systems by considering different operating modes under one or more incidents. The results show that using this model, a cost reduction of 50% is achieved. In the reference [25] modeling and testing of a VPP in the power system is performed. The purpose of this study is to plan the achievement of maximum revenue in the market. In [26], using a two-stage simulation, a complex of resources consist of CHP is scheduled in the day-ahead and real-time electricity market. In this system, real-time decision making power and heat is made and the goal is to achieve maximum power. In Ref. [27], using the game theory method, a method for dividing profits in VPPs including demand response loads has been performed in day-ahead and balance market. In this model, the uncertainty of market prices, renewable generations, consumption, and losses are considered. Reference [28] is a method for determining the optimal offer of a VPP consisting of a CHP and renewable energy sources and demand response loads. In this regard, three strategies have been investigated and the results show that the real-time pricing method is flexible and has a good performance. In [29], a method for planning a VPP unit, including renewable resources and loads with non-elastic characteristics in the electricity market is presented. The results of this study show that, by combining flexible resources with loads and renewable resources, system performance improves and the mathematical expected cost decreases. In [30], operational models of a set of VPPs are presented. In this model, the integrated multi-VPP management that is interrelated is examined; and income distribution between units is evaluated using game theory. In [31], the use of industrial flexible load and its planning in the power system has been investigated and various methods of this planning have been reviewed. In [32], the CHP planning and renewable resources in a distribution system has been investigated. In this regard, the planning problem has become a multi-objective planning problem and the objectives of the planning are to minimize costs and pollution. In [33], using a two-stage planning method, an optimal out-of-risk offer model for a VPP in the energy and spinning services market is presented, so that a risk value is considered for controlling the desired profit and the uncertainty of the renewable resources is taken into account, as well as the uncertainty caused by the load demands and reserves, is considered in the uncertainties of the day-ahead, reserve and balance market price. The goal of the VPPs plan is to maximize the profit in different markets. In [34], industrial VPP and its management have been studied, and it has been shown that profitability increases if a single management involves generators and loads in the form of a MG. Planning for this set is done in the short-term electricity market.

In this paper, the presented issue can be shortly explained as follows:

1. Prediction of uncertainties via hybrid method (HM) of WT-ANN-ICA.
2. Generating the scenarios of WS, tidal steam speed (TSS), PVPG, market price, electrical load demand and decreasing the scenarios with the scenario-reduction backward method, and modeling them through the tree scenario method.
3. Using the Nash equilibrium –genetic algorithm (NE-GA) hybrid method to determine the optimal MG strategy.
4. Studying the expected profit of energy resources with and without DR program.

2. The Proposed Method

An algorithm is proposed for programming generation and unit commitment of an MG including three WFs, one PV, one TST, one FC, two CHP units and ESDs considering NE-GA, Fig. (1). This flowchart has 6 steps including data receiving; uncertainties prediction; scenario generation and reduction process for stochastic parameters; extraction of energy resources profit; finding Nash equilibrium point using hybrid method of NE-GA; and the output results.

2.1. Uncertainties Prediction and Senario Generation

Load demands, wind speed, TSS, PVPG, and market price are considered to be stochastic in the modeling presented. To model such behaviors, Weibull and Normal probability distribution functions utilizing wavelet transform-artificial neural network-imperialist competitive algorithm [35] have been used to prediction and generate a number of scenarios for wind speed and other uncertainties (Load demands, TSS, PVPG, and market price), respectively. In this paper, this model is assumed to generate 100 scenarios for each parameter. To minimize the computation cost of the proposed scheduling procedure, k-means classification method [13] is used to reduce the number of applied scenarios to 10. The explanation of scenario generation and reduction processes is beyond the scope of this paper. As it can be seen in Fig. 2(a)–(e), different generated scenarios for the load demands, wind speed, TSS, PVPG, and market price e are illustrated, respectively.

2.2. Objective function of WFs, PV, TST, FC, CHP units and ESDs

In this study, the optimal scheduling of MG including WFs, PV, TST, FC, CHP units and ESDs is examined with the 24– hour time horizon as well as considering uncertainties and DR programs in order to maximize the expected profit. The multi-stage stochastic programing is applied to deal with uncertainties. Since the power generation of units should be determined before applying stochastic processes, they constitute the first or here-and-now decisions stages and do not depend on the scenarios. Other variables like buy or sell power from and to the market and charge or discharge of storage devices are at the second or wait-and-see decisions stage. This mixed integer nonlinear optimization problem is solved through MATLAB software.

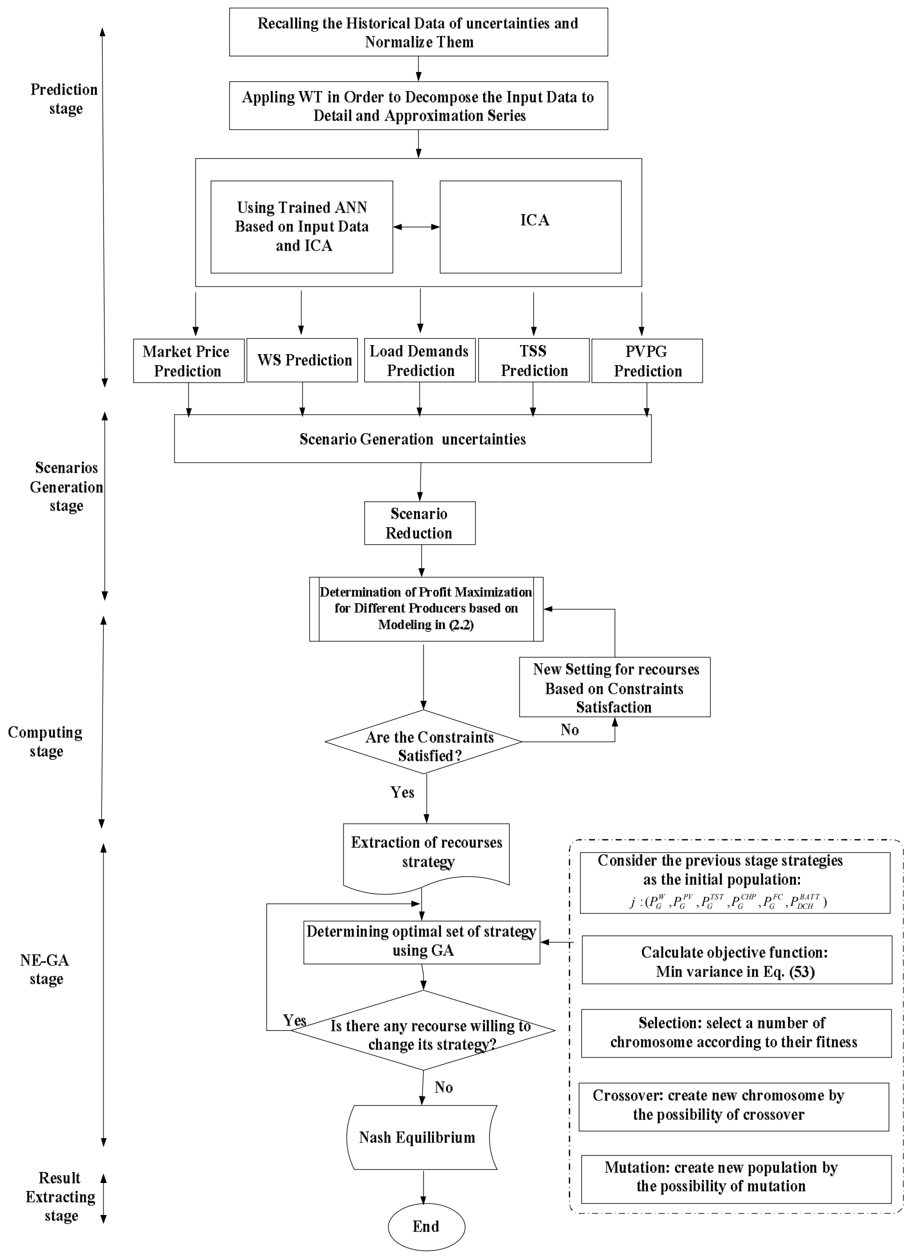


Fig. 1. The flowchart of the proposed method

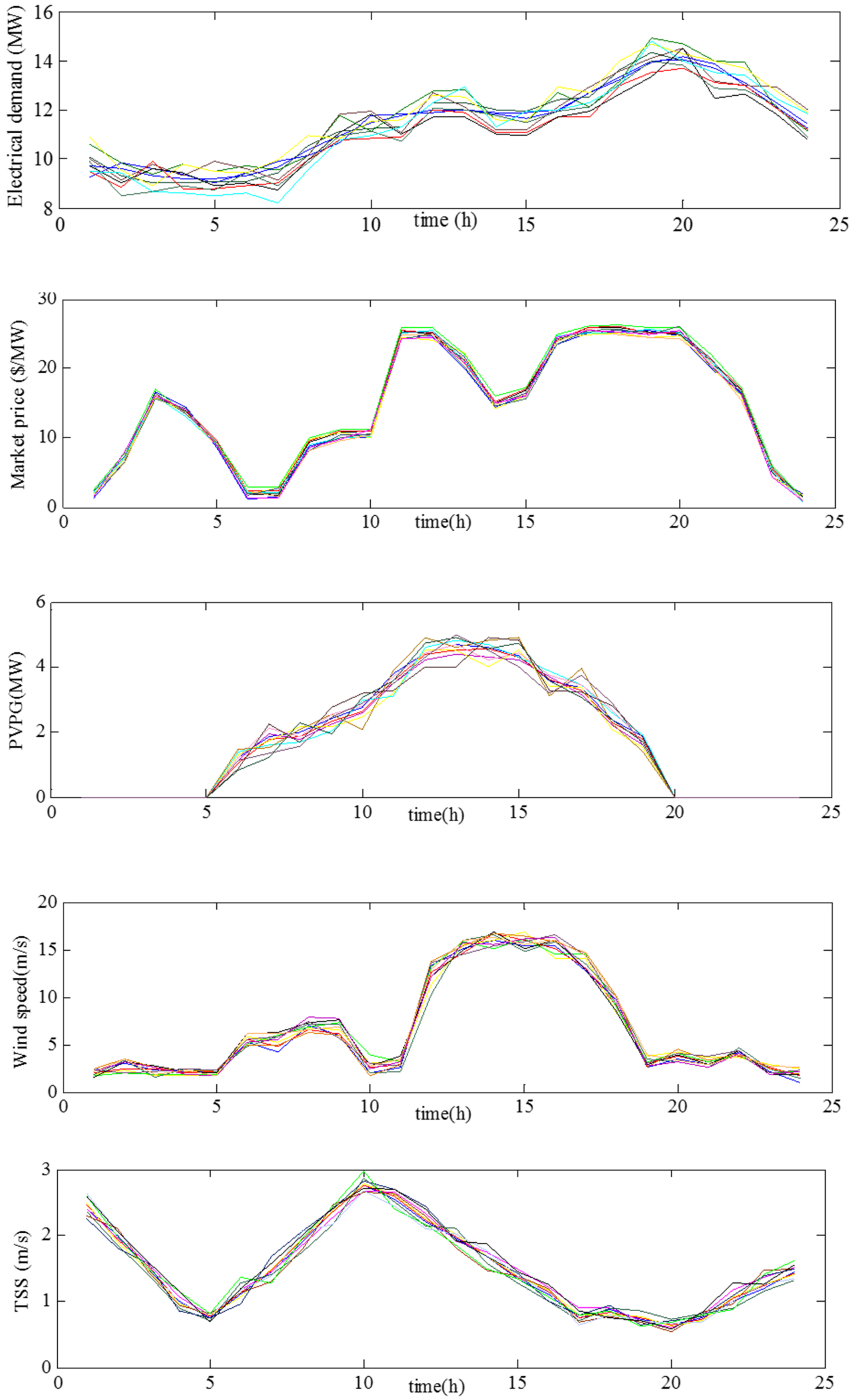


Fig. 2. The uncertainty scenario curves (a): Electrical demand, (b): Energy price, (c): PV power generation, (d): Wind speed, (e): Tidal steam speed.

$$MAX \qquad ER_T = \sum_{t=1}^{T} \rho_s [(P_G^i(s,t).E_P(s_p,t) - C_i(s,t)] \tag{1}$$

$$\rho_s = p_P \times \rho_W \times \rho_{TSS} \times \rho_{PV} \times \rho_{PL} \times \rho_{HL} \tag{2}$$

$$S = S_P, S_W, S_{PV}, S_{PL}, S_{HL}, S_{TSS} \tag{3}$$

$$C(W,t) = \sum_{W=1}^{W_N} A_W.M(W,t) \tag{4}$$

$$C(TST,t) = A_{TST}.M(TST,t) \tag{5}$$

$$C(s,CHP,t) = \sum_{CHP=1}^{CHP_N} [A_{CHP} + B_{CHP}.P_{G,CHP}(t) + C_{CHP}.P_{G,CHP}^2(t) + D_{CHP}.H_{G,CHP}^2(t) + E_{CHP}.H_{G,CHP}(t) + F_{CHP}.H(t).P(t)].M(CHP,t) + U_{COST}(CHP,t).SU(CHP,t) + D_{COST}(CHP,t).SD(CHP,t) \tag{6}$$

$$C(s_{PV},PV,t) = (A_{PV}. + [a^{CH}(PV)Z_{BATT}^{CH}(PV,t) + b^{CH}(PV)P_{BATT}^{CH}(s_{PV},PV,t)] + [a^{DCH}(PV)Z_{BATT}^{DCH} + b^{DCH}P_{BATT}^{DCH}(s_{PV},PV,t)]).M(PV,t) \tag{7}$$

$$C(s,K,t) = [[a^{CH}(K)Z_{BATT}^{CH}(K,t) + b^{CH}(K)P_{BATT}^{CH}(s,K,t)] + [a^{DCH}(K)Z_{BATT}^{DCH} + b^{DCH}P_{BATT}^{DCH}(s,K,t)] + CC(K)].M(K,t) \tag{8}$$

$$C(s,FC,t) = \left(A_{FC} + B_{FC}.P_G^{FC}(s,t)\right).M(FC,t) + U_{COST}(FC,t).SU(FC,t) + D_{COST}(FC,t).SD(FC,t) \tag{9}$$

$$SU(i,t) = M(i,t) \times (1 - M(i,t-1)) \qquad i \in CHP, FC, B \tag{10}$$

$$SD(i,t) = (1 - M(i,t)) \times M(i,t-1) \qquad i \in CHP, FC, B \tag{11}$$

$$P_{buy}(s,t) + \sum_{CHP=1}^{CHP_N} P_{G,CHP}(t) + P_G^{FC}(t) + \sum_{W=1}^{W_N} P_G^W(s_W,W,t) + P_{BATT}^{DCH}(s_{PV},PV,t) + P_G^{TST}(s_{TSS},TST,t) + P_{BATT}^{DCH}(s,K,t) = P_{sale}(s,t) + P_{BATT}^{CH}(s_{PV},PV,t) + P_{BATT}^{CH}(s,K,t) + \{(1 - DR(s,t).L_0(s,t) + L_{shift}(s,t)\} \tag{12}$$

2.2.1 Problem modeling

An optimal bidding strategy is modeled and analyzed. The objective function of this optimization problem applied for the first time is expressed as Eq. (1),where, is the probability of scenario s. According to Eq. (2), the probability of s-th scenario is obtained by multiplying the probabilities of WS, TSS, PVPG, market price, electrical load demand in each other. The function Ci is the total operation cost of each of unit defined in Eqs. (4-9). The objective function is to maximize the expected profit of each unit considering constraints related to unit usages. The startup and shut down constraints of CHP, FC, and boiler defined in Eqs. (10,11). The power balancing constraint of MG is obtained through Eq. (12). The other constrains related to DR programs, WFs, PV, TST, FC, CHP units and ESDs are reported by [35].

2.3 Nash equilibrium –genetic algorithm hybrid method

This paper presents a new method based on the combination of genetic algorithms to solve Nash problem and determine the optimum generation strategy of energy resources to maximize the profit. As mentioned, the energy resources intend to maximize their profit, so, there is no Agreement between the energy resources; and the game can be defined as a multi-player zero-sum one. Considering the relation between energy resources strategic, so, game theory is used for determining the optimum strategy and intelligent decisions.

2.3.1. Genetic Algorithm:

The genetic algorithm is an optimization method which uses Darwin's principle of natural selection for finding the optimum formula. In genetic algorithm, first, it is produced some answers for solving the problem recognized as the initial population, and each answer is recognized as a chromosome. Then, the appropriate number of chromosome pairs are selected according to their fitness rate to be used at the later steps. The chromosome, with higher fitness number, may be selected at the production steps several times, and then cross-over would be applied on the parents' chromosomes, and by composing them, it will be produced new chromosomes. Afterwards, the mutation would be applied on the chromosome resulted of cross-over, and will provide a new way for new information by changing the amount of chromosomes. Then fitness rate of new chromosomes are calculated in order to evaluate the children, and the new population is produced and evaluated. This process continues until the end condition of the algorithm to be provided.

2.3.2. Nash equilibrium

The concept of Nash equilibrium on which this paper is presented, is introduced for the games with two or more players, in which it is assumed that a player knows the strategies and pay-off of the other players, and he can obtain some pay-off just via his own choices and without directed imposition on the others'. John Nash tried to indicate that the result of relation between several players cannot be predicted, without considering them being together. There are many definitions for Nash equilibrium:

1)Nash equilibrium is a point in which none of the players cannot earn more profit by changing its own strategy when performance of the other players is fixed. In other words, xi is a Nash equilibrium point, if for each of the players we have:

$$\forall i: u_i(x_1*, x_2*, \ldots, x_i*, \ldots, x_n*) > u_i(x_1*, x_2*, \ldots, x_{i-1}*, x_i, x_{i+1}*, \ldots, x_n*) \quad (13)$$

Where xi means that the player xi is exited of the equilibrium point, and it will certainly lose.

2) Best response function of a player denotes the player best reaction (utility maximizing reaction) to any strategy profile chosen by other player. Player's best response function (correspondence) in a strategic game is the function that assigns to each a−i ∈ A−i the set:

$$BR(a_{-i}) = \{a_i \in A_i : u_i(a_i, a_{-i}) \geq u_i(a'_i, a_{-i}); \forall a'_i \in A_j\} \quad (14)$$

The action profile a∗ is a Nash equilibrium of a strategic game if and only if every player's action in this profile is the best response to the other player's actions (a∗−i):

$$ai^* \in BR(a - i^*) \qquad for \quad i = 1, ..., N \tag{15}$$

This function causes improving the time of calculation, especially, where the time is important. The presenting this paper is to obtain a strategy in which, if each of the players (energy resources) changed his strategy, he will lose; and this is precisely the concept of Nash point.

In this paper, to evaluate the performance of the proposed modeling, Evaluation Strategies (ES) such as profit maximization is considered as Eq. (16):

$$\begin{Bmatrix} p_G^{W*} \in \arg\max_{p_G^W} \left[ES(P_G^W, P_G^{PV*}, P_G^{TST*}, P_G^{CHP*}, P_G^{FC*}, P_{DCH}^{BATT*}, t).profit^W(t) \right] \\ p_G^{PV*} \in \arg\max_{p_G^{PV}} \left[ES(P_G^{W*}, P_G^{PV}, P_G^{TST*}, P_G^{CHP*}, P_G^{FC*}, P_{DCH}^{BATT*}, t).profit^{PV}(t) \right] \\ p_G^{TST*} \in \arg\max_{p_G^{TST}} \left[ES(P_G^{W*}, P_G^{PV*}, P_G^{TST}, P_G^{CHP*}, P_G^{FC*}, P_{DCH}^{BATT*}, t).profit^{TST}(t) \right] \\ p_G^{CHP*} \in \arg\max_{p_G^{CHP}} \left[ES(P_G^{W*}, P_G^{PV*}, P_G^{TST*}, P_G^{CHP}, P_G^{FC*}, P_{DCH}^{BATT*}, t).profit^{CHP}(t) \right] \\ p_G^{FC*} \in \arg\max_{p_G^{FC}} \left[ES(P_G^{W*}, P_G^{PV*}, P_G^{TST*}, P_G^{CHP*}, P_G^{FC}, P_{DCH}^{BATT*}, t).profit^{FC}(t) \right] \\ p_{DCH}^{BATT*} \in \arg\max_{p_{DCH}^{BATT}} \left[ES(P_G^{W*}, P_G^{PV*}, P_G^{TST*}, P_G^{CHP*}, P_G^{FC*}, P_{DCH}^{BATT}, t).profit^{BATT}(t) \right] \end{Bmatrix} \tag{16}$$

where, argmax f (•) is a subset of the definitional domain, which maximizes the function f (•), refers to the optimal bidding strategy of energy resources i, refer to is the profit obtained from energy resources at time t, is the jth evaluation strategy at time t, is a set of bidding strategy of MG.

To balance profit among energy resources and select the best bidding strategies, variance is presented as objective function [30]:

$$\min V = \sum_j (\overline{V} - V_j) \tag{17}$$

$$\overline{V} = \frac{1}{i}(V_1 + V_2 + \cdots + V_i) \tag{18}$$

$$V_i = \frac{\sum_{t=1}^{24} \left[ES(j,t).profit^i(t) \right]}{24 \times \max\left\{ ES(j,t).profit^i(t) \right\}} \tag{19}$$

3. Numerical Example

The structure of MG and numerical data concerned with energy resources are studied and then simulation results of optimal operation for the stochastic problem are analyzed.

Configuration of MG

In this article two case studies will be assessed:

1. Planning and determining the optimal strategy of MG energy resources connected to grid through NE-GA method,
2. Programming and determining the optimal strategy of MG connected to the grid and exploring the effect of DR problem on the profit of energy resources.

In cases 1 and 2, the MG is able to exchange energy through a grid based on electrical load demand and market price. Stochastic programming is applied on a typical MG, Fig. (3). The case studies are run on: three WFs, two CHP units, one TST, one PV, one low temperature fuel cell (PAFC), one electrical energy storage device together with the fixed and responsive electrical loads. The startup and shutdown costs of units are tabulated in Table 1. The heat buffer tank data and cost coefficients of CHP units are tabulated in Table 2. Both $DR_{\max}$ and $\varepsilon_{\max}$ are assumed 30%. The electrical-thermal characteristics of CHP units are displayed in Fig. (4). The parameters of WFs include: $WS_{co}(i) = 25^{m/s}$, $WS_n(i) = 11^{m/s}$, $WS_{ci}(i) = 2.5^{m/s}$ and the rated output power are equal to $P_{WN1} = 1.5^{MW}$, $P_{WN2,3} = 2.4^{MW}$. Historical data pertaining to the WS, electrical demand and market price, electrical energy storage devices data and photovoltaic power generation are proposed in [35]. The PV nominal power generation is $P^{MW}_{\max} = 4.68$, $P^{MW}_{\min} = 0$ and $\delta = 0.75$. Table (3) lists the parameters used for the tidal steam turbine [35].

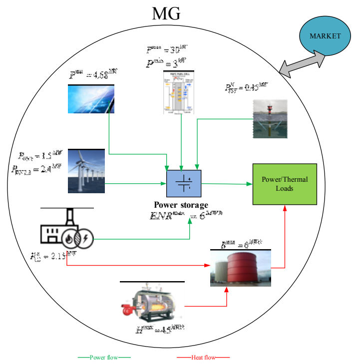


Fig. 3.Typical MG under study

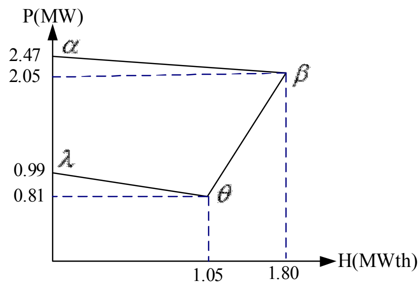


Fig.4. The electrical-thermal characteristic of CHP units

Table 1. The startup and shutdown cost of units

CHP units	A_{CHP}=0.0435	B_{CHP}=36	C_{CHP}=12.5	D_{CHP}=0.027	E_{CHP}=0.6	F_{CHP}=0.011
Heat Buffe Tank	$\eta_{loss} = 0.6$	$\eta_{gain} = 0.3$	σ=1%	$AH^{\max}_{discharde} =$ $AH^{\max}_{charge} = 2$	$AH_{\max} = 7$	$AH_{\min} = 0$

Table 2. The heat buffer tank data and cost coefficients of CHP units

Unit	UCOST	DCOST
CHP units	20	20
Fuel Cell	0.0207	0.0207
Boiler	9	9

Table 3. The tidal steam turbine data

Rated Speed	**2.4(m/s)**
Cut-in Speed	**0.7(m/s)**
Cut-out Speed	**4.2(m/s)**
Power Coefficient	**0.47**
Cross-sectional Area	**3.006(m^2)**

4. Simulation Results

Case Study 1: In the first case study, the effect of the proposed method on units planning and MG is studied by examining previous studies. Due to the fact that the MG is connected to grid, the MG management center in addition to providing its electrical and thermal load, has the ability to exchange electrical power with the main grid. So, although energy resources try to maximize their profits and determine the best strategy, the MG management center can also optimize its profit through power exchange. In Fig 5, the optimal generation bids of energy resources are shown using the proposed method for the WFs, TST, PV, FC, CHP, and the power exchanged between the MG and grid, respectively. These results are compared with the Ref. [35] (from the authors of this article). In the Ref. [35], there is no competition between resources in order to maximize its profit, and the objective of optimizing and determining the optimal strategy of the units is to maximize the profit of the MG. And this means that the owner of all production resources is MG, which is very difficult to realize this assumption. As shown in Fig 5-a, the WFs generation bids are shown in the 24-hour time horizons. Given the low cost of these units, the generation bids is at the maximum possible capacity based on wind speed. Similarly this trend for the TST unit is also in Fig 5-b. In the Fig 5-c, PV generation bids are shown. The energy storage devices of this unit have led to strategy changes relative to [35]. Which usually causes energy sales at hours with higher prices. In Fig 5-d, due to high generation costs in FC unit, usually power generation bids at the peak hours is higher in this unit, which simulation results also point to the same. In order to supply the MG heating load and the cost of generation of very high thermal power in the boiler, the generation of electric power in the CHP is dependent on the heating demand, so the generating bids of this unit is approximately the same as [35] that shown in Fig 5-e. The power of MG exchange with the grid using the proposed method in Fig 5-f will cause the power sales at peak hours and power purchases from the grid at low demand times and increase the profitability of the MG. In Table 4, the earned profit of units is compared using the proposed method and the Ref. [35]. Percentage of profit growth is related to the exchanged power between MG and grid, FC and PV unit with 9, 8 and 4.6 percent increase.

Table 4. Case study 1 results

	WFs	**TST**	**PV**	**FC**	**CHP units**	**Exchanged power**
Ref. [35]	1514.6	80.99	787.06	9.27	9155.2	647.12
NE-GA method	1537.1	81.72	823.48	10.01	9202.6	706.91

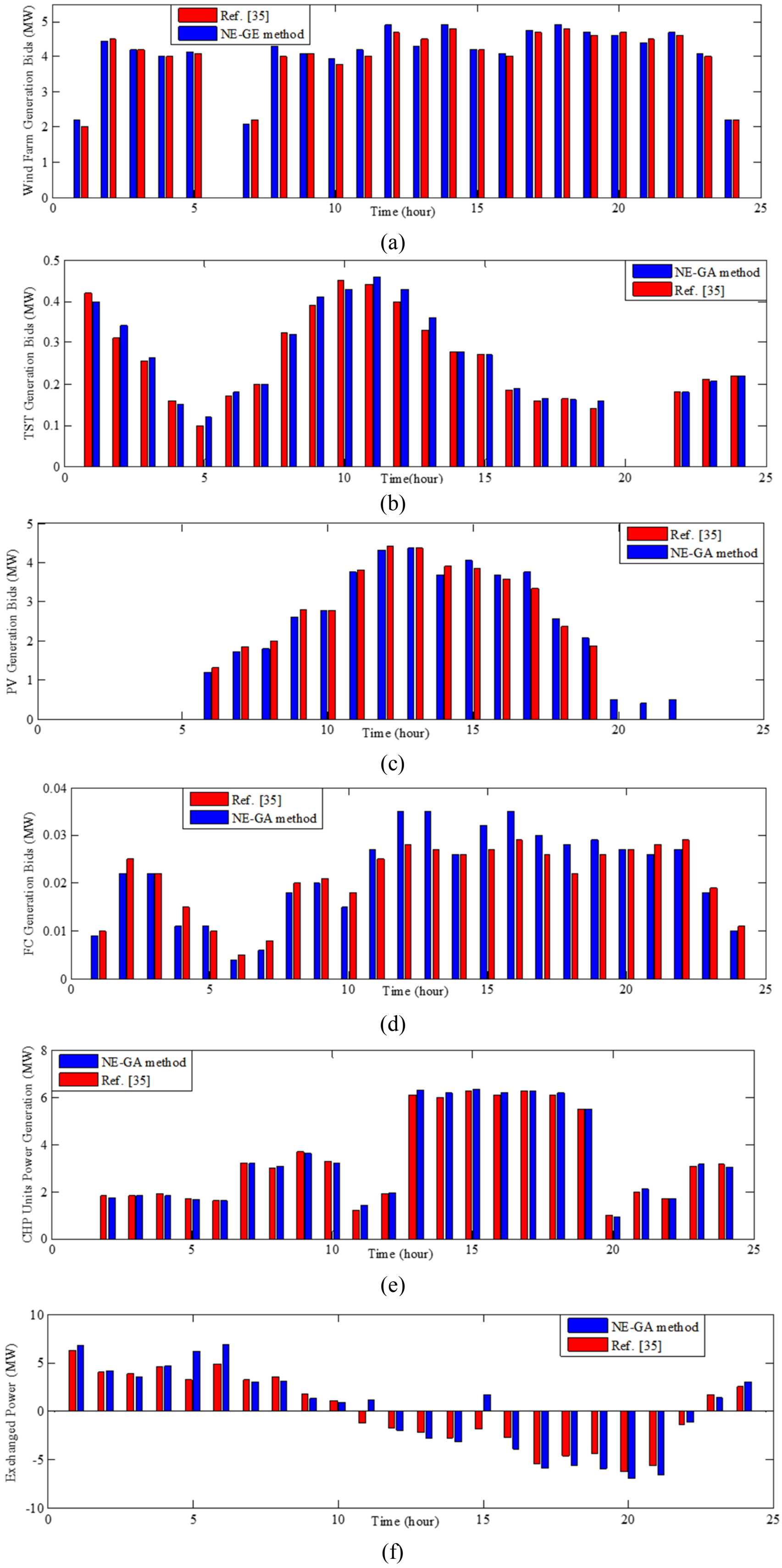


Fig. .5. The generated power of resources in the planning horizon

2. Case study 2: to explore the effect of DR program in determining of generation strategy of MG through NE-GA method. In this case, Critical Peak Pricing (CPP), Emergency Demand Response Program (EDRP) and CPP +EDRP methods are applied and energy resources can select the most appropriate method of DR program. In CPP method, the price of electricity varies according to the supply cost of electricity for different time periods; for example, a high price in a peak-load period; a medium price in an off-peak-load period; and a low-price in a low-load period. In EDRP programs, there are voluntary options and if customers do not interrupt their consumption, they are not penalized [34].

As it was mentioned before, there are different DR programs that can be used for the participation of interruptible loads in the scheduling problem. In this paper, 3 programs are used for this purpose. Based on this, 3 cases are considered to be examined in the proposed modeling. These are tabulated in Table 5.

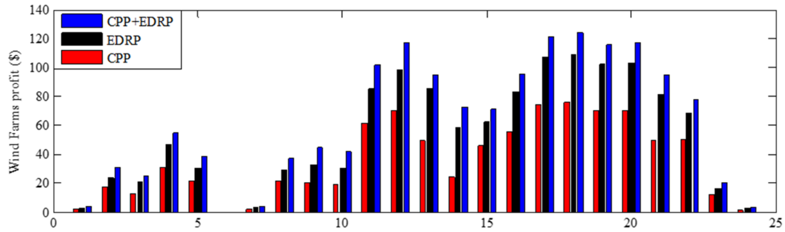
As it is shown in Fig. 6, the profit of different energy resources obtained in each DR program case is shown daily. This clarification concerns loads that have to select one DR program for their day-ahead scheduling and cannot choose another program based on the processes which are working in their properties. Thus, by using these figures, it can be found that the best DR program for achieving the maximum profit in a day can be obtained. Considering the energy resources profit in a day, it is obvious that CPP+EDRP and CPP are the most suitable programs for renewable and conventional units respectively. The value of DR participation in each energy resources is tabulated in Table 6. As it can be seen, units actively participate in DR strategies originated from scheduled and suitable shifting the load to achieve the most profit.

Table 5. Different DR programs

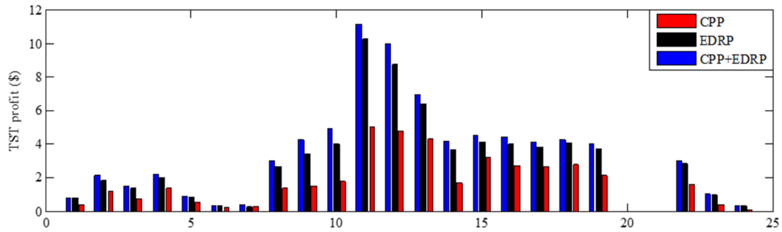
DR program type	Market price ($/MWh)	Incentive Value ($/MWh)
CPP	Scenario based on 20 $/MWh at 19 to 20	-
EDRP	Scenario based on 11 $/MWh at 10 to 16	16
CPP+EDRP	Scenario based on 20 $/MWh at 19 to 20 and 11 $/MWh at others	16

Table 6. Value of DR participation in each energy resources

Energy resources	Best DR program	Participation in market (MW)
WFs	CPP+EDRP	0.673
TST	CPP+EDRP	0.040
PV	CPP+EDRP	0.543
FC	CPP	0.0032
CHP	CPP	0.781
MG	CPP+EDRP	0.611



(a)



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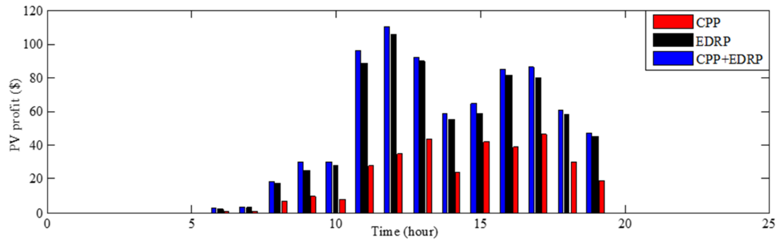
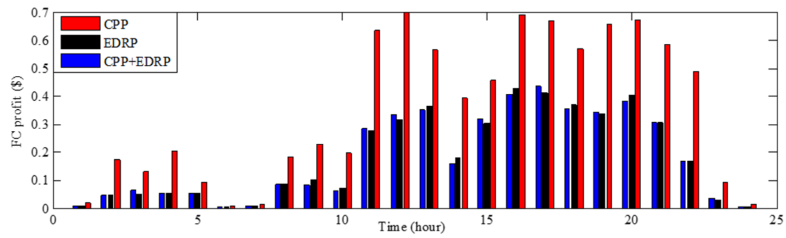


(c)



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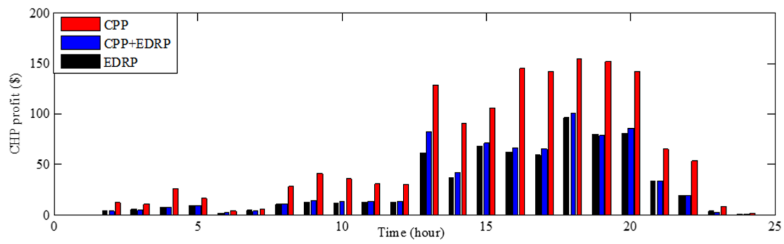
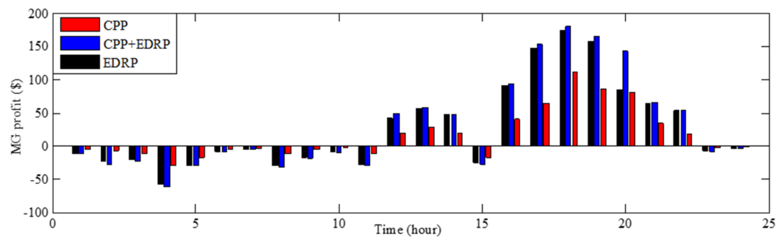


(e)



(f)

Fig .6. profit of different energy resources obtained in three DR program

4. Conclusions

In this paper, a new algorithm to manage energy resources of MG for scheduling issue has been considered. Firstly, the prediction and scenario generation of uncertainties are organized. Then, a new formulation to plan a day-ahead scheduling of MG is proposed. The model is presented as a stochastic mixed integer nonlinear programming optimization problem with regard to different generation, load, and system constraints. The objective of the problem is to maximize the profit of energy resources. This objective can be obtained Nash equilibrium point by the ability of the genetic algorithm.

Using proposed method, the profit growth related to the exchanged power between MG and grid, FC and PV unit with 9, 8 and 4.6 percent increased.

The obtained results show that the proposed modeling can be an appropriate way to have access to the maximum profit for energy resources with different DR programs. Considering results, it is obvious that CPP+EDRP and CPP are the most suitable DR programs for renewable and conventional units respectively.

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A Study of the Application of Artificial Intelligence in Human Resource Management

Mohammad Jodeiri Abbasi[1], Hassan Hajebi[2], Reza Fathipour[3], Younes Baghaei[4], Jalil jabarilotf[5]
[1,3,4,5]Department of Engineering, Ahar Branch, Islamic Azad University, Ahar, Iran.
[2]Department of Project Management, Ahar Branch, Islamic Azad University, Ahar, Iran.
Email: mohammad.jodeiri@iau.ac.ir (Corresponding Author)
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Abstract

Technology has changed the speed of development in all industries throughout the dynamic and competitive environment worldwide. Artificial intelligence is attributed to a technology that enables industry to develop more rapidly and accomplish achievements more effectively. This technology has entered different scientific fields such as finance, human resources, marketing, production, and Artificial intelligence system enables an organization to enhance its current efficacy. The exploitation of artificial intelligence technology in human resource management has had many challenges and advantages. The present study has tried to investigate about using artificial intelligence in human resource management. Artificial intelligence could easily be applied in all human resource processes. Currently, it is mostly used in recruitment processes, resume assessment, chatbots, and interviews. Many mega-corporations such as Microsoft, Google, and Unilever have been using this technology in their companies during some recent years in order to apply and develop it. The focus of the current study is on a probe of the application of artificial intelligence in human resource management and it was found that it has had a tremendous effect on human resource management issues.

Keywords: Technology, human resource management, organizations, artificial intelligence

1. Introduction

Using artificial intelligence in human resource management may be called the most astonishing event among recruitment scholars in the year 2018. The selection of artificial intelligence in human resource management can be called “a new era in human resources” in a way that artificial intelligence alters the usual and daily tasks carried out by human beings to change the recruitment business. The fourth industrial revolution has led to outstanding changes in different fields of science such as engineering, medicine, economics, social sciences, and management with the advent and development of novel technologies such as artificial intelligence, internet of things, big data, cloud computing, and block chains. These technologies have created many challenges and opportunities for the organizations through which the recognition and utilization of those technologies can affect the yield, reduce costs, and save time.

The acceptance of novel technologies has been so great that the new era has encountered with a principal change in many aspects. Industry 4 which is also known as the smart industry is considered as the fourth industrial revolution and has been posed by professor Class Shoab (the founder and the administrative manager of worldwide economy assembly) (9).

Smart human resource is a concept introduced within the emergence of industrial revolution 4. Smart human resource includes technologies such as artificial intelligence, internet of things, and big data used through human resource activities. Throughout the competitive environment in fourth industrial revolution, human resources play a vital role in organizations (12).

Digital human resources is attributed to a flexible approach to develop staff and to use the active role of digital environment in simulation of changes and effective use of the experiences and talents of the staff. Unlike the traditional ones, digital human resources focus on increasing the efficiency of the staff and the presentation of innovative resolutions and consider the employees as an asset that should be supported (10).

Artificial intelligence can help us in enhancement of human resource processes such as recruitment, services compensation, training, and developing the staff, decision making prediction, staff's exit prediction, and many others in an organization. The enhancement of human resource management efficiency through the use of artificial intelligence has been changed into an important process in developing the future human resource management trends (8).

Some of the capabilities of artificial intelligence for human resource management are as follows:

1) Automated performance of repeated tasks and saving time and the appropriation of time for more strategic works
2) Video analysis of the applicants and recognition of their face states, stress, topic awareness, body language, and effective communication capability through deep learning techniques and finally the selection of the best applicants for recruitment
3) Designing a supportive smart decision making system, using neural network techniques to create a just system for the assessment of wages and salary (3).

Therefore, regarding the importance, utilization trend, and the development of artificial intelligence inhuman resource management in many organizations and the international companies, we have tried through the present research to review the documentations and utilize digital human resource management to investigate about using artificial intelligence in different processes of human resources using data based human resources, advantages and tools in artificial intelligence in human resources. The results of the present study can help us in recognizing the vast use of this technology in Iranian organizations and companies.

In this study we have dealt with a complete review of the application of artificial intelligence in recruitment, training, services compensation, future staff behavior prediction, talent management, and performance assessment.

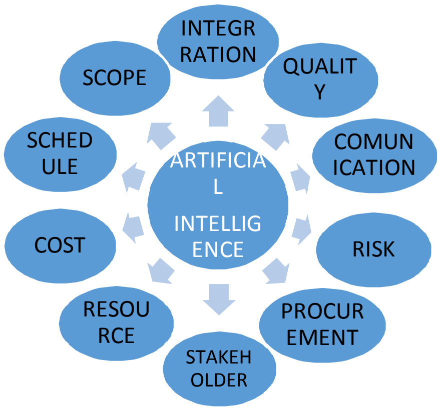


Fig.1. The impact of artificial intelligence on project management

The importance of artificial intelligence in project planning

A project consists of a set of tasks designed to achieve a specific goal. A project can be developing a new product or service, building a bridge or building, renovating a house, updating a data system, implementing a new business, etc.

Regardless of the nature and size of the assignment, every project manager strives to meet the project's objectives, i.e. deliver it within the set time and budget. Effective project planning paves the way for its success.

Project planning is one of the basic components of project management. Determines the scope of the project and determines the goals to achieve them. The project plan includes how to implement, monitor, control and close the project. The plan should include any project constraints, including costs, risks, resources, and deadlines. The project plan consists of six basic steps:

• Create task list
• Formation of the budget plan
• Preparation of risk management plan
• Produce a communication plan
• Preparing the project schedule
• Allocation of appropriate resources for appropriate tasks

Artificial intelligence-based tools help project managers perform various tasks at each stage of the project planning process. It also enables project managers to process complex project data and discover patterns that may affect project delivery. AI also automates most redundant tasks, thereby increasing employee engagement and productivity.

According to Gartner, artificial intelligence will eliminate 80% of the manual tasks of project management today by 2030. AI machines handle everything from programming to data collection, tracking to reporting, and more.

Artificial intelligence in project management

From scheduling to analyzing work team patterns, AI has become a clear advantage for project managers.

Here are some of the applications of artificial intelligence that help with the project management cycle:

Knowledge-based expert systems KBES system

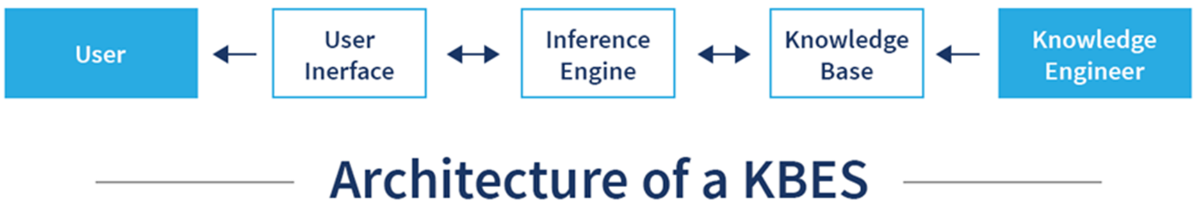
A knowledge-based expert system is a computer program that represents the knowledge and analytical skills of one or more human experts on a specific problem. This system captures the human expert's experience and encodes it into the computer so that any user can understand it.

The KBES architecture diagram

The knowledge engineer or human expert gives the information to KBES. This information is often declarative, for example, the expert states some facts, rules or relationships in the knowledge base. The inference engine then uses the knowledge base as a data file to determine knowledge and provide output.

2. Human Resource Management

When we speak about human resources, a project manager should make sure that all team members required are adjusted for the project development. He acts both as the leader and the manager. This means that the project manager should make sure that he has access to the required training team, development, materials and equipment, appropriate relationship between the beneficiaries, technical and spiritual supports and also he can get proper rewards for activities being developed and the climax of achievements he gets (14).



2.1 Planning and estimating human resources

Based on the report by Project Management Institute (2017), first the project manager is responsible to identify the intended project team members in project planning stage. Then he should recognize and identify the roles required by team members such as authorities, responsibilities and merits. Also he is responsible to estimate the required work force to carry out all the needed tasks.

To do so, project managers use a set of instruments and techniques to foster the decision making process which includes expert judges, bottom-up estimation, similar estimation, parametric estimation, data analysis, project management information system, and meetings. But he is not confined to what were proposed above.

The efforts carried out in planning and the different stages following that comprise the project have a great effect on increasing the success and efficiency of the project (1).

2.2 Human resource absorption

After making decisions on the required resources, it is the project manager who should absorb a team of experts with certain capabilities for investment in administration stages. To absorb the members for this team, the project managers make decisions using multiple variables analysis method to choose potential staff. These criteria include cost, capability, experience, knowledge, skill, outlook, and environmental factors related to geographical position, time zone, and the capability to create connections (14).

Fig.2. Systematization of artificial intelligence and recruitment of human resources

2.3 The development and management of human resource team:

When the required team is prepared, it is the project manager's responsibility to make sure to receive an appropriate development team that entails the improvement of team merits, team environment, and the interactions among team members.

To guarantee high throughput and output for each team, the project manager should make sure that the appropriate training and merit development have been guaranteed for project team. This can be achieved through preparing online classes, couching sessions or instructions, or even in service training (14).

Communication is another important factor that should be included in team management because it lets the project manager to follow team development, to present in time and outstanding feedback, and also he can make sure that the team members get all required emotional and technical supports and cultivate their sacrifice (14). The inclusion of team members in decision making sessions and during team making activities can enhance relationships.

The creation of appropriate work environment to increase the satisfaction and performance of the staff and applying the required changes in the team are highly important in projects. The project managers can present the challenges and opportunities, feedback and in time support when required, and recognize and reward for good performance (14).

The study carried out by Thamhain (11) showed that the appropriation of challenging professional tasks and the presentation of proper support for project teams increase their commitment and reduces communication obstacles and fight dangers and enhance the overall project team performance. Also the project manager should assess the development and quality of the works during team management because it provides an understanding of the weak points and strengths of a team or a member of a certain team.

3. Research Method

The present study is a documentary review of the research carried out in the field regarding the use of artificial intelligence in human resource printed in international journals. Based on the major goal in the present research which deals with the identification of the use of artificial intelligence in human resource management, the studies carried out since 2017 and included in different databases were investigated (Wiley, Sage, Science Web, Google scholar, digital human resource (HR), Artificial Intelligence (AI) and human resource (HR)). To search for the related literature in the field required to carry out the current study during one month, the following keywords were searched in databases mentioned: artificial intelligence and human resource management, data driven HR, AI, AI tools in HR.

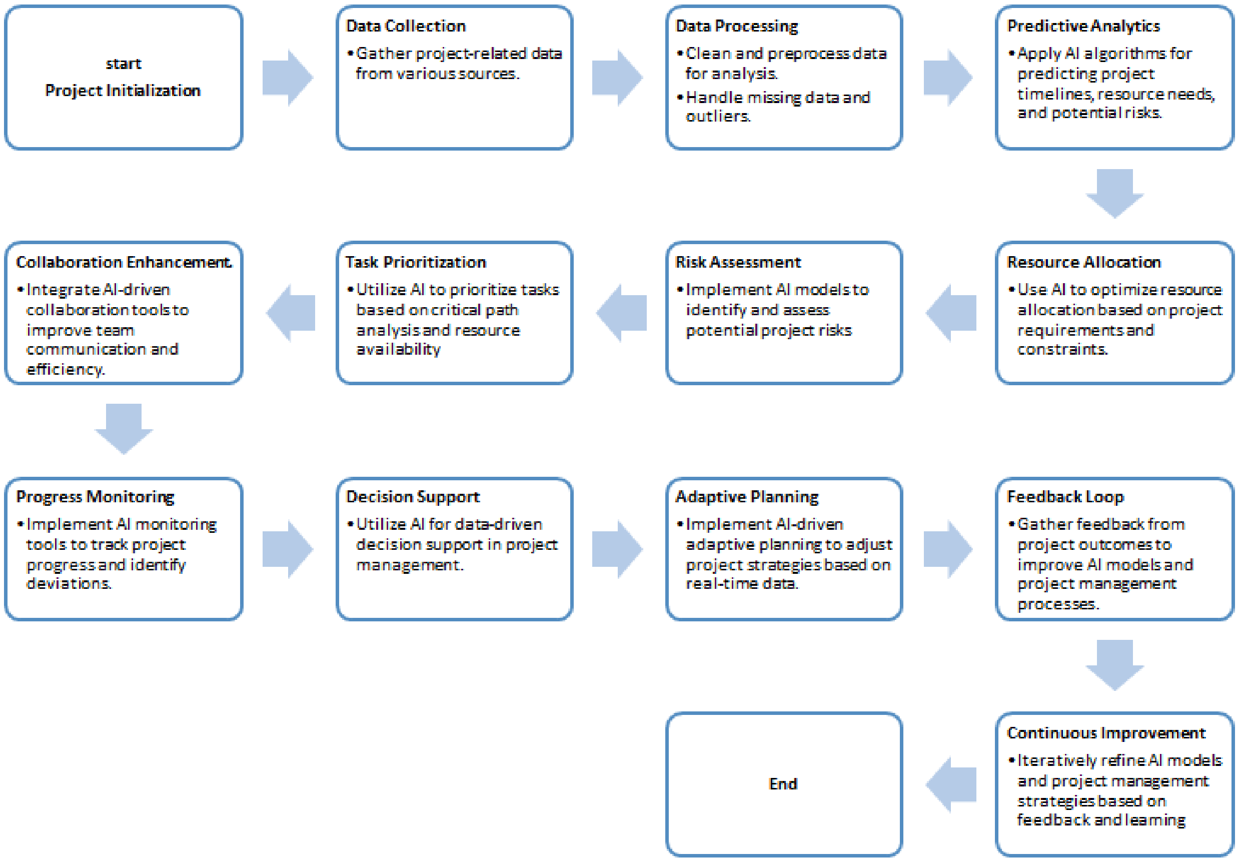


Fig.3. AI in project management flowchart

4. Findings

Artificial intelligence exists everywhere. It includes smart and driverless vehicles to communication bots that talk with customers without the customers being informed that they are not talking with a human being (5). Tom Stechora, the vice for talent recognition and individuals' analysis in IBM Company has explained artificial intelligence as: "it is a facilitator that helps us to present appropriate talent in time and achieve personality" (2). From among the subcategories of artificial intelligence we can refer to machine learning, deep learning, natural language processing, and neural networks each of which can help us in some of human resource processes. According to the studies carried out in the field, 76 percent of organizations believe that artificial intelligence has had a considerable effect on workforce absorption and this has resulted in artificial intelligence being considered as a necessary tool in human resource (7). The use of artificial intelligence in human resource is different from what is done in reality. This technology helps human beings to understand staff instead of controlling them. This technology can lead to higher yields and greater satisfaction of the staff and reduces their job leave (8).

In table 1, some of effects of artificial intelligence on human resource management related to peruse and post use stages of the utilization have been mentioned.

Table 1: The effects of artificial intelligence and some of human resource processes (4)

Process	Before using artificial intelligence	After using artificial intelligence
Recruitment	- Time consuming - Manual Bias in decision making in some cases	- Increasing recruitment quality - Saving the time and cost - Decision making without bias
Training and development	- Training through experienced professors Longer time and longer processes - Very costly - Low feedback	- Individualization of training through machine learning - High speed training - Accessibility of feedback at anytime - Low costs
Services consumption	- Unjust payment system - Group rewards - Delays in processing - High operational costs	- Just payment system - Reward individualization - Payment flexibility - Reduction of costs
Performance management	- Low information - Delays in performance time - Bias - Gender inequality	Collection of data from different sources - Real time assessment capability - Deletion of psychological bias - Reduction of gender discrimination
Preservation	Lack of appropriate supervision on staff's needs - Payment differences	The analysis of consumption for staff's services to recognize the needs of the staff - Reduction of differences in payments

There are many tools created based on artificial intelligence that are used to carry out the processes related to recruitment. In table 2, a number of these tools are introduced briefly.

Table 2: Tools utilized in recruitment processes

Software name	The major function	The technique used
Hirevue	Doing interview for recruitment	Natural Language Processing
Mye	Automated recruitment, interview time appointment, doing interview, assessing the applicants, communication through chat bots	Natural Language Processing and machine learning
Zoho	Resumes' management, finding staffs, communication with different recruitment channels, doing interview	Machine learning and Natural Language Processing
MyInterview	Automatic interview with recruitment applicants	Machine learning
Visume	Finding staffs, assessment and selection of appropriate individuals for the organization and proper to absorb the talented individuals	Robot, Machine learning and Natural Language Processing
Vervoe	Ranking the applicants and comparing them with millions of the data related to other applicants and automated recruitment through assigning algorithms	Machine learning and Natural Language Processing
Hyreo	An assistance for the applicants to communicate with employers through using chat bots	Machine learning and Natural Language Processing
Pymetrics	Behavioral assessment of applicants based on emotions, notices, efforts, fairness, concentration and learning, tool designing based on ethics and fairness in recruitment	Machine learning

5. Discussion and Conclusions

During some recent years, artificial intelligence has been able to get notice of some big and advanced organizations in order to make benefits from this technology. Findings of the present study showed that artificial intelligence has been vastly utilizedin human resource management. This technology can be used in processes such as: recruitment, training, salary and wages, performance assessment, prediction, and data based decision making. Artificial intelligence has great capabilities in recruitment and makes the recruitmentincumbents to appropriate less time and cost to achieve more appropriate recruitment results. Through the use of this technology a high volume of resumes could be screened and unrelated resumes could be deleted using it and only the staffs with certain qualifications to get employed by the organization are considered to be interviewed. Additionally, using natural language processing techniques and platforms based on artificial intelligence, we can interview the applicants and select the best individuals for the jobs asked along with recognition of the applicants' stress, dominance, and anxieties. Also artificial intelligence is able to communicate with the staff permanently through communication bots and respond their common and repeated questions regarding issues such as how to ask for off days, how to compensate the services, and how to recognize assessment indexes automatically.

It could be predicted that artificial intelligence will be considered more seriously in future by big organizations, specifically those organizations that propose information technology services and strategies required in human resource management. Also, it could be predicted that in future we will encounter the deletion of jobs such as: secretaries, telephone operators, typists, translators, and secretariat incumbents who have monotonous and repeated works. On the other hand, in future we can observe the creation of jobs such as human resource analyst, intelligence and human resource specialists, and emotion analysts.

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Comparison of Artificial Intelligence Methods on the Performance of an Energy Conversion Cycle

Sarang Ezazi[1]
[1]Department of Mechanical Engineering, Ahar Branch, Islamic Azad University, Ahar, Iran.
Email: sa.ezazi@iau.ac.ir(Corresponding author)

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Abstract

In the present research, the performance of a double absorption heat transformer is investigated through the Variable Metric and the Conjugate Directions methods. The main desired parameters to optimize are COP, ECOP, and exergy destruction. The results showed no considerable difference in COP, ECOP, and total exergy destruction rate achieved by the two methods. Besides, it was clear that, the design of the condenser and the absorber is very important. On the other hand, for the exergy destruction rate of components in some cases, the first algorithm performed better, while in other cases, the second algorithm did. Computer programming is accomplished through the EES.

Keywords: COP, DAHT, ECOP, exergy destruction, optimization

1. Introduction

In recent decades, the optimal using of energy has been an essential issue due to their limited resources. One of the most desirable energy-saving devices that run on thermal energy at low or medium temperatures is the Absorption Heat Transformer [1]. Absorption heat converters have low electrical energy consumption, which leads to a reduction in the emission of pollutants such as carbon dioxide [2].

A type of double absorption heat transformer, which had been experimentally constructed by Mostofizadeh et al. [3], and is known as the third type DAHT, was theoretically investigated by Zhao et al. [4], which performed a higher COP when compared to formers. A new cycle for mono-absorption and double-absorption systems based on heat reabsorption from solution and refrigerant lines was introduced by Hernandez et al. [5], which has a lower working pressure than the existing converters, but its performance factor is also reduced. Wakim et al. [6], simulated the single absorption model to eliminate the contradictions of previous studies and obtained different results, including the presence of an extremum point in the curve of the coefficient of performance towards the increase in the temperature of the absorber. Wang et al. [7], through an advanced and economic exergy analysis by simulation method showed that only 21.28% of the exergy destruction rate could be avoided by improving the cycle efficiency. Mahmoudi et al. [8], performed a thermodynamic analysis on a proposed cogeneration cycle, and they estimated the minimum cost of the total product unit of \$42.6/GJ, the maximum exergy efficiency of 27.9%, and the maximum mass flow rate of distilled water of 0.53kg/s. Tang et al. [9], investigated the performance improvement of a new cycle, which is designed by adding an AHT to the supercritical carbon dioxide Brayton cycle, and showed 4.96% higher exergy efficiency when compared to the critical carbon dioxide cycle. Ezazi et al. [10], proposed five new cycles for the double absorption heat transformer and analyzed their energy efficiency and exergy efficiency compared with the third type of double absorption heat transformer.

A cycle including single absorption heat transformer, vapor absorption refrigeration, and a humidification-dehumidification-desalination system was presented by Beniwal et al. [11]. The thermodynamic performance of the system has been investigated in terms of coefficient of performance, refrigeration temperature, and the amount of distilled water production. Aulido et al. [12], used the artificial intelligence technique to calculate the absorption temperature in the second stage in a two-stage absorption converter by controlling the refrigerant flows based on the calculation of the flow ratio in both stages. Liu et al. [13] proposed a new cycle including heat exchanger and refrigeration cycles for cooling using a low-temperature source, so that, results showed the proposed system has a great potential to receive low-grade heat and create refrigeration below 15°C. With a broader look at the technical literature, it is clear that finding the optimal working conditions has always been on the minds of researchers.

In the present research, the third type double absorption heat transformer has been chosen due to its wide application. Then the optimization has been conducted to determine the optimal working conditions from COP, ECOP, and exergy destruction aspects, which is a concern for researchers.

2. Performance Description

An impure water desalination system attached to a third type of DAHT introduced by Khamooshi et al., [14] is shown in Fig. 1.

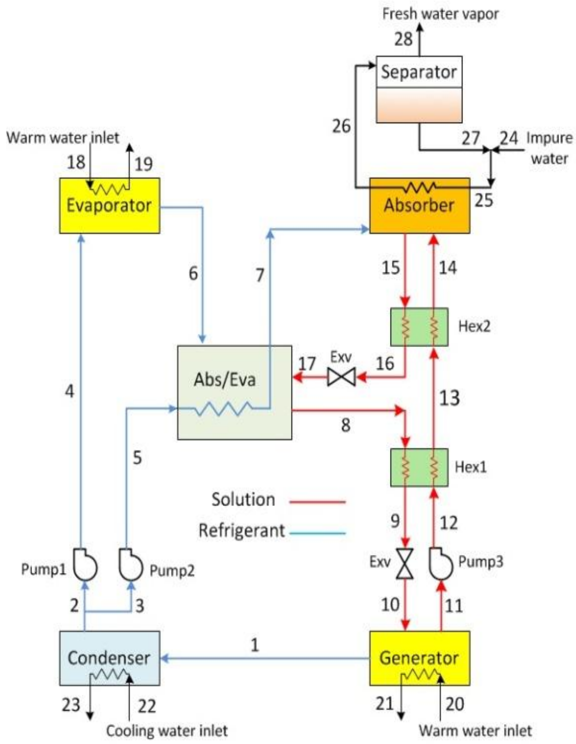

Fig.1.Schematic diagram of a DAHT coupled to a desalination system.

In the mentioned system, the wasted heat energy from industrial processes, Q_{Gen}, feeds generator at a relatively low temperature, T_{Gen}, to vaporize a portion of water refrigerant from LiBr_H_2O solution. The refrigerant flows to condenser where a phase change to saturated liquid occurs. Then, the condensed refrigerant is divided into two flow lines. One portion is pumped to evaporator, where receives a quantity of the waste heat, Q_{Eva}, at an intermediate temperature, T_{Eva}, and becomes saturated vapor.

The other portion flows to Abs\Eva via a pump at a higher pressure to produce steam at a higher temperature, $T_{Abs\backslash Eva}$. The steam in absorber will be absorbed to strong solution coming from the generator at a higher temperature, T_{Abs}. This is an exothermic process in which, desired thermal energy, Q_{Abs}, at higher temperature, T_{Abs}, is released. In addition, the strong solution already recovered some heat through two heat exchangers towards the absorber. The output weak solution from the absorber flows to the absorber-evaporator to absorb the saturated vapor that comes from the evaporator. The recent process, is exothermic and some heat is produced, $Q_{Abs\backslash Eva}$, through it too. Impure water from outside of DAHT receives the Q_{Abs} and becomes partially evaporated. Finally, desired pure fresh water vapor is extracted through a separator.

3. Simulation

Assumptions, input parameters, and basic equations needed for modeling are presented in this part.3.1. Assumptions

Some assumptions are consideredas follows:

(1) All processes are under steady conditions [2,3,5,10,13,14].

(2) Changes in kinetic and potential energies are neglected.

(3) The Pressure drop because of friction in the piping system and components is ignored [2,3,4,5,14].

(4) Heat transfer to the environment is ignored for all components.

(5) The Solution is saturated at the generatorand the absorber outlet. Refrigerant is saturated at the evaporator and condenser outlet [2,3,4,5,10].

(6) The input energy of the cycles issupplied from a heat source withtemperature range of 90~100°C [3,10].

(7) The amount of input heat energysupplied to the evaporator is assumed to be the same in all cycles andtemperatures of the generator and theevaporator are equal [3,10].

The input parameters of modeling besides related ranges are presented inTable 1.

Table 1. Input parameters

parameter	value
T_{con} (°C)	20~30
$T_{eva}= T_{gen}$ (°C)	80~90
$T_{abs/eva}$ (°C)	105~115
T_{abs} (°C)	130~165
$T_{heat\ source}$ (°C)	T_{eva}+10
Max. mass rate of heat source (kg/s)	20
$T_{cooling\ water}$ (°C)	T_{con}-4
Mass flow rate of cooling water (kg/s)	13.8
η_{HEX} (%)	80

3.2.Evaluation of performance

It should be noticed that, each component of the cycle, is considered as a control volume to evaluate the thermodynamic performance. Subsequently,the principle of conservation of mass and energy is considered in each case through equations 1 to 3.

$$\sum \dot{m}_{in} = \sum \dot{m}_{out} \tag{1}$$

$$\sum \dot{m}_{in} x_{in} = \sum \dot{m}_{out} x_{out} \tag{2}$$

$$\dot{Q}_{cv} + \sum \dot{m}_{in} h_{in} = \sum \dot{m}_{out} h_{out} + \dot{W}_{cv} \tag{3}$$

Based on the first law of thermodynamics, the energy performance coefficient, as in equation 4indicates the ability to upgrade the input thermal energy, in absorption cycles [7,10].

$$COP = \frac{\dot{Q}_{abs}}{\dot{Q}_{eva} + \dot{Q}_{gen}} \quad (4)$$

Based on the second law of thermodynamics, the ratio of output thermal exergy to input thermal exergy, is defined as the exergy performance coefficient, as in equation 5 [15,16].

$$ECOP = \frac{\dot{Q}_{abs}(1 - \frac{T_\circ}{T_{abs}})}{\dot{Q}_{eva}(1 - \frac{T_\circ}{T_{eva}}) + \dot{Q}_{gen}(1 - \frac{T_\circ}{T_{gen}})} \quad (5)$$

The amount of heat energy required for water desalination is another significant parameter, which is given through relation 6 [14].

$$\dot{Q}_{utilized} = \dot{m}_{25}(h_{26} - h_{25}) \quad (6)$$

Another important parameter in the performance evaluation of the absorption heat transformer is the exergy destruction rate, which always should be tried to be minimized and is defined by equation number 7 [17].

$$E\dot{x}_D = T_o \dot{S}_G \quad (7)$$

The equations related to energy conservation of the cycle of Figure 1 are expressed in Table 2.

Table 2. Energy equations

Item	Equation
Con	$\dot{Q}_{con} = \dot{m}_2 h_2 + \dot{m}_3 h_3 - \dot{m}_1 h_1 = \dot{m}_{22}(h_{23} - h_{22})$
Eva	$\dot{Q}_{eva} = \dot{m}_4(h_6 - h_4) = \dot{m}_{18}(h_{18} - h_{19})$
Gen	$\dot{Q}_{gen} = \dot{m}_1 h_1 + \dot{m}_{11} h_{11} - \dot{m}_8 h_{10} = \dot{m}_{20}(h_{20} - h_{21})$
Abs\Eva	$\dot{Q}_{abs\_eva} = \dot{m}_8 h_8 - \dot{m}_2 h_6 - \dot{m}_{15} h_{17} = \dot{m}_3(h_7 - h_5)$
Abs	$\dot{Q}_{abs} = \dot{m}_{15} h_{15} + \dot{m}_3 h_7 - \dot{m}_{11} h_{14} = \dot{m}_{25}(h_{26} - h_{25})$
Hex 1	$T_{13} = T_{12} + (T_8 - T_{12})\eta_{Hex1}$ $\dot{Q}_{Hex1} = \dot{m}_8(h_8 + h_9) = \dot{m}_{12}(h_{13} - h_{12})$
Hex2	$T_{14} = T_{15} + (T_{15} - T_{13})\eta_{Hex2}$ $\dot{Q}_{Hex2} = \dot{m}_{15}(h_{15} + h_{16}) = \dot{m}_{13}(h_{14} - h_{13})$
Exv	$h_i = h_e$

Equations of exergy destruction rate of the cycle are expressed in Table3.

Table 3. Energy destruction rate equations

Item	Equation
Con	$E\dot{x}_D = T_o(\dot{m}_2 s_2 + \dot{m}_3 s_3 - \dot{m}_1 s_1 - \dot{m}_{22} s_{22} + \dot{m}_{23} s_{23})$
Eva	$E\dot{x}_D = T_o(\dot{m}_6 s_6 + \dot{m}_{19} s_{19} - \dot{m}_4 s_4 - \dot{m}_{18} s_{18})$
Gen	$E\dot{x}_D = T_o(\dot{m}_1 s_1 + \dot{m}_{11} s_{11} - \dot{m}_{10} s_{10} + \dot{m}_{21} s_{21} - \dot{m}_{20} s_{20})$
Abs\Eva	$E\dot{x}_D = T_o(\dot{m}_8 s_8 + \dot{m}_7 s_7 - \dot{m}_5 s_5 - \dot{m}_{17} s_{17} - \dot{m}_6 s_6)$
Abs	$E\dot{x}_D = T_o(\dot{m}_{15} s_{15} + \dot{m}_{26} s_{26} - \dot{m}_{25} s_{25} + \dot{m}_{14} s_{14} - \dot{m}_7 s_7)$
Hex 1	$E\dot{x}_D = T_o(\dot{m}_{13} s_{13} + \dot{m}_9 s_9 - \dot{m}_{12} s_{12} - \dot{m}_8 s_8)$
Hex2	$E\dot{x}_D = T_o(\dot{m}_{13} s_{13} + \dot{m}_9 s_9 - \dot{m}_{12} s_{12} - \dot{m}_8 s_8)$
Exv	$E\dot{x}_D = T_o(\dot{m}_{10} s_{10} - \dot{m}_9 s_9)$
Exv	$E\dot{x}_D = T_o(\dot{m}_{17} s_{17} - \dot{m}_{16} s_{16})$

3.3. Optimization

The optimization is carried out to achieve the maximum amount of COP, ECOP, and the minimum amount of exergy destruction rate of the DAHT cycle in the present study. Two different optimization algorithms are used for this purpose.The first algorithm is the Variable Metric method and the second algorithm is the Conjugate Directions method.

The temperature of the absorber, evaporator, generator, and condenser are considered as independent variables by the limits defined in Table 1. The simulation has been done through the EES [18].

4.Result

4.1. Validation of the results

In order to validate the thermodynamic analysis, the results of the present study in a specific case are compared to the results of Khamooshi et al. [14], and are presented in Figure 2.

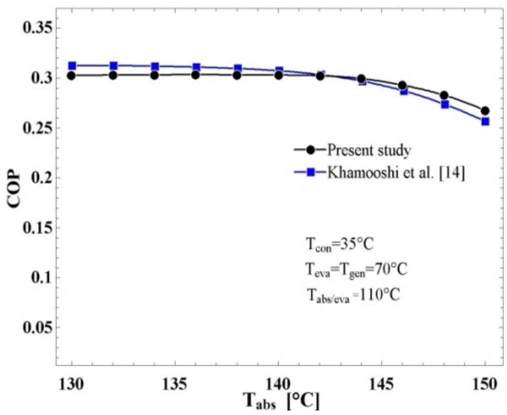

Fig. 2. Validation chart for thermodynamic analysis

4.2. Results of thermidynamic analysis

This section provides an in-depth analysis of how the operating conditions of the cycle components influence its overall performance.

Additionally, it includes a comprehensive presentation of the optimization results derived from these operating conditions.

Figure 3 illustrates how the coefficient of performance is affected by raising the absorber temperature. It is clear that the maximum value of the COP of the third type DAHT occurs in the temperature range between 150-165°C.

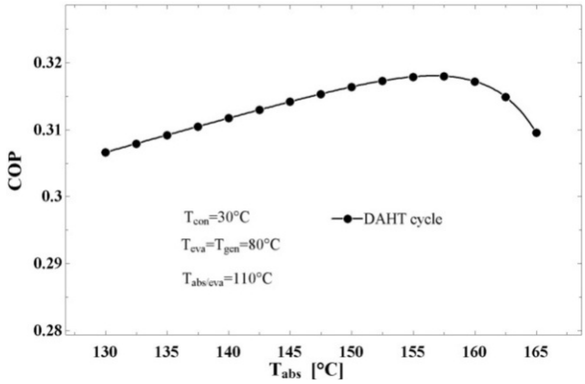

Fig. 3. The effect of the absorber temperature on the COP

Figure 4, shows the effect of absorber temperature increase on ECOP. It is observed that the exergy coefficient of performance has a similar behavior tothe energy coefficient of performance.

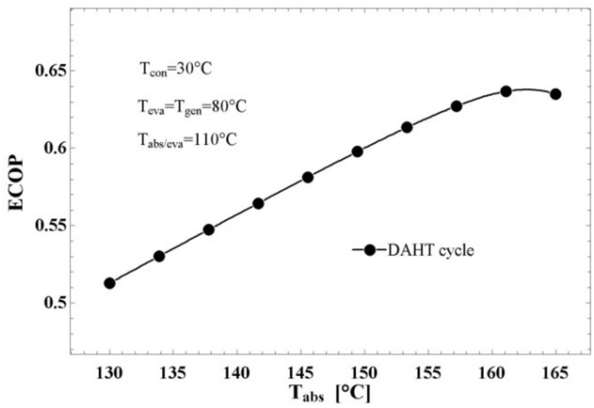

Fig. 4. The effect of the absorber temperature on the ECOP

Figure 5, shows how produced heat will be affected by absorber temperature.

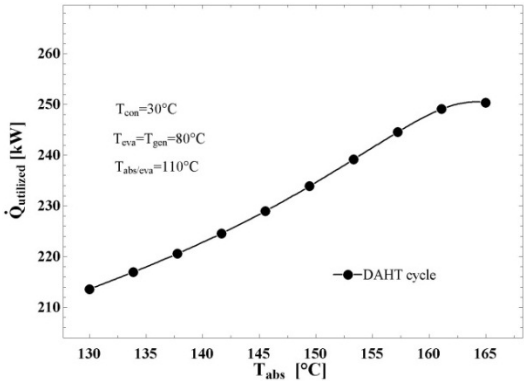

Fig. 5. The effect of the absorber temperature on the produced heat

A summary of the operation of the cycle is shown in Figures 3 to 5. But, the main aim of the study is to find optimum performance conditions through two different methods. Subsequently, the results are shown in Tables 4 to 10.

The maximum COP that is achieved through optimization is shown in Table 4.

Table 4. Simulation results for COP

	T_{Abs} (°C)	T_{Gen} (°C)	T_{Con} (°C)	COP
V.M. meth.	165	90	20	0.3317
C.D. meth.	165	90	22.38	0.3318

As observed, there is a negligible difference in COP between two methods. However, the temperature of condenser has an increase of about 11.9% revealing the importance of condenser design.

Table 5. Simulation results for ECOP

	T_{Abs} (°C)	T_{Gen} (°C)	T_{Con} (°C)	ECOP
V.M. meth.	165	80	21.16	0.66787
C.D. meth.	165	80	20	0.669

The results of Table 5 show the difference in ECOP is negligible through two methods. However, the temperature of condenser has decreased by about 5.48% which reveals the importance of the condenser design.

Table 6. Simulation results for exergy destruction rate of absorber

	T_{Abs} (°C)	T_{Gen} (°C)	T_{Con} (°C)	$Ex_{D, abs}$ (kW)
V.M. meth.	160	80	25	1.621
C.D. meth.	130	80	30	0.9677

From Table 6, the exergy destruction rate of the absorber has an increase of about 40.3% and the condenser temperature difference is about 20%. But the point is that the absorber temperature is low by conjugate direction algorithm that is more logical, Because, it is clear that the temperature increase results in more exergy destruction.

Table 7. Simulation results for exergy destruction rate of evaporator

	T_{Abs} (°C)	T_{Gen} (°C)	T_{Con} (°C)	$Ex_{D, eva}$ (kW)
V.M. meth.	160	80	30	0.2562
C.D. meth.	163	80	30	0.2562

According to Table 7, it is clear that there is no difference in exergy destruction rate of the evaporator. But the temperature of the absorber has an increase of 1.87% which is sufficiently little.

Table 8. Simulation results for exergy destruction rate of generator

	T_{Abs} (°C)	T_{Gen} (°C)	T_{Con} (°C)	$Ex_{D, gen}$ (kW)
V.M. meth.	160	80	25.03	1.112
C.D. meth.	165	80	30	0.6472

From Table 8, the conjugate direction method resulted in, the higher temperature in the absorber and condenser the less exergy destruction in the generator, while, the generator temperature is constant.

This is not a correct scientific fact. Therefore, the first algorithm gives better results in this case.

Table 9. Simulation results for exergy destruction rate of condenser

	T_{Abs} (°C)	T_{Gen} (°C)	T_{Con} (°C)	$Ex_{D, con}$ (kW)
V.M. meth.	160	80	25	0.04138
C.D. meth.	165	80	30	0.00152

Results show in Table 9, that the higher the temperature in the condenser the less energy destruction in the condenser itself. This is strongly false.

Table 10. Simulation results for exergy destruction rate of total cycle

	T_{Abs} (°C)	T_{Gen} (°C)	T_{Con} (°C)	$Ex_{D, con}$ (kW)
V.M. meth.	130	80	30	3.393
C.D. meth.	129	80	30	3.394

According to Table 10, the same results are achieved for the exergy destruction rate of the total cycle. In other words, both algorithms demonstrated similar performance.

5. Conclusion

In the present research, the performance of a double absorption heat transformer has been optimized from COP, ECOP, and exergy destruction rate points of view through two different algorithms. The results showed no considerable difference in COP, ECOP, and total exergy destruction rate achieved by the two methods. However, for the exergy destruction rate of components in some cases, the first algorithm performed better, while in other cases, the second algorithm did. Therefore, a consensus on the effectiveness of the optimization methods could not be reached at the district level. Therefore, it is recommended that these methods be evaluated on a case-by-case basis.

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Identifying the Causes of Accidents and Evaluating them Using the Tribod - Beta Method in the Electricity Industry

Abbas Jamshidigahrouei*[1]M.H.Ershadi[2], Mehdi Khousroshirin zadeh[3]
[1,3] Electricity distribution company of Chaharmahal and Bakhtiariprovince ,Shahrekord, Iran
[2]Department of Engineering, Khomeinishahr Branch, Islamic Azad University, Isfahan , Iran Email:abbas.jamshidi133@gmail.com(Corresponding Author)
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Abstract

Examining the records of accident analysis shows that so far more direct and indirect causes of accidents have been dealt with and more rooting has not been done in the field of revealing the hidden causes of accidents. Unfortunately, most of the shallow analyzes of accidents focus on the obvious causes of accidents. If in the next steps it is necessary to identify the hidden causes of accidents that are usually hidden from the eyes of non-experts. In this article, while considering the obvious and hidden causes of accidents, the evaluation of two accidents that happened in the electricity distribution company of Chaharmahal and Bakhtiari province is discussed. By drawing the tree of each incident, the percentage of frequency of the causes of each incident is calculated. The results are as follows: Non-observance of safety principles with the highest percentage of frequency (66%) had the greatest impact on the occurrence of these accidents. The lack of supervisor supervision and non-observance of training have played a role in the occurrence of these incidents with the same percentage of frequency (33.3%).

Keywords: incident, Tripod-Beta, obvious causes, hidden causes, electricity industry

1. Introduction

According to the report of the International Labor Organization (ILO), there are 2.3 million occupational accidents leading to death, 160 million non-fatal work-related diseas and 317 million non-fatal occupational injuries worldwide [1]. With the expansion of electricity technology and non-compliance with safety requirements in the use of its energy, we always witness the occurrence of many accidents for the experts and employees of this field, as well as for the consumers of household and industrial electricity [2]. Since many groups such as exploitation, repair and renovation groups and ordinary people are exposed to electricity distribution network installations; The occurrence of repeated and sometimes shocking accidents in the electricity distribution network sector, despite the existence of comprehensive safety regulations and instructions and providing solutions after the accident and then forgetting it with the passage of time, strengthens the possibility that there is still no coherent system to investigate. There is no root cause of accidents in electric power distribution companies, and in the investigation of accidents, it is enough to identify superficial and obvious causes [3].

Therefore, it seems that the introduction of these superficial causes under the title of the causes of the accident has not solved the problem and it shows the bitter truth that every incident has been repeated many times and we see that similar incidents with similar reasons are happening repeatedly. The causes of accidents are divided into two categories: obvious causes and hidden causes [4]. Unfortunately, most of the shallow analyzes focus on the obvious causes of these incidents. If in the next steps it is necessary to identify the hidden causes of accidents that are usually hidden from the eyes of non-experts. In this method, it is tried to consider the obvious and hidden causes in parallel in the evaluation and analysis of the incident [5]. Examining the records of accident analysis shows that so far more direct and indirect causes have been discussed and more rooting has not been done in the field of revealing the hidden causes of accidents. Therefore, the need to achieve a systematic method to investigate the root causes of accidents, motivated the authors of this article to find a way to achieve this goal.

2. Materials and Methods

This article introduces tripod beta method and its application in the analysis and evaluation of accidents that occurred in electric power distribution companies. By drawing the beta tripod tree, the author introduces the symbols and components of this method. In order to demonstrate the application of this method in the analysis of incidents, two incidents were selected as samples from the incident table of the electricity distribution company of Chaharmahal and Bakhtiari province and analyzed these two incidents. At the end, suggestions are made to improve the causes of accidents.

3. Tribot - Beta evaluation Method

Today, the use of hazard identification and risk assessment methods is expanding in various industries, so that currently there are more than 70 different qualitative and quantitative risk assessment methods and techniques in the world. These methods and techniques are usually used to identify, control and Reducing the consequences of risks is used. Most of the existing methods of risk assessment are suitable methods for assessing risks and their results can be used for management and decision-making regarding the control and reduction of its consequences without worry, each industry can use this method depending on its needs. have different advantages and disadvantages compared to each other. Therefore, one of the duties of the existing health and safety management system in every industry (HSE) is to check all the methods of assessing risks and dangers and choosing the appropriate method for implementation in the respective industry and organization. In general, it can be said that from the type of method used in risk assessment and the depth of its assessment, the ability of the existing safety system can be understood to some extent, and as a result, the safety management method in the mentioned industry [6,7]

Therefore, due to the high sensitivity of safety in the electricity industry and considering the unfortunate consequences, the need for continuous monitoring of reinforcement, evaluation and elimination of hazards in the field is felt. Therefore, after studying and reviewing the existing methods and techniques, the Tripod-Beta method in terms of cost, execution time, simplicity, ease of showing the relationship between human errors, training, implementation and implementation without the need for software, graphical description of the event and analysis Incidents have been selected from two aspects of control and defense in the electricity industry. The theory of this method is based on the Swiss cheese model, and due to its methodology and standard tables, it is widely used and cited in various organizations and industries. It provides relatively comprehensively. By using this method, it is possible to identify the superficial causes, preconditions, and hidden causes that caused the occurrence of unsafe behavior and conditions, determine the path of the accident, and identify the defects in the control and defense systems that are caused by failure to act. He stated that they caused the accident in time [8,9,10]. The basis of this analysis is based on three pillars, Hazard, Target, and Event. Tribod - Beta tree is as follows:

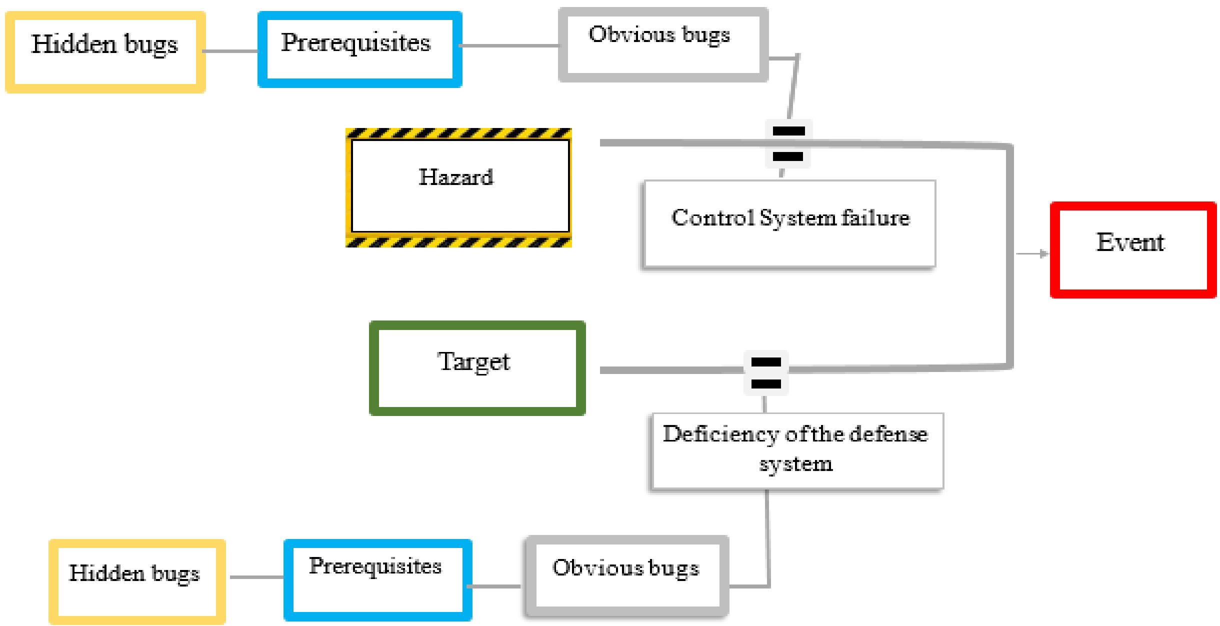

Fig.1. Tripod-Beta tree diagram

The method of analyzing incidents based on the Tripod Beta model

1. Draw the tree and determine the risk, goal and event
2. Specifying protection systems (control and defense)
3. Determining surface defects (unsafe practices or unsafe conditions)
4. Using checklists to determine preconditions and hidden problems
5. Determining the list of preconditions and hidden problems effective in the occurrence of an accident based on the checklist and entering them in the relevant table to manage hidden problems.

4. Tribod-Beta Chart Symbols

4.1. EVENT

An event is a change of state that results from the interaction of a hazard on a target. Important events in electricity distribution companies can be mentioned as: transformer explosion, medium pressure electrocution, falling from the power base. [11].

4.2.HAZARD

It's either a source of energy, matter, or the potential to be harmed, or damag. Like heat, electricity, flammable chemicals, height[12]

4.3. TARGET

It is the subject or case that the risk has affected and probably caused damage to it, and it includes four groups as follows:

A- People (injury or damage to the health of personnel or third parties)

B- Equipment/capital (damage to unit or equipment, loss of materials, interruption or stoppage of operations, damage to third party capital)

C- Environment (damage and pollution in the environment)

D- Validity(mass media controversy, public attention, protest, prosecution, commercial restrictions, regulations) [13]

4.4. Superficial causes

There are problems that were identified in the initial investigation and are divided into two categories as follows:

• Insecure conditions (physical problems of control or defense)

• Unsafe actions (technical errors) [11]

4.5. Hidden causes

Hidden problems are inefficiencies or abnormal conditions that create preconditions. (These pre-conditions lead to superficial problems and are specified through a checklist) [14]

5. Routing and Incident Control by Tribod - Beta Method

The basis of incident control is the creation of appropriate control and defense systems in such a way as to prevent the intersection, collision and interaction of the risk factor and the target factor. It is obvious that when these control and defense systems are available or do not have proper function, the possibility of interaction between the two mentioned factors is provided and an event occurs. In this method of analyzing these systems, the causes of their malfunctions are determined.

To complete the model, it is necessary to specify the following:

✓ What control or defense measures were in place that did not work properly.

✓ What other control or defense measures were necessary in the place [15].

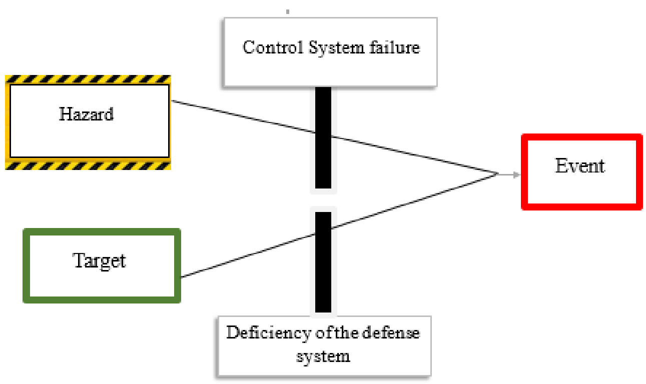

Fig.2. Events management diagram

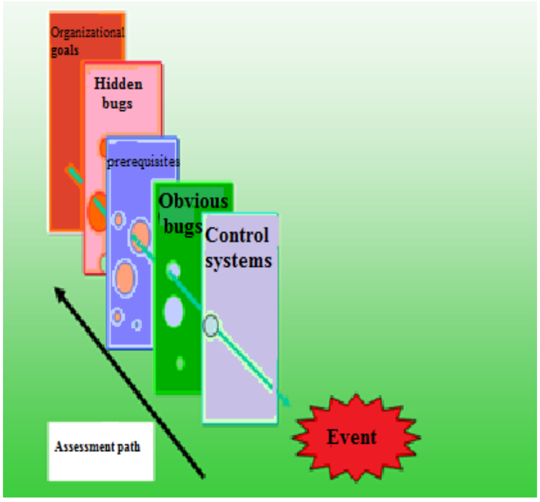

Fig.3. Path of finding the cause by the Tripod - Beta method

6. Case Study and Incident Description

A: Description of the incident 2019/09/14

In this article, the information of the personnel accidents of the contracting companies of Chaharmahal and Bakhtiari province electricity distribution company in 2019 was used.

On a sunny day in the middle of November of 2019 at around 12 noon, there was a public report that a branch of a tree collided with a low voltage network and caused

A connection is received during the wind in one of the villages of the region. At around 15:10, after visiting and checking the network, the colleagues of the operational group will start to repair the weak pressure network as described above. The lift is installed in the place and one of the simbaans (accident person) is installed in the lift basket and disconnects the branch connected to the electricity network. Then he proceeded to install the spacer, and during the installation of the spacer and after tightening three of the five network wires from top to bottom, he was electrocuted in his hand. The person accompanying him immediately separates the elevator carrying his injured colleague from the vicinity of the weak wire pressure network and transfers him down.

At the same time, one of the residents of the village called the 115 emergency service (after taking him downstairs and performing CPR, the deceased began to breathe. Meanwhile, due to the distance of about 15 kilometers from the accident site to the city center and the time it took for the ambulance to reach the place After the accident, the villagers moved to the hospital with a car, accompanied by their colleagues, during which the deceased again suffered a cardiac arrest and CPR was performed again until the ambulance arrived on the way. The deceased was transferred to the ambulance car, but unfortunately, transfer to the hospital and resuscitation did not work and she died. The tree of this incident by Tribod - Beta method is as follows:

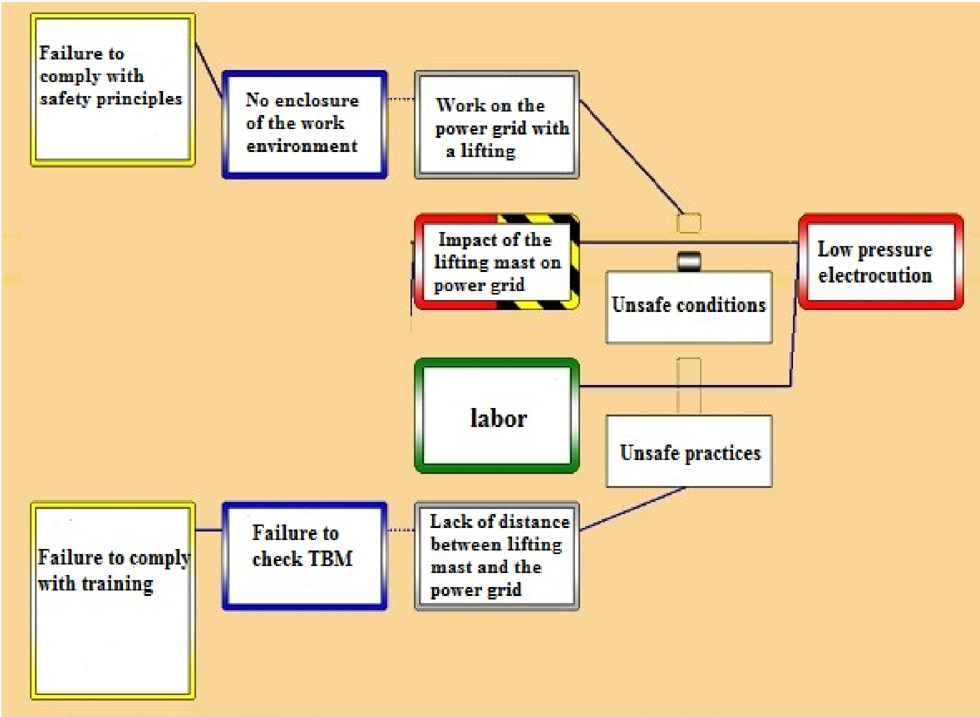

Fig.4. Tree of the incident dated 09/14/2019

B: Description of the incident 2017/03/31

The mentioned person is sent to the place to install the pole in the electricity distribution network. Without considering the safety instructions and not enclosing the working environment, the person fell into the hole dug for the installation of the beam and broke the person's right hand and left ankle. After the incident, the injured person was sent to the hospital. The Tribod- Beta diagram of the incident is as follows.

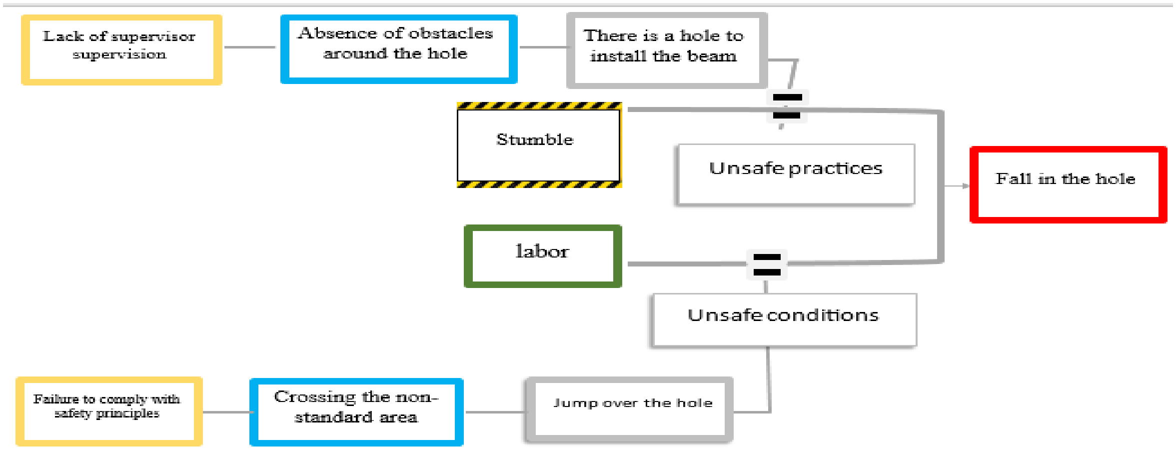

Fig .5. Tree of the incident dated 2017/03/31

According to the Tribot-Beta graph of the above incidents, the frequency table of each cause of the incidents is as follows:

Table 1. Frequency percentage

The cause of the accident	Percent
Failure to comply with safety principles	66.6%
Lack of supervisor supervision	33.3%
Failure to comply with training	33.3%

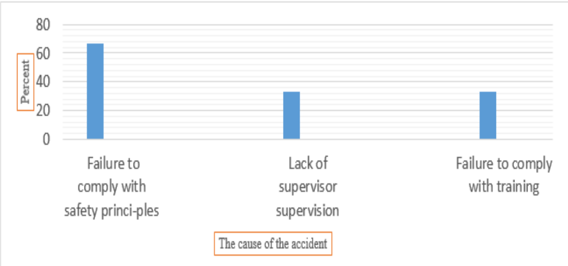

Fig .6. Frequency percentage chart

According to the frequency table of each of the causes leading to the accident, it can be concluded that Failure to comply with safety principles has had the greatest impact on accidents with a frequency of 66.6%.

7. Results

The obvious and hidden causes and preconditions of this incident are as follows:

7.1. Obvious causes

- Failure to use personal protective equipment
- Improper positioning and unsafe body position during work
- Not securing the conditions before doing the work (not covering the network)
- Doing the work in the wrong way
- Failure to carry out TBM before the execution of the work in order to identify the risks ahead and choose the safest and most technical way of doing the work (in such cases, the best reference for choosing the safe steps of the work is to refer to the safety regulations in the distribution department and the execution method depending on the type of work It is possible to say that acting on it will prevent the occurrence of an accident.)
- Unsuitable environmental conditions (surrounding the network by walnut trees and creating unsuitable conditions for the proper installation of the lift and safe work) the desired location in the annual pruning has not been fully pruned due to the fruitfulness of the tree and has created unsafe working conditions.

7.2. Prerequisites of the incident

- Absence of a codified implementation method for installing a network lock (spacer) in the weak pressure network, doing the work in the wrong way
- Improper supervision including the following
- Before doing the work: the supervisor has not visited and checked the personal equipment and properly secured the work environment.
- While doing the work: choosing the right path to do the work and removing the existing obstacles has not been done, and also the proper supervision for the work has not been done in the correct way in terms of technical and safety.
- False self-confidence and, as a result, doing work without using personal protective equipment (insulated gloves) and not paying attention to the supervisor's instructions
- Improper supervision of the employer (operating contractor):

The operation contractor, based on the contract and article 91 of the labor law, is obliged to inspect and supervise his

forces in terms of compliance with safety principles. In this incident, the failure to comply with this issue is evident.
- Inappropriate mental and psychological conditions.

7.3. Hidden causes

- Inadequate and ineffective risk identification, risk assessment and corrective measures
- insufficient and ineffective technical and safety training

Inadequate and ineffectiveness of safety culture

8. Suggestion

- Cultivation among Simban colleagues and working groups to perform TbM. Discussing the safest and most technical work method, choosing and agreeing to do it, the best reference for safe selection of work steps is to refer to the safety regulations in the distribution department and the implementation method depending on the type of work.
- Directly responsible pay a lot of attention to the important issue of the mental and psychological stability of Simbans when they are sent to do work, considering the high risks of working in power distribution networks, which may be the first mistake of a Simban person, the last mistake. It is obvious that Simban He must have enough concentration while doing work, which is not possible in inappropriate mental and emotional conditions.
- The use of personal and group protection equipment by simbaans and compliance with safety and technical regulations
- Explaining the advantages and importance of using personal protective equipment in preventing accidents for Simbanans (creating a culture of safety)
- Supervision of the employer (contractor) on the use of individual and group equipment of Simban forces under supervision
- High supervision of the company's experts and managers on the correct performance of workers and their employers (contractors) in terms of compliance with safety and technical regulations.
- Supervising the correct implementation of preventive technical measures in electricity distribution facilities to increase the reliability of the network and eliminate or reduce the risk for people and Simbans, including the correct execution of pruning in this incident.

9. Conclusion

In this article, we first introduced the Tripod-Beta method, and then, using this method, a real accident that occurred in the electricity distribution company of Chaharmahal and Bakhtiari province was analyzed. The tree of this accident was drawn and the obvious and hidden causes of the accident were discussed and suggestions were made to prevent such accidents.

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Machine learning and Deep learning Applications in Stock Price Prediction: Top Trend and Bibliometric Analysis

ArashSalehpour [1*], Karim Samadzamani [2]
[1]Department of Computer Engineering, Tabriz Branch, Islamic Azad University, Tabriz, Iran
[2]Depaetment of Computer Engineering , university Collage of Nabi Akram , Tabriz , Iran
Email:arash.salehpour@tabrizu.ac.ir(Corresponding Author), kszamani@ucna.ac.ir
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Abstract

This paper conducts an exhaustive bibliometric examination of Machine Learning and Deep Learning applications in Stock Price Prediction from 2013 to 2022. The stock market's economic significance and volatility underscore the interest in predictive models. Numerous studies use techniques like Support Vector Machines, Neural Networks, and Reinforcement Learning to forecast market trends. Complexities, including uncertainty and data density, pose challenges in financial forecasting. The study employs Scopus and advanced visualization tools for trend analysis. Queries focusing on "Deep learning," "Machine learning," and "Stock price prediction" yielded 131 papers from 93 sources. The analysis reveals a 36.55% annual growth rate, with China, India, and South Korea as leading contributors. The recurring and co-citation networks illuminate influential papers and prominent themes. "Automated news reading: Stock price prediction based on financial news using context-capturing features" emerges as a pivotal document. Thematic maps highlight evolving trends like "neural networks" and "financial markets." Applying Lotka's Law uncovers uneven author contributions. The paper emphasizes electronic trading, deep learning, and investment themes in stock price prediction research. This analysis offers insights into research trends, influential authors, and emerging themes. It is a valuable resource for researchers, practitioners, and policy-makers exploring the fusion of machine learning, deep learning, and stock price prediction.

Keywords: Stock Price Prediction, Bibliometric, Financial Markets, Deep Learning, Machine Learning

1. Introduction

One of the significant ways that publicly traded corporations may generate money is via the stock market, which is also the primary component of the capital market. The stock market is sometimes referred to as the "barometer of the economy," which indicates that its volatility is strongly tied to the expansion or contraction of the overall economic market. Stock market prediction has been an appealing issue for scholars in various professions. In particular, a significant number of research have been carried out to forecast the movement of the stock market by using machine learning techniques such as support vector machine (SVM), Neural Networks, Deep learning, and reinforcement learning. Researchers from various professions have long been interested in predicting the stock market's direction. Financial markets have been intensively investigated for learning, a well-known method in many applications. Popular algorithms such as support vector machine (SVM) and reinforcement learning may assist in maximizing profit while keeping risk low when it comes to stock option purchases.[1, 2] The market for financial services is an intricate, ever-evolving, and non-linear dynamical system.[3] Because of these two primary considerations, bibliometric methods are currently applied to almost every area of research. Bibliometric metrics are used widely as indicators in various fields, including research performance, productivity, influence, and impact. This is the foundation upon which traditional bibliometrics is built and the area in which it excels best in its evaluative power. Financial forecasting is characterized by high uncertainty, a dense amount of data, noise, non-stationarity, a lack of organization, and hidden relationships. Politics, the status of the economy as a whole, and the expectations of traders are only a few factors that might influence the movement of prices in the financial markets. Consequently, predicting the changes in price in the financial market is a tricky endeavor. The results of academic investigations are increasingly pointing to the conclusion that price shifts in the market are not the result of random chance. Instead, they function in a manner that is very dynamic and non-linear, making it possible that the standard "random walk" assumption for futures prices is nothing more than a "cloak of randomness" covering a noisy non-linear process that's concealed behind it. [4-6]

One of the most common applications of machine learning methods is financial time series forecasting. Researchers have shown that advanced forecasting algorithms can effectively predict price fluctuations in the financial market. On the other hand, financial experts see the informational efficiency of the financial markets as a good indicator. Prediction of Prices in Financial Markets with the Application of Machine Learning Even though many financial economists are convinced that the EMH is accurate, a significant portion of the ML literature investigates the extent to which prices in financial markets can be predicted and the extent to which model-based trading is profitable. For instance, predicting financial markets is a common application area for the development of novel approaches and for demonstrating the potential of these methodologies. The dynamic regression modeling strategy, which predicts future market values based on previous changes in those prices and other price time series, has emerged as the method of choice in recent years..[7]The bibliometric analysis is a rigorous approach, using quantitative and statistical descriptions to characterize the evolving intricacies of knowledge in a particular topic.[8-10]

2. Data Collection

The Scopus database was searched, and R studio and biblioshiny software were used to analyze and visualize the trends. Data were obtained from the Scopus database, which is widely recognized as being suitable for bibliometric analysis of scientific publications due to its stringent evaluation process, comprehensive scientific publications, and influential and credible information provided. This is one of the reasons why the database has gained such widespread acceptance. The search results might be retrieved using the formula TS = (“Deep learning” OR “Machine learning” AND “Stock price prediction”). The document type was an article; English was the only language allowed, and the publication period lasted ten years.

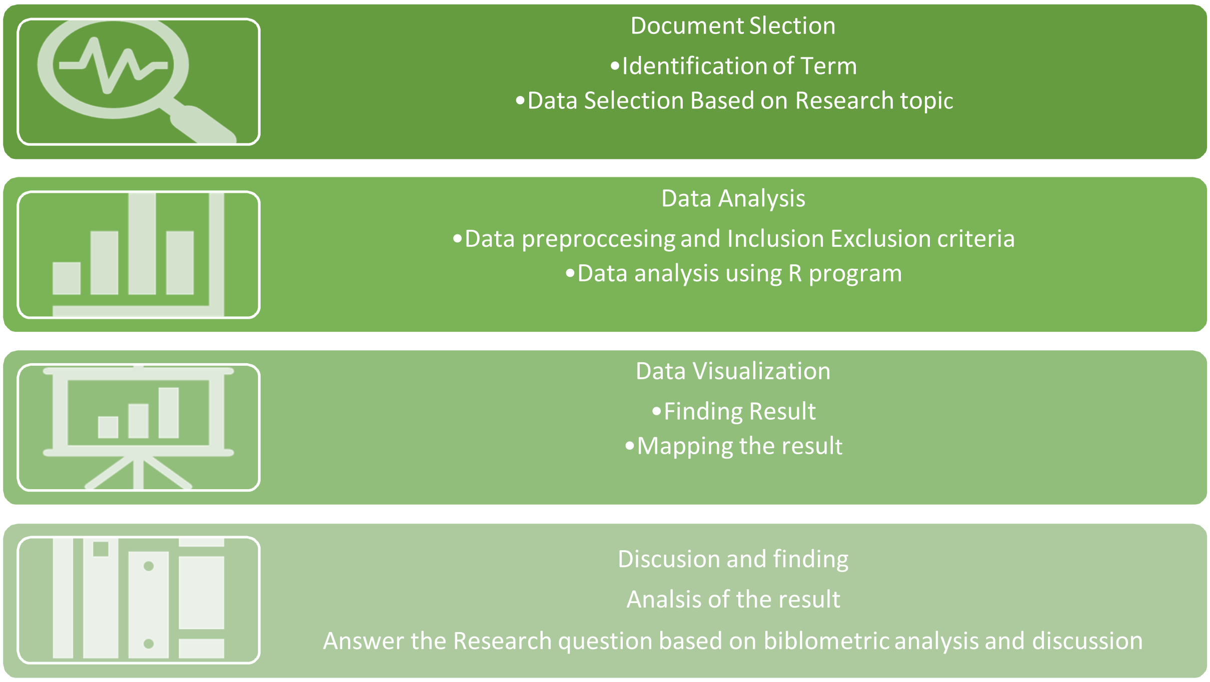


Fig.1.Data Analysis Process

1.1.1 Loading and converting data

The second step, known as "loading and converting data," comprises changing the data into an appropriate format and analyzing it using bibliometric tools. This procedure is known as "loading and converting data." The next step is to make the data seem to be of more outstanding quality. Bibliometrics data may be accepted chiefly; however, cited references may contain several copies of the same book published by different authors because the great majority of bibliometrics data may be depended on. The precision of the underlying data determines the calculation's precision. For example, it is possible to detect duplicate papers and misspelled phrases using different preprocessing techniques. A method for choosing and fine-tuning keywords, making a query based on both the TITLE, KEYWORD and the

ABSTRACT, the search was done., as shown in Table 1.

1.1.2 Data Analysis Tools

Quantitative data analysis is turned on its head by bibliometrics. Using quantitative methods, Bibliometrics studies scholarly publications, such as journal articles, and the citations that support them. We use Biblioshiny as the primary tool with R studio. [3]Microsoft Office Excel (2019). (Microsoft Corporation, Redmond, Washington, USA) was used to manage and analyze the characteristics of the publications. It visually analyzed keywords and the author's contributions and countries. The clustering algorithm creates a co-citation network and performs density visualization analysis.

1.1.3 Word Cloud

The most frequent word all over the documents is "forecasting, "which appears 76 times; "financial markets" appears 66, "stock price prediction" 54, "commerce"36, electronic trading 36, "deep learning" 35, and "long short-term memory"28, "investments"27 "costs"25, machine learning 23.

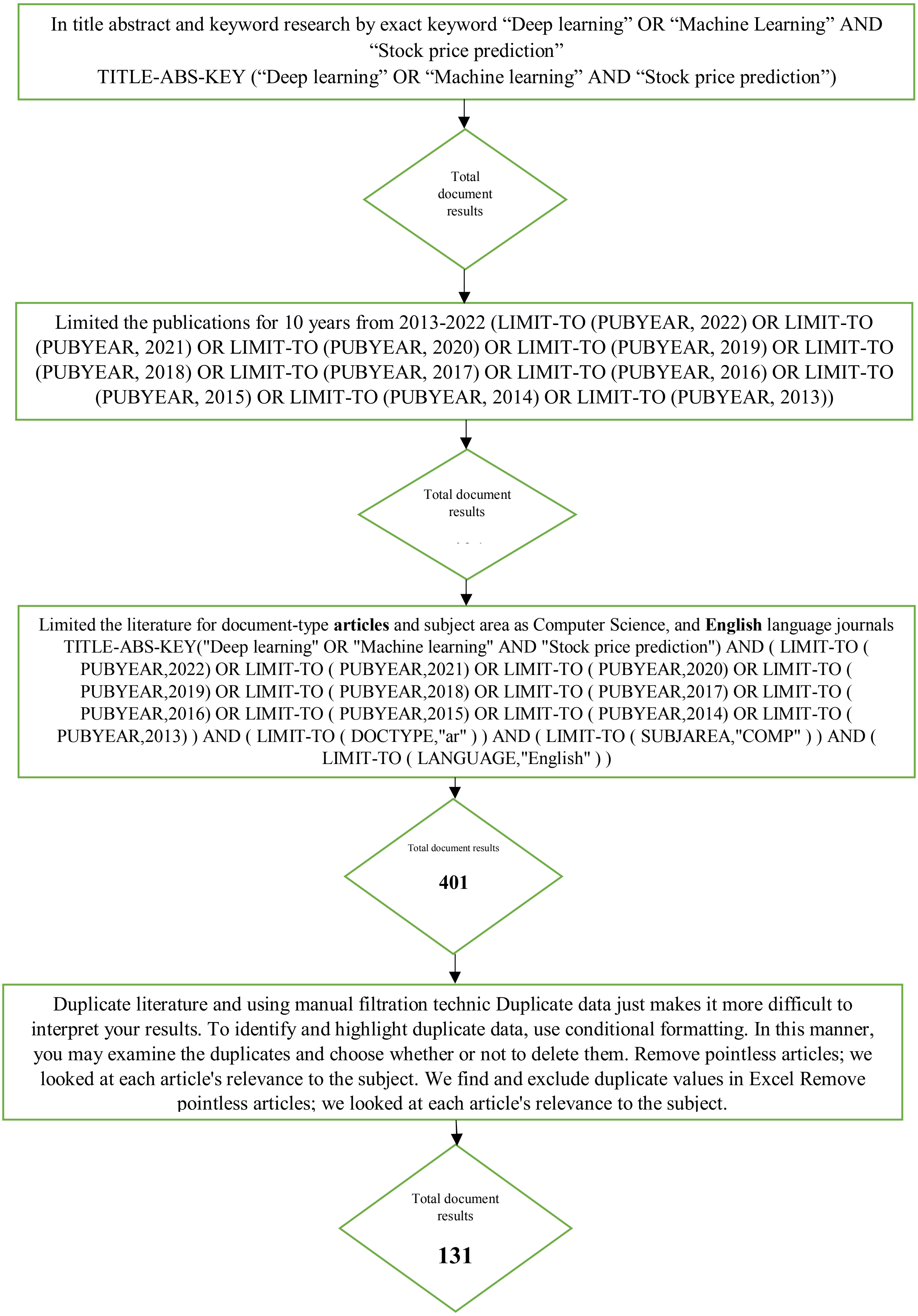


Fig.2.Step-by-step query and refin*e*

Table 1. Step-by-step query and refine

Final query used for data collection.
TITLE-ABS-KEY (("Deep learning" OR "Machine learning" AND "Stock price prediction")) AND (LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))

1.2 Study approach and tools

Our database contains 131 papers from 93 sources, and the collection's period was 2013-0222. The average number of citations per document was 12.72, and we identified 381 authors among 131 documents. The annual growth rate is 36.55%, and international authorship is 12%. We use biblioshiny in this section and RStudio.

Table 2. Main information of Data The main Information and tables illustrate the distribution of literature from 2013-2022, achieving an average growth rate of 36.55.%. It is noticeable that research productivity was almost stable from 2013-2018, but considerable

Description	*Results*
	MAIN INFORMATION ABOUT DATA
Timespan	2013:2022
Sources (Journals, Books, etc)	93
Documents	134
Annual Growth Rate %	36.55
Document Average Age	1.72
Average citations per doc	12.72
References	4617
	DOCUMENT CONTENTS
Keywords Plus (ID)	591
Author's Keywords (DE)	368
AUTHORS	
Authors	381
Authors of single-authored docs	7
	AUTHORS COLLABORATION
Single-authored docs	7
Co-Authors per Doc	3.07
International co-authorships %	12.69
	DOCUMENT TYPES
	3
article	131

1.2.1 Annual scientific production

We can conclude that the highest number of publications related to Stock price prediction with machine learning and deep learning focus in the year 2021 .

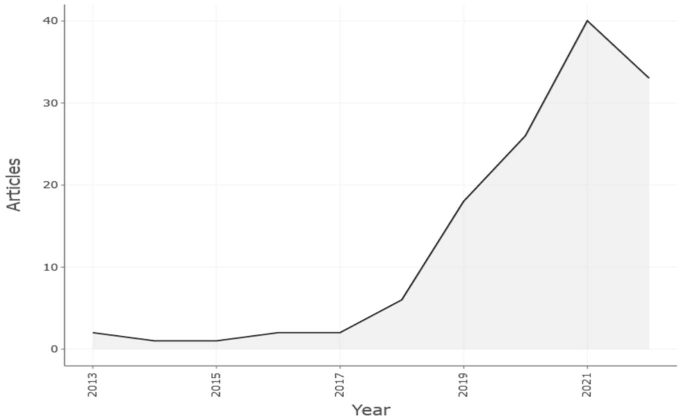


Fig.3. Annual Growth Rate

1.2.2 The countries that publish the most applications of Machine learning and Deep learning in Stock Price Prediction are based on our survey.

The following table presents a ranking of the countries in terms of their level of participation in research in stock price prediction using machine learning and deep learning. This investigation was based on calculating the writers' associations with their own countries, and the findings revealed that China was the most prolific and influential country.

Table 3. The countries that publish the most

region	*Freq*
CHINA	113
INDIA	101
SOUTH KOREA	34
AUSTRALIA	22
UK	15
USA	13
INDONESIA	12
EGYPT	10
BANGLADESH	8
ITALY	6

1.2.3 Most cited countries

When compared to nations located all across the world, China stands out as having the highest total number of 527 citation.

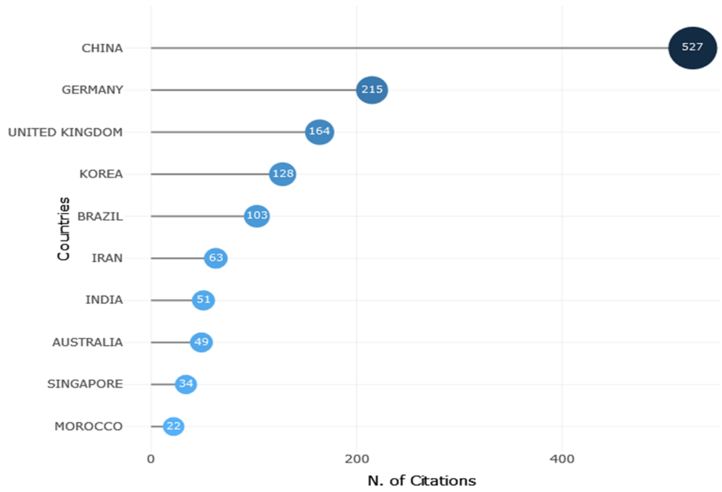


Fig.4 Most cited countries

1.2.4 The distribution of research publications

In addition, Figure 7 illustrates the distribution of research publications on Machine learning and Deep learning applications in Stock Price Prediction around the globe. A significant amount of research has been conducted and published on the subject of Stock Price Prediction. The volume of publications from each nation has caused their countries to become represented in the color patterns. Figure 7 presents a ranking of the ten countries that have contributed the most to the total number of scientific articles. With 113 document pages, China is the country with the most production. India is just a little behind China in second place with 100 papers, while South Korea comes in second with 34 papers. Compared to other nations, Australia holds the fourth position, with 22 papers covered. The next place goes to the United Kingdom with 15 pieces of paper, followed by the United States with 13 sheets, and Indonesia with 12 papers.

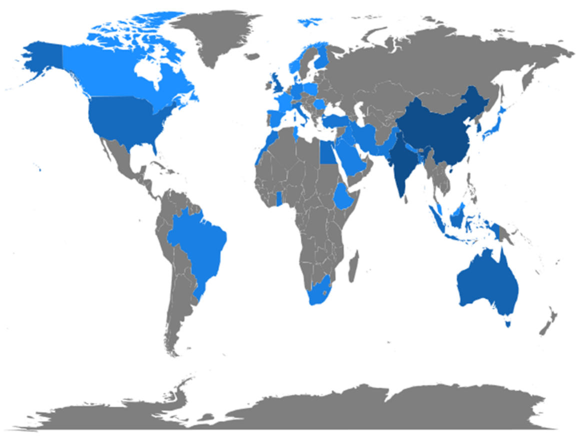


Fig.5. The distribution of research publications

1.2.5 Corresponding Author's Country

Figure 8 further elaborates on the related author's nationality, with the resulting graph revealing China, Australia, and India as among the nations with the most significant MCP counts of scientific papers addressing Machine learning and Deep learning applications in Stock Price Prediction. In this analysis, China, India, and South Korea considered SCP (single-country production). These nations have significantly impacted Machine learning and Deep learning applications in Stock Price Prediction.

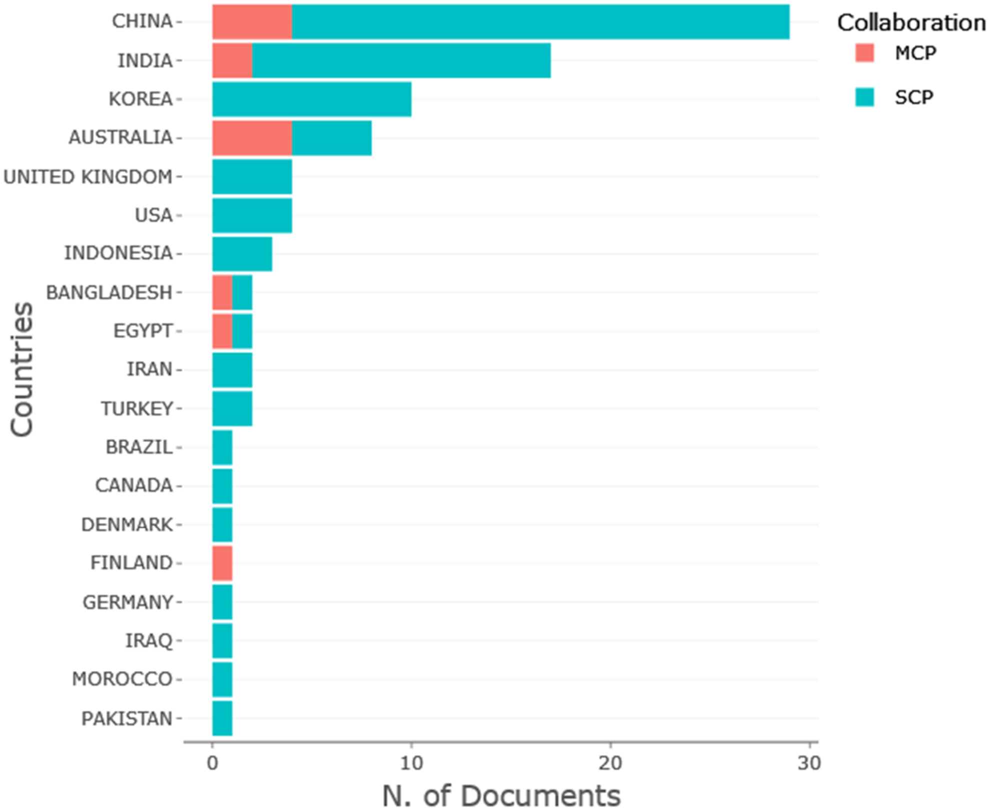


Fig.6. The Most Corresponding Author's Country

1.2.6 Countries' Production over Time

Different nations and economies make different contributions to the ever-increasing amount of published material that exists in the globe. When taken as a proportion of the overall world production, the publishing output of any nation or economy reveals that the historically significant producers have contributed the most. In the high-income economies (China, Germany, and other similar countries), the most increased publication occurred in 2020. China's growth rate is notable.

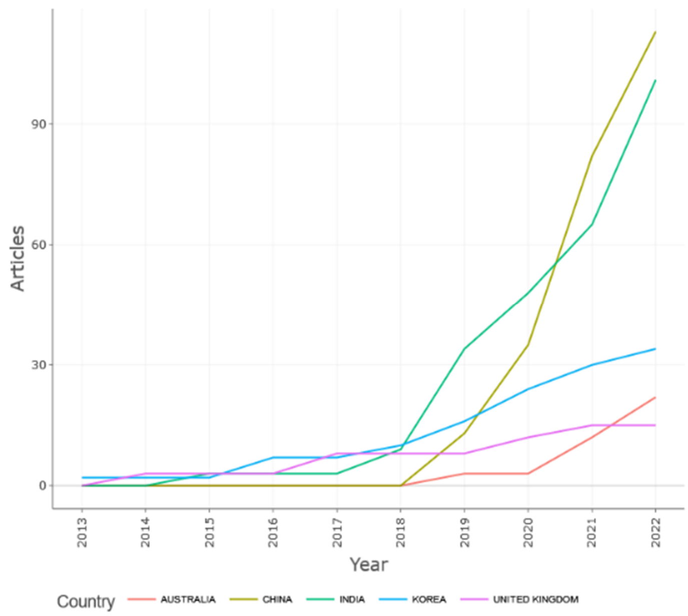


Fig.7. Countries' Production over Time

1.2.7 Most Relevant Affiliations

The data came from articles that were published in Scopus during the years 2013 and 2022. Because it identifies the institution in the region that is doing the most remarkable research activity, this data may be used by funding agencies and early-career researchers. Researchers may find this material helpful in locating a trustworthy source in this area and acquiring articles pertinent to their work. The distribution of scientific documents by institutions or connections is broken out and explained in Figure 10. According to the findings, ten different universities have produced the most work on the subject of research. The university that came in first position is located in China and is called Nanjing Tech University. It is the premier institution in producing scientific papers on stock price predictions. The university has contributed 8 document articles. The Capital University of Economics and Business, located in China, is the second most represented affiliation in producing scientific materials. In addition, there are educational establishments such as the Chinese Academy of Science in China. These universities are examples of establishments that have produced six publications. Each of the following universities: Symbiosis International University in India 6 publications; Dali University in China produced five publications; Seoul National University Soongsil University, both in South Korea and Sri Sivasubramanian Nadar College of Engineering in India; and Swinburne University of Technology located in Australia each of which has five publications, are the most recent universities to publish papers in Machine learning and Deep learning applications in Stock Price Prediction.

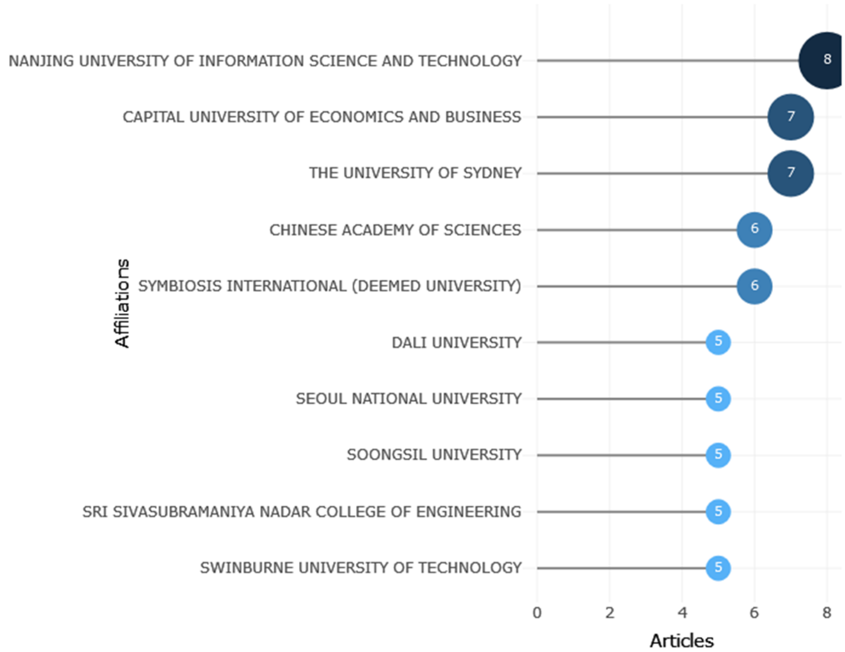


Fig.8. Affiliations

1.3 Citation Analysis

The average citation per document is 15.37

1.3.1 Most Local Cited Sources (from Reference Lists)

Over the last several years, emphasis has shifted toward using the number of citations received as a proxy for academic production. The primary results indicated a substantial growth in intellectual creation. Automated news reading: Stock price prediction based on financial news using context-capturing features is the most globally cited document in this study; to see whether textual information from financial news articles can be used to increase stock price prediction accuracy, we look at past techniques that only produced accuracy close to random guessing chance. We augment current text mining approaches by utilizing more expressive features to represent text and by incorporating market input into our feature selection process. As shown in this paper, classification accuracy may be improved by using a robust feature selection in conjunction with complicated feature types. Thus, over-fitting is avoided when using a machine learning methodology because of our method's ability to choose semantically meaningful features. In addition, we show that our strategy is very successful in the real world of trading. The approach may be used in any other application field as long as you have textual information and accompanying impact data.[11]The most locally cited source is Expert system with Application, with 141 citations, IEEE Access with 87, then system with Application 79 Neurocomputing 72 Expert System with Application 52 Plos One 31 Applied Soft Computing30 Procedia Computer Science 30 The Journal of finance29decision Support System 20

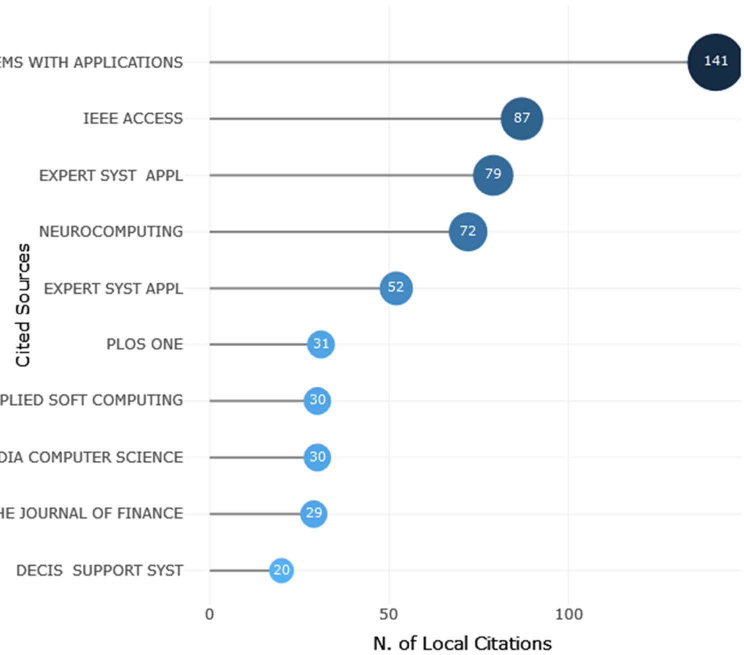


Fig.9.most cited sources

1.3.2 Source clustering through Bradford's Law

In physics, Bradford's Law of Scattering governs scattering and declining returns. As Bradford said when he first proposed his concept in 1948, "There are a few extremely prolific magazines, a greater number of more middling producers, and a yet larger number of steadily falling output" for each field of study. A Pareto distribution describes this shape in several fields. Consider the scenario when a researcher has identified five essential scientific periodicals for his or her field. Let us assume that there are 12 relevant papers published in such journals every month. Now imagine that the researcher must consult an extra ten journals to locate another twelve relevant papers. If so, the researcher has a Bradford multiplier bm of 2 (10/5). This researcher will have to scour times as many publications as possible to find each additional dozen papers. Most researchers recognize no value in continuing their search after reviewing the contents of the first five, ten, twenty, forty, etc. journals. The journals that are most frequently cited in the research that has been done on a particular issue or subject area are those that fall into the "top third" (also known as the "core" of the journals for that issue or subject area). As a result, these journals are the most likely to be of interest to academics who work in that particular field. The quantity of citations received by journals in Zone 2 is considered average. Journals in Zone 3, however, make up the "long tail," which is seldom cited and is hence seen as having little relevance to the subject at hand.[12]Bradford's law is used in Fig. 12. Bradford's law describes the distribution of papers in a field throughout a set of journals, with the bulk of articles clustering around a small set of authoritative publications. The findings demonstrate a high percentage of journals that are released with a limited quantity of documents. Bradford's law said, as seen in Figure 12, that the leading journals that have been published in Stock Price Prediction, such as Expert System with Application, International Journal of Recent Technology and Engineering, Applied Intelligence, and IEEE Access, are the leading journals in Stock Price Prediction using machine learning or deep leaning.

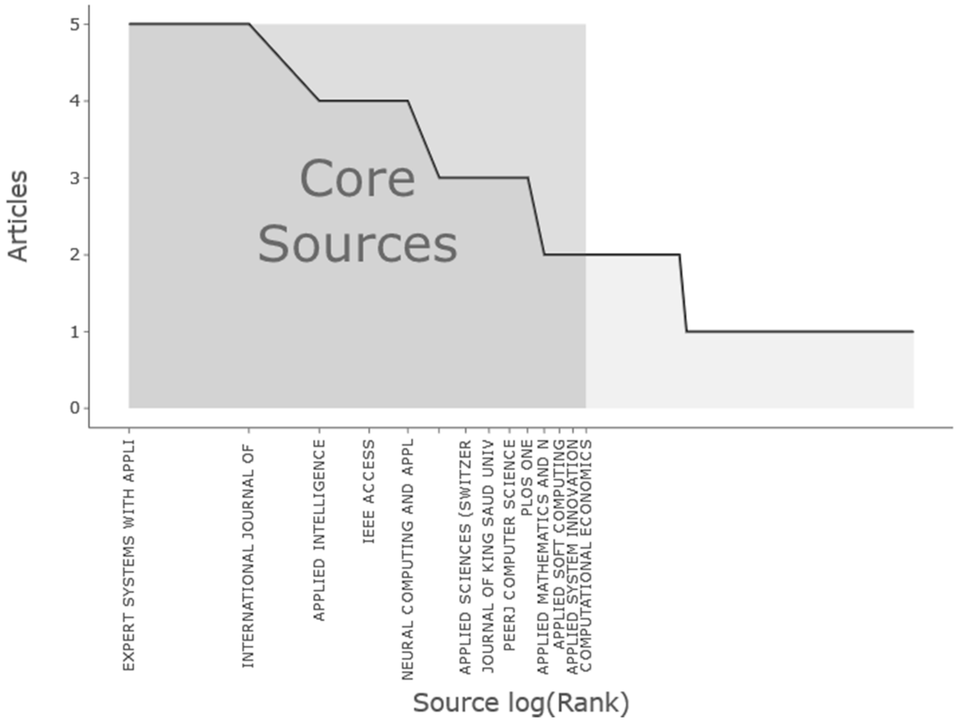


Fig.10. Source clustering through Bradford's Law

1.4 Network Visualization

1.4.1 Lotka’s Law and productivity patterns of authors

The application of Lotka's Law of Scientific Production offers a framework for investigating inequalities in the patterns of authors' productivity in a particular subject and throughout a specific period. Since its release, several writers have used Lotka's Law within the context of the written works of various academic fields. The implementation of Lotka's Law of Authorship Productivity in the subject of Dentistry Literature is fruitful and productive. The equation below summarizes Lotka's Law as:

$$X^{\alpha}Y = K \qquad [13]$$

where Y is the number of authors producing X number of articles in any given subject area [13]To rephrase, Lotka's rule states that for every x writer, there are about 1/x authors who contribute just once, and 60% of all authors contribute only once. It follows that around 60% of writers in any given subject will have just one publication, 15% will have two publications (1/22 times 60), 7% will have three publications (1/32 times 60), and only approximately 6% will contribute up to 10 contributions apiece in the literature of any discipline. Based on Figure 13, we can conclude the findings of the research, which had a large number of contributors. Of these contributors, about 281 writers contributed just one document, which accounts for 0.953 of the total contributions made by the authors.

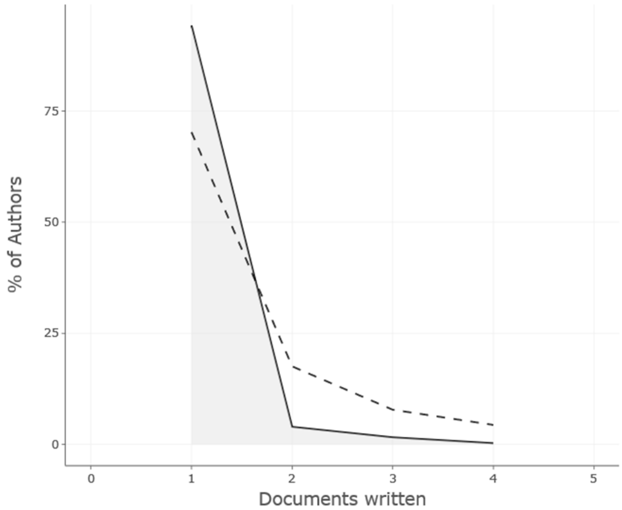


Fig.11. Author Productivity through Lotka's Law

1.4.2 Most Global Cited Documents

Top 10 most locally cited Documents top two are “Automated news reading: Stock price prediction based on financial news using context-capturing features”in Decision Support Systems [11]With a total citation of 215, a TC per year of 21.54, and a normalized TC of 1.76. The second document, titled “Deep learning-based feature engineering for stock price movement prediction” Knowledge-Based Systems [14] with total citation of 155 and TC per year 38.75 and normalize TC 6.37

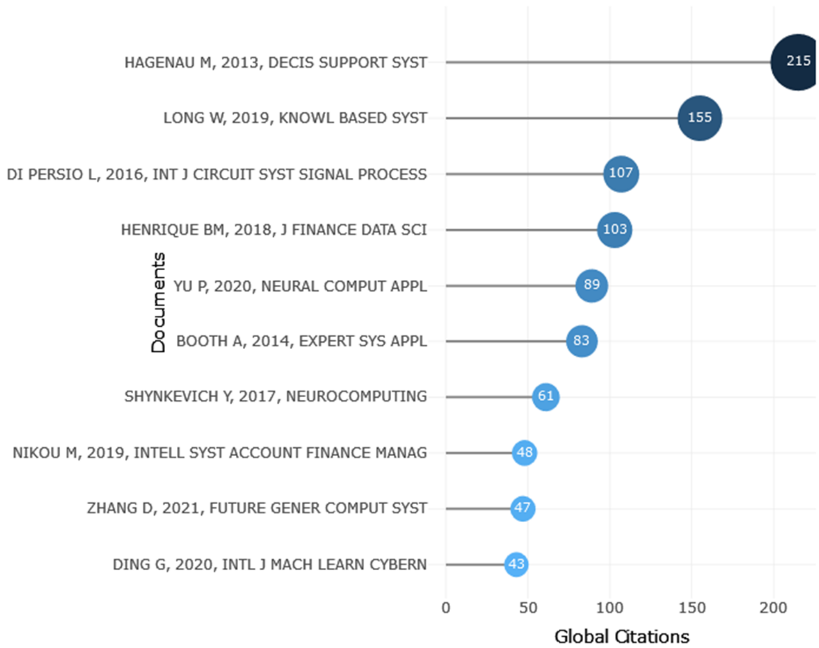


Fig.12. Most Global Cited Documents

1.4.3 Most Local Cited References

Top 10 most locally cited References in the literature. The most cited paper introduces Recurrent backpropagation as a slow learning method to retain knowledge over lengthy periods, mostly because of inadequate, declining, incorrect backflow. Propose a new, efficient gradient-based solution we call long short-term memory to solve it (LSTM).[15]

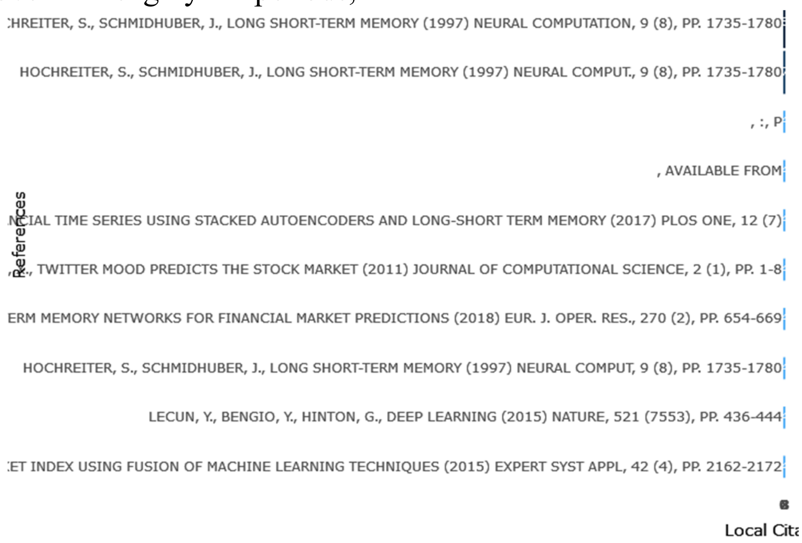


Fig.13.Most Local Cited References

1.5 Co-occurrence Network

A co-occurrence network is an undirected graph constructed using a corpus of documents as its starting point. Each node in the graph represents a unique word in a vocabulary, and each edge represents the frequency with which two words co-occur in a document. In order to show the links between words in a corpus of texts and to extract information about those associations, use co-occurrence networks; for instance, you might use a co-occurrence network to figure 17 out the terms that are most often found along with the specific word.

Table 4. Table of Co-occurrence Network

Node	*Cluster*	*Betweenness*	*Closeness*	*PageRank*
algorithm	1	0.802585	0.011905	0.011671
algorithms	1	0.062457	0.011494	0.009035
investment	1	1.014941	0.012048	0.012199
article	1	0	0.011236	0.008442
neural networks, computer	1	0.165673	0.011494	0.009054
prediction	1	0	0.011236	0.008442
forecasting	2	239.3254	0.020408	0.101109
financial markets	2	173.9004	0.019608	0.095172
stock price prediction	2	119.5112	0.019231	0.080455
commerce	2	82.28423	0.018519	0.058166

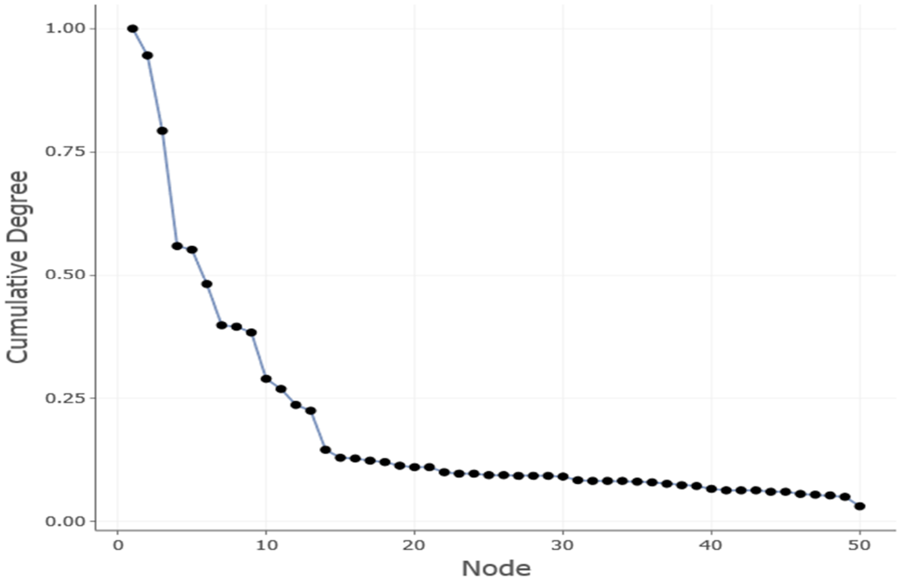
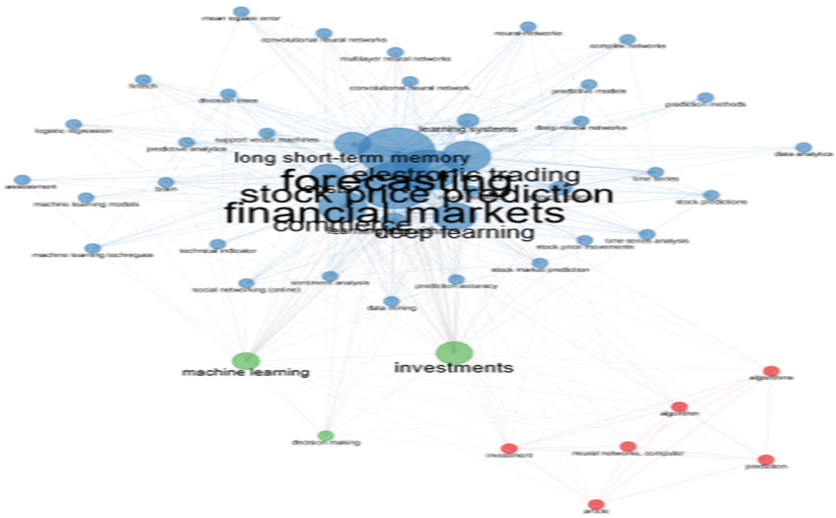


Fig.14. Degree Plot of Co-occurrence Network



Figu.15. Co-occurrence Network

1.6 Co-citation Network

With a field of papers, the first two articles include Rochester's. 1997 with Betweenness of 496, through the development of a cutting-edge, highly effective gradient-based technique named long short-term memory (LSTM). By truncating the gradient when it does not cause damage, LSTM can learn to bridge minimum temporal gaps of more than 1000 discrete-time steps by imposing continuous error flow through constant error carousels inside specialized units. Fischer t. 2018 with a Between's of 180.

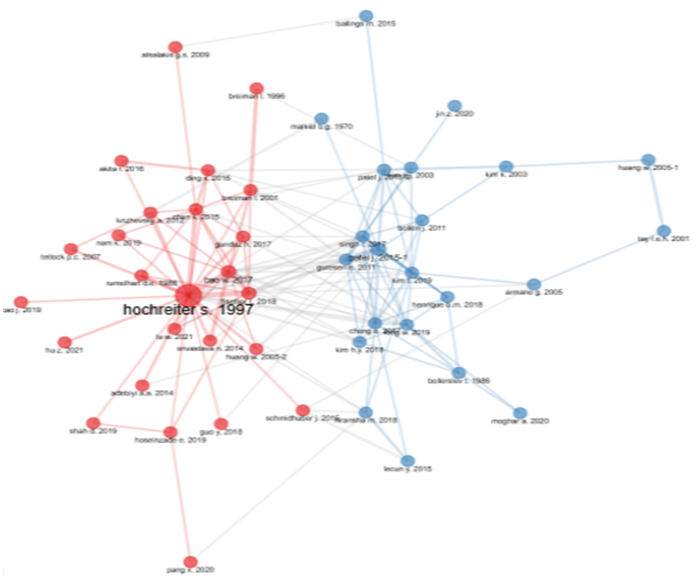


Fig.16. Co-citation Network

1.7 Word Dynamics

We discovered that research on stock market prediction expanded with a rise in themes, such as electronic trading and machine learning subjects in 2019.

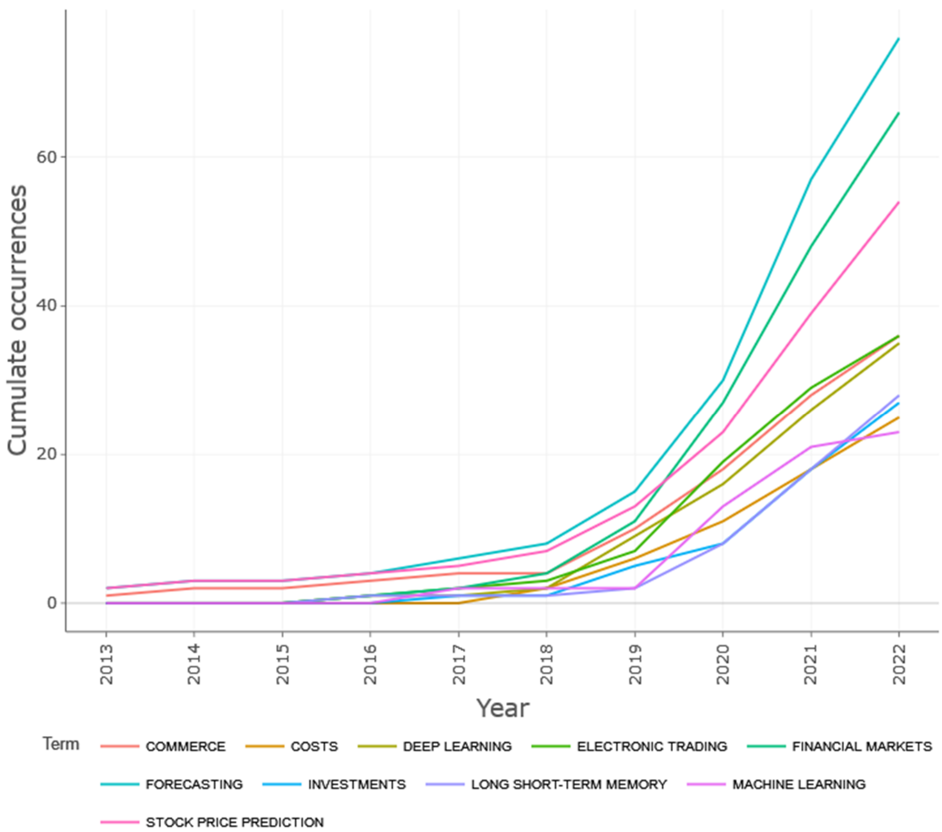


Fig.17. Word Dynamics

1.8 Trend Topics

Bibliometric analysis of the academic literature in terms of the subject distributions of the academic material This investigation makes it possible to get information on the publishing patterns of authors who acknowledge that their work is a part of the bibliometric study and the phrases they use in their work.

Figure 20 demonstrates what has been hot in Machine learning and Deep learning applications in Stock Price Prediction. Each year has a unique set of themes to explore. From 2018 through 2021, the terms "neural networks" and "stock price movements" appeared in 12 different contexts, making it one of the trendiest themes in writing. The writers discussed the second issue in this trend, "Commerce," " Machine Learning," and electronic trading," 95 times between 2019 and 2021. Moreover, the word "stock price prediction," "financial markets," and "forecasting" was used 195 times to describe the subject of study between 2020 through 2022. Nonetheless, neural networks and Stock prices are some of the trend issues the writers explore in 2022.

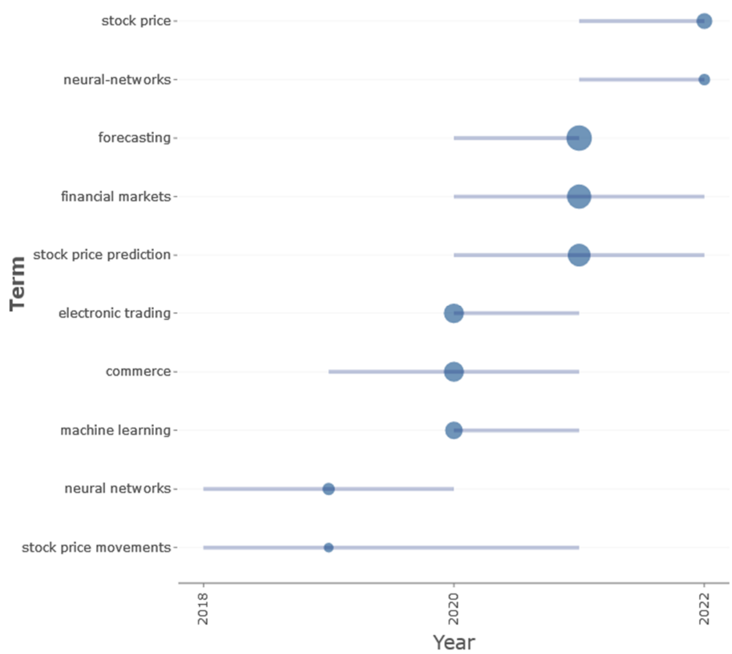


Fig.18. Trend Topic

1.9 Thematic Map filed keywrods plus

A "thematic map" is a kind of map that zeroes down on a single overarching concept or topic as its primary point of interest. How a specific topic or distribution differs around the world is highlighted by a thematic map. Bibliometrics use the theme map to sketch out the conceptual structure of a topic. The latter uses a co-occurrence network of phrases to evaluate the dominant topics, themes, and trends in academic discourse in a specific discipline.

Table 5. Table of thematic map top ten records

Occurrences	*Words*	*Cluster*	*Cluster_Label*
5	algorithm	1	algorithm
5	algorithms	1	algorithm
5	investment	1	algorithm
4	article	1	algorithm
4	neural networks, computer	1	algorithm
4	prediction	1	algorithm
2	marketing	1	algorithm
2	economic aspect	1	algorithm
2	human	1	algorithm
2	humans	1	algorithm

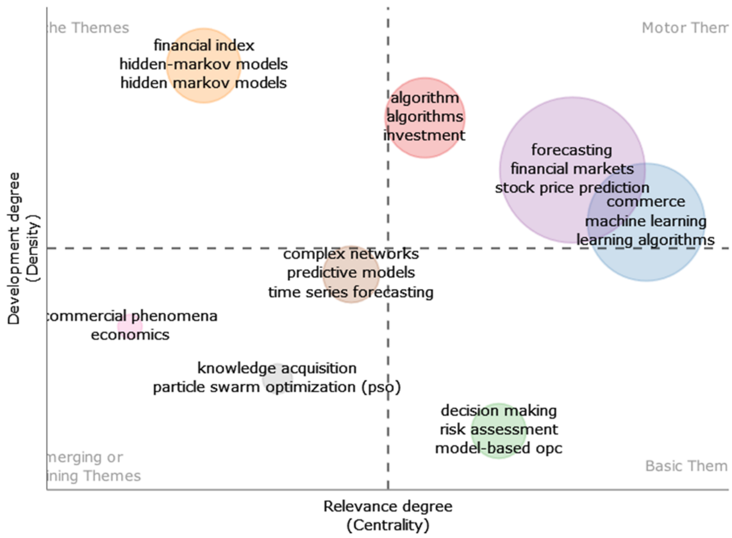


Fig.19. Thematic Map filed keywords plus

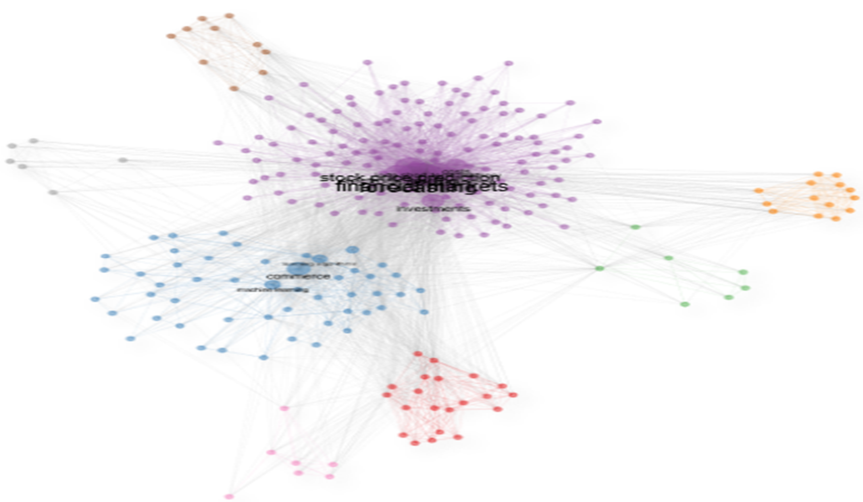


Fig.20. Thematic Map Network

1.9.1 Thematic Evolution

A "thematic map" is a kind of map that zeroes down on a single overarching concept or topic as its primary point of interest. How a specific topic or distribution differs around the world is highlighted by a thematic map. Bibliometrics use the theme map to sketch out the conceptual structure of a topic. The latter uses a co-occurrence network of phrases to evaluate the dominant topics, themes, and trends in academic discourse in a specific discipline

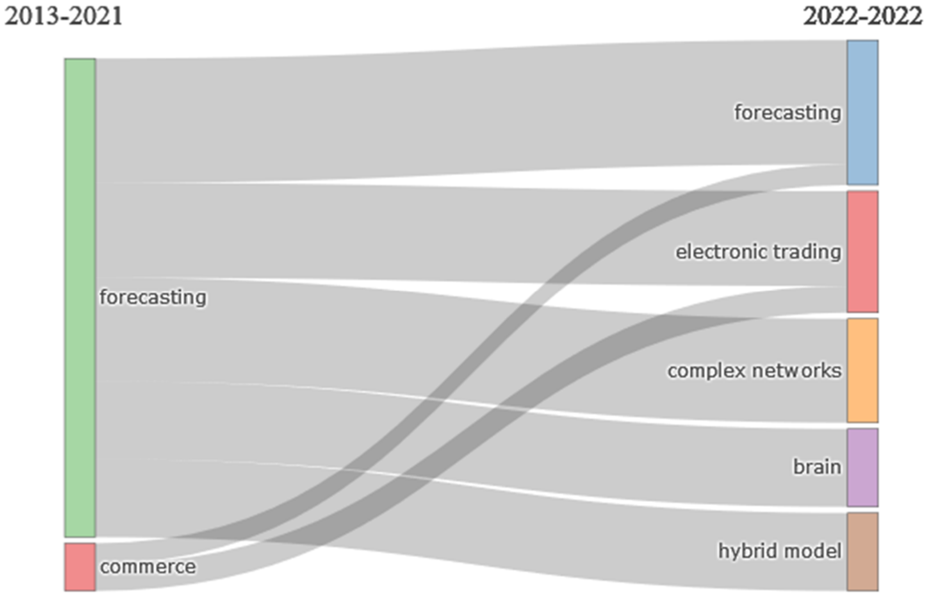


Fig.21. Thematic Evolution

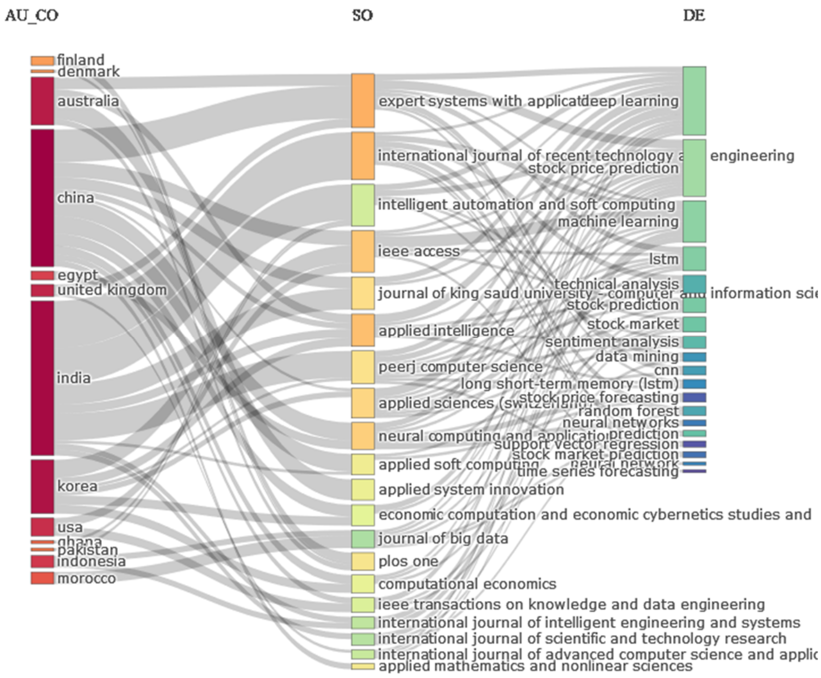


Fig.22. This presents the connectedness between the journal, the country, and keywords. It was created to depict the proportion of the participation of each country with a specific journal and topic represented by the keyword.

2 Three Map Analysis keywords Plus

Figure 23 shows the tree map used in this study by Keyword Plus. The investigation outcome demonstrates that the articles' writers employed keywords to express the magnitude of the term in the publications. The terms that are much larger than the others indicate the frequency with which the writers of the abstract use that particular word. Based on Figure 23, we can conclude that the word "forecasting" has the most significant size in this investigation, as it was used 76 times. This indicates that the writers used it as the primary phrase for forecasting throughout their work.

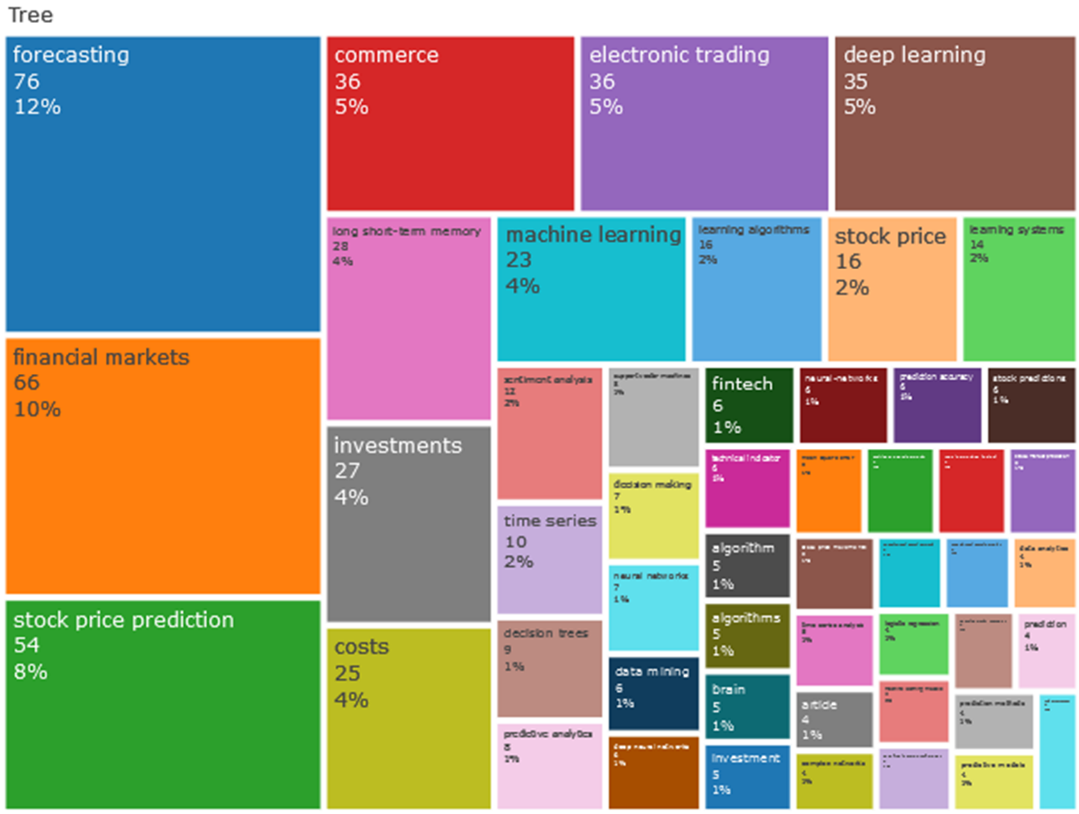


Fig.23.Tree Map Analysis

3 Factorial Approach

3.1 conceptual structure map method: MCA multiple corresponding analysis filed keyword plus

Multiple correlation analysis (MCA), shown in Figure 24, is used to assess the conceptual structure map in this research. Thus, the authors of this research have discovered a statistically significant split between the two groups. The red cluster highlights the importance of the term "stock price movement" inside the cluster and the focus of the study. Other factors, such as those related to stock price prediction and data mining, are also emphasized. The red cluster result indicates that community involvement is crucial in sentiment analysis and stock price movement.Additionally, the blue cluster represents the second grouping. The term "preferences" in the investment context is the most significant concept in the blue cluster.

These examples of algorithms—conservation and protected areas, for example—should be given more priority by the stock price prediction. For this reason, the blue cluster also stresses the park's role as the focus of investment.[14]

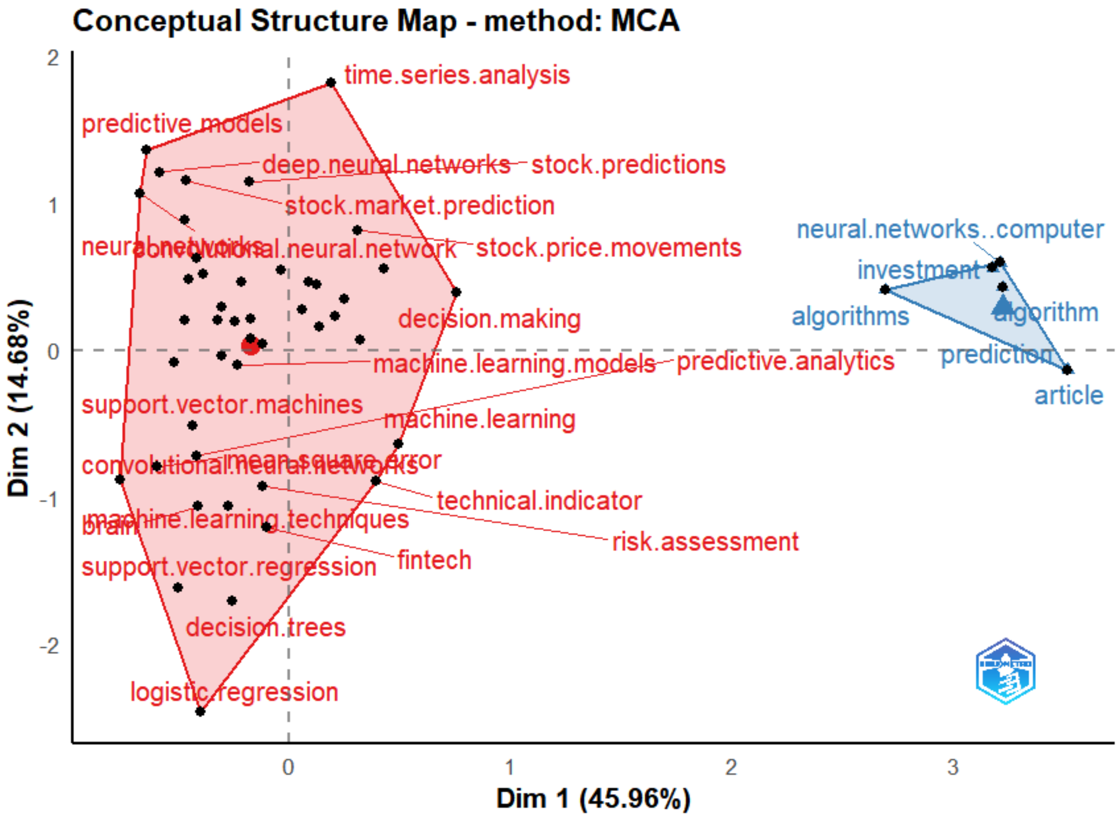


Fig.24.Multi Dimensional Scaling Analysis

3.2 Factorial Analysis topic dendrogram Multiple Correspondence analysis filed keyword plus

A dendrogram graphically represents the findings of hierarchical cluster analysis. Hierarchical cluster analysis This graphic looks like a tree, and it shows how each level of hierarchical clustering is represented as the combination of two branches of the tree into a single one. The branches are symbolic representations of the clusters produced at each stage of the hierarchical clustering process. The method of Multiple Correspondence analysis and keyword plus words by cluster include forecasting, Financial Markets, stock price prediction, commerce electronic trading, deep learning, long short-term memory, investments, costs, and machine learning.

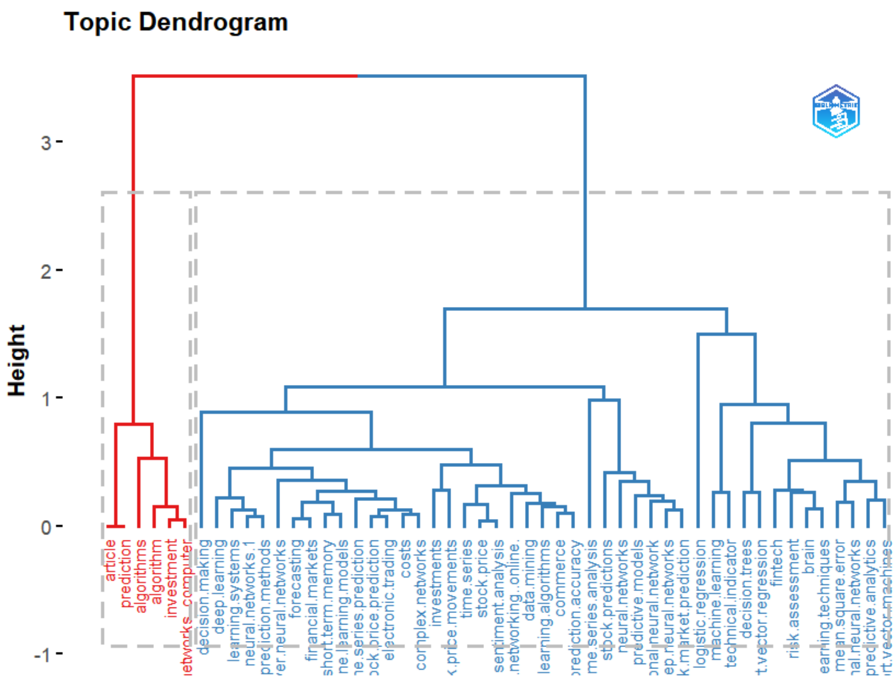


Fig.25. Factorial Analysis topic dendrogram

4. Conclusion

In conclusion, this paper provides a comprehensive and insightful exploration of the landscape surrounding Machine Learning and Deep Learning applications in Stock Price Prediction. Through an extensive bibliometric analysis spanning 2013 to 2022, this research has shed light on critical trends, influential contributors, and evolving themes within the field. The study's findings underscore the continued significance of predicting stock market movements, given its pivotal role in economic activities. Adopting advanced machine learning techniques reflects the persistent drive to enhance predictive accuracy and capture intricate market dynamics. By leveraging tools like Support Vector Machines, Neural Networks, and Reinforcement Learning, researchers have navigated the challenges posed by data complexity and market uncertainty. Analyzing publication patterns, author contributions, and country affiliations reveals an expanding landscape of research productivity. China's substantial presence in publications and citations underscores its dominance as a global contributor to this domain. This trend showcases the growing interest and commitment of countries like India and South Korea to establish their positions in this vital research area. Exploring co-occurrence and co-citation networks has highlighted influential papers and unveiled thematic shifts over the years. The emergence of "neural networks," "financial markets," and "stock price movements" as persistent and evolving themes reflects the community's focus on understanding complex market behaviors and enhancing prediction methodologies. Ultimately, this study enriches our understanding of the intricate relationship between Machine Learning, Deep Learning, and Stock Price Prediction. By offering insights into research trends, influential authors, and emerging themes, this paper is a valuable resource for researchers, practitioners, and policy-makers. As the field evolves, this comprehensive analysis provides a foundational reference point for further exploration and advancement in the quest for more accurate stock price prediction models.

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Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Scopus

Conflicts of Interest: The authors declare no conflict of interest.Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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