Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X
IMPACT FACTOR: 7.056

IJCSMC, Vol. 13, Issue. 11, November 2024, pg.45 – 58

Optimization Algorithms for Enhancing Fulfillment Engine Services in High-Demand Environments

Bhageerath Bogi

Independent Researcher, USA

DOI: https://doi.org/10.47760/ijcsmc.2024.v13i11.005

Abstract:
A hierarchical production planning system in a make-to-order setting is discussed in this work. Finding optimal production parameter settings to take use of well-established planning techniques is a difficult issue in this situation. In order to improve the systems overall efficiency, we provide a modular power system in this study that uses a Hydraulic Free Piston Engine (HFPE) as the power unit. We also design a power distribution control approach. The best practices and strategies for putting them into practice are determined. The usage of energy-saving technology, techniques for boosting recovery during braking, strategies for energy-efficient energy consumption, and ways to improve the traction drive's energy efficiency are all taken into consideration. This is because to server availability issues and resource limitations. Fault tolerance, migration prediction, and just anticipating failure are a few instances of algorithms having a single purpose. Fault tolerance is another example. The goal of this study is to identify the best course of action for switching from a poorly performing system to one that is doing effectively. The ability to anticipate a virtual machine's failure in a timely manner is crucial because of problems like wasted resources, energy, and money. The reliability of virtual machines, or VMs, has been a problem from the early days of cloud computing. Preventive procedures are an essential part of a fault tolerance system and are necessary to ensure service continuity. This means that improving and highlighting the proactive failure prediction of virtual machines is essential. Reduced downtime and improved scalability are the main drivers behind this. To safely move the resources that were expected to fail from one virtual machine (VM) to another, a strategy was used. The migration took less time to finish when the compression technique was used, but resource use went up. Effective defect prediction approaches in cloud computing are made possible by artificial intelligence in this article, which enhances resource optimisation.
Keywords: Virtual Machine (VM), Fault Tolerance System, Energy Consumption, Hydraulic Free Piston Engine (HFPE), Cloud Computing, Optimization, Planning Methods, Distribution Control Strategy, Energy Consumption, Environment.

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

I. INTRODUCTION

Due to their variable power outputs, the growing integration of Distributed Energy Resources (DERs) in contemporary distribution networks may result in voltage swings. Although over-voltage circumstances are more likely to occur, both under-voltage and over-voltage problems may arise in distribution networks with substantial DER penetration [1]. When DER production exceeds the load in a distribution network's sub-circuits, over-voltage circumstances may arise. This results in reverse power flow, which raises feeder voltages [1, 2]. When solar PVs are integrated between a Step Voltage Regulator and its Regulating Point (SVRRP), under-voltage problems may arise in a grid. There is a decrease in the quantity of SVR taps when a DER is operating at a leading power factor and near an SVR [2]. In contrast to the situation when the DER is run at a power factor around unity, this results in a lower voltage profile in the feeder [2, 3]. Furthermore, low voltage circumstances in the grid may result from a rapid ramp-down of PV output or an abrupt drop in PV generation during periods of high demand [3].

All distribution networks, however, are required by the ANSI C84 standard to maintain the voltage of their customers within a specified range (0.95 to 1.05 Pu) [1, 3]. Consequently, one of the best methods for reducing voltage fluctuation issues that has been effectively implemented in distribution grids is Volt-VAR optimisation (VVO) [3, 4]. Coordination of utility-owned device schedules, including the condition of capacitor banks and the tap settings of on-load tap changers (OLTCs), with reactive power injection/absorption by smart inverters, such as PV inverters and battery energy storage (BES) inverters, is the main purpose of daily VVO [3]. Using information on solar production and the load profile, the VVO schedules the available resources to keep the network's voltage profile within a reasonable range for a variety of PV generation or load conditions [4]. While maintaining the feeder's intended voltage profile, the VVO method must lower power losses throughout the distribution network [4]. Furthermore, to make sure that the usage of VVO solutions does not adversely affect inverter efficiency, the power losses resulting from altering their power factor must be taken into account [3, 5].

Over the years, modular power architecture (MPA) has attracted a lot of interest because of its notable flexibility in energy output characteristics and comparatively high efficiency [3, 5]. By regulating a certain number of autonomous power units, MPA attains great efficiency and allows the power system to function within an efficient range [4]. Fuel cells' linear link between fuel flow mass rate and power output made them popular in early power units.

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

Several fuel cells have been successfully constructed to increase the overall system efficiency [5, 6].

As shown by the establishment of a power system design that included an internal combustion engine and a battery, power units may take many different shapes [6, 7]. In order to guarantee regular power system functioning even in the face of severe circumstances brought on by unit failures, they also suggested a fault-tolerant control technique [4, 6]. Using comparable control techniques, a series-parallel hybrid powertrain architecture for automobiles was able to provide stable vehicle operation under failure patterns [6, 8]. However, the robust crankshaft construction of traditional internal combustion engines sometimes limits their adaptability [4, 6]. Researchers have created a number of new power unit patterns in recent decades in an effort to achieve flexible layout and energy output. One such pattern is the Hydraulic Free Piston Engine (HFPE), which has drawn more attention because of its straightforward design, low weight [6, 7], adaptable arrangement, and power output [6].

The internal combustion phase and the hydraulic phase are the two primary components of HFPE, in contrast to traditional crankshaft engines that are limited by the crankshaft and connecting rod [6, 7]. The piston assembly, which consists of the pump and combustion pistons, connects these two stages [6, 7]. In order to transform fuel energy into hydraulic energy, the moving piston assembly uses the gas pressure from the combustion chamber and the hydraulic pressure produced by the pump to undergo reciprocating motion [7].

Lithium-ion batteries (LIA) will continue to be the most common battery type used in electric cars, according to the IEA. At the moment, Li-Ion batteries may account for as much as 45% of an EV's price [6, 8]. This is predicated on a five-year average service life in the manufacturer's suggested settings. The unequal load caused by road conditions and the high cyclicality (reversibility) of the charge/discharge processes as a result of the battery's energy recovery in the electric braking mode are the distinguishing characteristics of battery operating modes in electric vehicles (EVs) [8]. When using the ETS, [8, 9], the battery is subjected to a broad variety of temperatures, heavy forced modes, variations in load current, and random changes in the frequency, length, and time of charge/discharge cycles [6, 7]. All of these elements have a major impact on the degeneration of electrode materials, altering the battery's operating parameters [6, 7], which causes the characteristics to deteriorate and accelerates battery wear [7, 8].

Therefore, a wide range of issues must be resolved in order to implement AB as a component of EFV, including identifying the factors influencing AB's ageing processes, managing

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

discharge/charge modes effectively, and figuring out the best ways to control the EFV power unit without degrading its dynamic properties [8, 9]. One significant technical and economic element influencing the pace of manufacturing of autonomous cars is AB service life [8, 9]. As a result, it is important to investigate problems pertaining to extending battery life and enhancing energy efficiency [9].

Manufacturing businesses often encounter difficult market conditions related to shifting demand and sophisticated products [9, 10]. In addition to product quality, their clients usually place a premium on logistical performance (such as service levels, delivery lead times, and average lateness) [10]. Despite referring to distinct planning levels, a number of choices that have a significant impact on one another must be properly made in order to stay competitive. Typical issues in this context are often described as tasks such as scheduling, lot size, order release, and capacity planning [11, 12]. Generally speaking, different choice levels correspond to varying aggregation degrees and time spans [12]. The primary cause of this is the growing degree of uncertainty associated with longer planning horizons [12, 13]. A hierarchical planning system may be used to try to coordinate choices made at various levels [13]. In the framework of make-to-order manufacturing, we introduce such a system. Data from the automotive supplier business has been used to develop our experimental framework [13].

Thus far, there hasn't been enough discussion about the best parameterisation of lot sizing techniques in this situation. Nonetheless, it has been specifically suggested that planning parameters be optimised concurrently. In a two-stage production system with varying customer due dates, an analytical model for concurrent capacity and anticipated lead time optimisation has been introduced [13, 14]. A disassembly remanufacturing system's planned lead times have been examined. In order to establish projected lead-times in capacity needs planning, a technique developed using Lagrange's method of indeterminate coefficients has been presented [13, 14]. Lead times for a system of make-to-order manufacturing that are planned [15]. To determine the ideal values of the planning parameters, they integrated their model into a non-linear optimisation algorithm; nevertheless, they note that it would have been beneficial to include the dynamics of MPS in this case [15].

Base stock levels, kanban counts, and projected supply lead times are all trade-offs in production/inventory systems with numerically advanced demand information [15, 16]. In a make-to-stock setting, they used a simulation-based optimisation technique. Inventory system optimisation using simulation has been explored [16]. Job shop scheduling is an operational planning issue that is addressed via simulation and optimisation [16, 17]. The use of

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

simulation-based sequencing optimisation has been explored for a production-inventory system with many items. They limit their search to straightforward structured rules that can be characterised by a few parameters since the issue is too complicated for an analytical solution [18]. They used a genetic algorithm as an optimiser in conjunction with a simulator. As part of their hybrid simulation optimisation approach, genetic algorithms [18, 19].

This method was used to optimise the control policies and production planning for remanufacturing scenarios [19, 20]. Supply chain network operational choices are supported by optimization-enabled discrete-event simulation. A simulation-based optimisation method that uses a relaxation-based schedule generating process to couple simulation with optimisation. They use this method to establish production plans for businesses that produce special purpose glasses on a make-to-order basis [16]. A decision assistance tool for steel production based on simulation optimisation is presented. They use an optimisation module created using Opt QuestTM to connect their simulation model for optimisation. They use their tool to do tests that look at the effects of altering two system elements at once in addition to single factor studies [16, 17].

This technology has the potential to change computer and storage accessibility in a number of ways in the very near future. The cloud gives cloud computing service provider's access to a more cost-effective and efficient infrastructure or platform [18]. Using cloud services is advantageous for a number of reasons [16, 17]. The extensive use of cloud technology has greatly increased service quality and reliability [18]. The pay-as-you-go cloud computing concept is based on the idea that the user is in charge of deciding whatever service level best suits their need. By connecting their gadgets to the Internet, users may use software, infrastructure, or cloud platforms [18] to run their own applications.

One may ascertain the level of quality that a service offers by looking at its metrics and Service Level Agreement (SLA) [18, 19]. A network of virtual machines (VMs), which act as the computing units in a cloud environment, may be created by connecting large and small data centres. This might be done to create a framework for the cloud. These virtual machines (VMs) should be able to do their tasks as quickly as is humanly possible according to the existing conditions [19]. This utility's main purpose is to transfer or swap out virtual machines without interfering with already running programs. For instance, it may be used to a broad range of applications to provide fault tolerance, alter virtual machine stacks, and save power consumption [20].

The major and secondary components of the plan are separated, as the name implies. In the past, both grids and clusters have been used to control the distribution and storage of various

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

resources [23]. Virtual environment resource optimisation may occur either as a stand-alone process or as part of a cloud service [24, 25]. The vast majority of scientists focus a large amount of their research on fault tolerance. The extent to which a process may be managed successfully without negatively impacting the outcomes it generates is known as failure tolerance [22, 23].

This will have no effect on the system's capacity to withstand total annihilation of the computers or the resources [21, 25], and an external trigger has no bearing on the intended operation. All of the world's issues may be linked to an overabundance of tools and processes. Furthermore, additional resources are required in order to finish the task using the already accessible software.

II. LITERATURE REVIEW

(Xing, Z. 2024) [26] Research on modular composition, configuration, and associated control techniques has increased as a result of the automotive industry's recent tendency towards vehicle modularisation. In order to improve the system's overall efficiency, we provide a modular power system in this work that uses a hydraulic free piston engine (HFPE) as the power unit. We also design a power distribution control approach. First, we use MATLAB/Simulink to create a simulation model of the HFPE and identify the modular power system's setup scheme. We verify the simulation model from a fundamental standpoint. Second, we investigate the power unit control strategy utilising the machine learning regression prediction method based on the HFPE simulation model, allowing the power unit to transition between dynamic operating conditions.

(Carpio, J. 2017) [27] The transportation industry has seen the fastest growth in fuel use over the last several decades. In Spain, transport accounts for 36% of energy consumption and 25% of greenhouse gas emissions. Because of this, a new emissions legislation has been enacted. The permissible limits of combustion gas emissions for new cars sold in every EU member state are governed by such laws. Parallel-hybrid electric cars are the subject of this study in an effort to combat rising environmental pollution and lower energy use. The current study models electric and parallel-hybrid electric vehicles using the Matlab/Simulink environment, which enables us to access various vehicle characteristics like engine power, battery type and size, or weight, and to see how modifications can impact the vehicle's performance and travel distance.

(Nayak, M. R. 2023) [28] In an effort to reduce pollution and fight climate change, vehicles all around the globe are switching to electric power. Increased public access to electric

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

vehicle charging stations (EVCS) is necessary to maintain this process. Significant technical, financial, and environmental challenges will arise from the unplanned increase in EVs and EVCS, which will affect the environment, EV users, charging stations, and the distribution network. Preventing the problems requires scheduling and coordinating EV charging and discharging at EVCSs.

(Li, K. 2020) [29] Cloud computing, a pay-as-you-go paradigm where computer resources and services are effectively given to cloud customers, is becoming more and more popular as the need for computing resources increases. Profit maximisation is usually the aim for cloud providers. However, cloud providers have a significant difficulty in maximising revenues in a fiercely competitive cloud industry. This article proposes a study of profit optimisation strategies to boost cloud provider profitability via the deployment of virtual network functions (VNFs), service quality enhancement, service pricing, and energy consumption reduction. The pricing plan for cloud resources to maximise income is covered after the strategy for enhancing the quality of user services.

III. METHODOLOGY

The model presented suggests that scientific approaches may be used to predict the inability to accomplish a task. A data flow and task dependencies are used to illustrate a process or computation for the sake of these applications in science [30]. When using Cloud resources, the effect of failure on these workflow activities may be reduced by proactively assessing data from different scientific workflows using state-of-the-art failure prediction techniques for machine learning [30, 31]. Real-time data analysis is used to achieve this. Task failures may occur during the scientific workflow scheduling process due to a number of reasons, such as excessive or insufficient resource usage, execution time or cost exceeding the threshold value, incorrect installation of necessary libraries, memory or disc space running out, and other similar situations [30, 31]. The main focus of the suggested paradigm for this study is the failure of tasks (of the central processor unit, [31], random access memory (RAM), disc storage, and network bandwidth) due to resource overutilization [33].

Figure 1 [31] displays the flowchart for defect prediction methods in a cloud computing context to enhance resource optimisation. The three main components of the fault prediction approach are feature selection from the input dataset using the PCA algorithm, data classification using Random Forest, Naive Bayes, and linear regression, and failure prediction [30, 31].

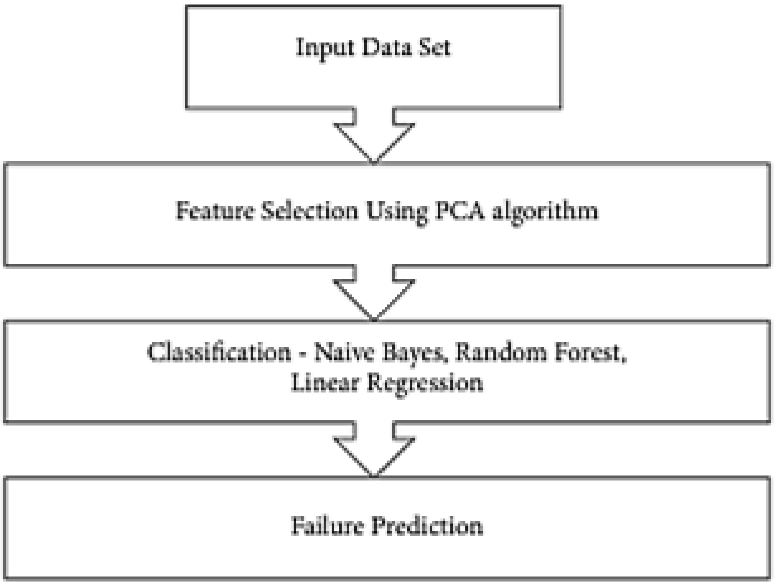

Fig. 1 Techniques for predicting faults in cloud computing environments to enhance resource optimisation. [31]

Either the forward selecting or the backward elimination technique may be used to determine which set of independent variables makes up the most beneficial set [31, 32].

IV. RESULT

The Laser Interferometer Gravitational-Wave Observatory (LIGO) and the sRNA Identification Protocol using High throughput Technology (SIPHT) [32]. Just a few of the many instances of scientific process applications that are examined and documented as part of the recommended methodology are included in spiral [32]. By comparing the threshold values for CPU, [33], bandwidth, random access memory, and disc utilisation, the resource consumption characteristics were assessed. By examining the historical data of unsuccessful tasks brought on by overuse of virtual machines (VMs), the threshold values have been established [33]. The procedure would be considered failure if the value of the utilisation parameter exceeded the upper limit of the threshold; if not, it would be considered successful [32]. After that, a machine learning approach with the fewest practical RMSE, MAPE, and overall accuracy errors was used to build the failure prediction model. It was determined to take this measure [32].

Task ID, VM ID, Data Centre ID, CPU Utilisation, Bandwidth Utilisation, RAM Utilisation, [32, 33], Disc Utilisation, Task Size, and Status are the nine characteristics that make up the input data set. Three criteria—accuracy, sensitivity, [34], RMSE, and specificity—are used in this work to assess and compare the performance of many alternative algorithms. Results are shown in Table 1–4 [34].

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

Table 1 Classifier Accuracy Compression for Predicting Task Failure in a Cloud Environment. [34]

Naïve Bayes	Random Forest	Liner regression
121.25	97.51	89.08

Table 2 Sensitivity compression of classifiers for cloud-based task failure prediction. [34]

Naïve Bayes	Random Forest	Liner regression
126.96	92.65	80.96

Table 3 Classifiers' Specificity Compression for Predicting Task Failure in a Cloud Environment. [34, 35]

Naïve Bayes	Random Forest	Liner regression
122.69	93.65	84.59

Table 4 Classifiers' RMSE compression for task failure prediction in a cloud setting. [35]

Naïve Bayes	Random Forest	Liner regression
15.58	26.54	38.45

$$Accuracy = \frac{TP+TN}{TP+TN+FN+FN} \quad \ldots\ldots.1$$

$$Sensitivity = \frac{TP}{TP+FN} \quad \ldots\ldots.2$$

$$Specificity = \frac{TN}{TN+FP} \quad \ldots\ldots.3$$

where FP stands for false positive, FN for false negative, TP for true positive, and TN for true negative [36, 37].

The electro-mechanical connection for EVs may be controlled to save energy. Both earlier research and the authors' work [4] demonstrate this. A Sliding Mode Control (SMC) algorithm is suggested by the authors. According to the authors' analysis, this algorithm produces positive outcomes for distributed drive electric vehicles (DDEVs). The Traction Control System (TCS) makes use of it [35, 36]. Conditions that cause a loss of traction may occur in certain crucial instances when a normal TCS is operating. You can resolve this issue using SMC. The foundation of SMC is figuring out the ideal sliding speed. In this instance, torque is transmitted at a faster pace. SMC enhances handling and dynamic performance for DDEVs, according to simulations conducted using the d SPACE software tool.

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

Altering the gearbox may improve the handling and power consumption of EVs, particularly those that are highly loaded. A more effective utilisation of power may be achieved by using multi-speed gearboxes [37]. Different gearbox alternatives for EVs are taken into consideration. Additionally, potential ideas were recognised in addition to the existing status of industry and research [36, 37]. According to the authors' research, using a multi-stage gearbox layout may reduce the driving cycle's energy consumption by a few to thirty percent [38]. Naturally, the kind of vehicle and traffic conditions will determine how much energy is saved [39, 40]. Given the high cost of upgrading from a basic to a multi-speed gearbox, it is important to identify the circumstances in which such an upgrade would be financially justifiable.

V. CONCLUSION

In the event that a virtual machine fails, the majority of fault tolerance approaches now in use concentrate more emphasis on creating clones to replace it than on anticipating the failure beforehand. In the case of a virtual machine (VM) failure, a number of the existing methods prioritise migration above recovery.

The creation of the vehicle model is crucial, according to an analysis of the majority of authors' works in the area of electric transport vehicle energy efficiency. Physical principles are fundamental to the development of vehicles, yet researchers often lack a complete understanding of the physical and chemical makeup of objects and occurrences. Every model has a certain range of applications, and what works for one item may not work for another. There isn't a single, universal strategy for increasing energy efficiency. After a careful feasibility examination of the many suggested models, a decision must be made.

In order to increase the energy efficiency of electric vehicles, this study examines the primary techniques and technologies now in use. Various approaches are used for various kinds of vehicles, as the overview that was provided makes clear.

Reductions in downtime and increased scalability are the main drivers behind this. To safely move the resources that were expected to fail from one virtual machine (VM) to another, a strategy was used. Utilising the compression approach improves resource utilisation while decreasing the time required to finish the move. In order to enhance resource optimisation, this article presents artificial intelligence that made it possible for cloud computing to use efficient defect prediction approaches.

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

REFERENCES

[1]. Mamun, K.A.; Islam, F.R.; Haque, R.; Chand, A.A.; Prasad, K.A.; Goundar, K.K.; Prakash, K.; Maharaj, S. Systematic Modeling and Analysis of On-Board Vehicle Integrated Novel Hybrid Renewable Energy System with Storage for Electric Vehicles. Sustainability 2022, 14, 2538.

[2]. Jin, Z.; Li, D.; Hao, D.; Zhang, Z.; Guo, L.; Wu, X.; Yuan, Y. A portable, auxiliary photovoltaic power system for electric vehicles based on a foldable scissors mechanism. Energy Built Environ. 2022.

[3]. Chao, P.-P.; Zhang, R.-Y.; Wang, Y.-D.; Tang, H.; Dai, H.-L. Warning model of new energy vehicle under improving time-to-rollover with neural network. Meas. Control. 2022, 55, 1004–1015.

[4]. Kokourov, D.V.; Malozyomov, B.V. Algorithm for improving energy efficient wheel motor for electric vehicles. J. Phys. Conf. Ser. 2021, 2061, 012049.

[5]. Laadjal, K.; Cardoso, A.J.M. Estimation of Lithium-Ion Batteries State-Condition in Electric Vehicle Applications. Issues and State of the Art. Electronics 2021, 10, 1588.

[6]. Arango, I.; Lopez, C.; Ceren, A. Improving the Autonomy of a Mid-Drive Motor Electric Bicycle Based on System Efficiency Maps and Its Performance. World Electr. Veh. J. 2021, 12, 59.

[7]. Mei, J.; Zuo, Y.; Lee, C.H.; Wang, X.; Kirtley, J.L. Stochastic optimization of multi-energy system operation considering hydrogen-based vehicle applications. Adv. Appl. Energy 2021, 2, 100031.

[8]. Wu, X. Research and Implementation of Electric Vehicle Braking Energy Recovery System Based on Computer. J. Phys. Conf. Ser. 2021, 1744, 022080.

[9]. Istomin, S. Development of a system for electric power consumption control by electric rolling stock on traction tracks of locomotive depots. IOP Conf. Ser. Mater. Sci. Eng. 2020, 918, 012157.

[10]. Domanov, K.; Shatohin, A.; Nezevak, V.; Cheremisin, V. Improving the technology of operating electric locomotives using electric power storage device. E3S Web Conf. 2019, 110, 01033.

[11]. Debelov, V.V.; Endachev, D.V.; Yakunov, D.M.; Deev, O.I. Charging balance management technology for low-voltage battery in the car control unit with combined power system. IOP Conf. Ser. Mater. Sci. Eng. 2019, 534, 012029.

[12]. M. Becherif, F. Claude, T. Hervier, and L. Boulon, "Multi-stack Fuel Cells Powering a Vehicle," Energy Procedia, vol. 74, pp. 308-319, 2015.

[13]. M. Raceanu, N. Bizon, and M. Varlam, "Experimental Results for an OffRoad Vehicle Powered by a Modular Fuel Cell Systems Using an Innovati ve Startup Sequence," Energies, vol. 15, no. 23, 2022.

[14]. B. Wwa, C. Jsb, B. Zza, and L. A. Cheng, "Optimization of a dual-motor c oupled powertrain energy management strategy for a battery electric bus," Energy Procedia, vol. 145, pp. 20-25, 2018.

[15]. N. Bizon, S. Pierfederici, M. Bahrami, and P. Thounthong, "Power equaliz er for a series fuel cell architecture based on load tracking control," Renew able and Sustainable Energy Reviews, vol. 166, 2022.

[16]. S. Zhou et al., "A review on proton exchange membrane multi-stack fuel c ell systems: architecture, performance, and power management," Applied Energy, vol. 310, 2022.

[17]. W. Kong, Y. Luo, Z. Qin, Y. Qi, and X. Lian, "Comprehensive Fault Diagnosis and Fault-Tolerant Protection of In-Vehicle Intelligent Electric Power Supply Network," IEEE Transactions on Vehicular Technology, vol. 6 8, no. 11, pp. 10453-10464, 2019.

[18]. L. Boulon, A. Bouscayrol, D. Hissel, O. Pape, and M.-C. Pera, "Inversion-Based Control of a Highly Redundant Military HEV," IEEE Transactions on Vehicular Technology, vol. 62, no. 2, pp. 500-510, 2013.

[19]. R. Mikalsen and A. P. Roskilly, "A review of free-piston engine history and applications," Applied Thermal Engineering, vol. 27, no. 14-15, pp. 23 39-2352, 2007.

[20]. R. Mikalsen and A. P. Roskilly, "A computational study of free-piston diesel engine combustion," Applied Energy, vol. 86, no. 7-8, pp. 1136-1143, 2009.

[21]. R. Mikalsen and A. P. Roskilly, "Coupled dynamic–multidimensional modelling of free-piston engine combustion," Applied Energy, vol. 86, no. 1, pp. 89-95, 2009.

[22]. Z. Zhao, F. Zhang, Y. Huang, C. Zhao, and F. Guo, "An experimental study of the hydraulic free piston engine," Applied Energy, vol. 99, pp. 226-2 33, 2012.

[23]. A. Hibi and T. Ito, "Fundamental test results of a hydraulic free piston internal combustion engine," Proceedings of The Institution of Mechanical Engineers Part D-Journal of Automobile Engineering, vol. 218, no. 10, pp. 1149-1157, 2004.

[24]. B. Catal, "Software fault prediction: a literature review and current trends," Expert Systems with Applications, vol. 38, no. 4, pp. 4626–4636, 2011.

[25]. R. Malhotra and A. Jain, "Fault prediction using statistical and machine learning methods for improving software quality," Journal of Information Processing Systems, vol. 8, no. 2, pp. 241–262, 2012.

[26]. Fei, M., Zhang, Z., Zhao, W., Zhang, P., & Xing, Z. (2024). Optimal power distribution control in modular power architecture using hydraulic free piston engines. Applied Energy, 358, 122540.

[27]. Alegre, S., Míguez, J. V., & Carpio, J. (2017). Modelling of electric and parallel-hybrid electric vehicle using Matlab/Simulink environment and planning of charging stations through a geographic information system and genetic algorithms. Renewable and Sustainable Energy Reviews, 74, 1020-1027.

[28]. Ray, S., Kasturi, K., Patnaik, S., & Nayak, M. R. (2023). Review of electric vehicles integration impacts in distribution networks: Placement, charging/discharging strategies, objectives and optimisation models. Journal of Energy Storage, 72, 108672.

[29]. Cong, P., Xu, G., Wei, T., & Li, K. (2020). A survey of profit optimization techniques for cloud providers. ACM Computing Surveys (CSUR), 53(2), 1-35.

[30]. X. Zhang, K. P. Rane, I. Kakaravada, and M. Shabaz, "Research on vibration monitoring and fault diagnosis of rotating machinery based on internet of things technology," Nonlinear Engineering, vol. 10, no. 1, pp. 245–254, 2021.

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

[31]. M. Glass, M. Lukasiewycz, T. Streichert, C. Haubelt, and J. Teich, "Reliability- Aware System Synthesis," in Proceedings of the 2007 Design, Automation and Test Europe Conference and Exhibition, pp. 1–6, Nice, France, April 2007.

[32]. D. Koch, T. Streichert, S. Dittrich, C. Strengert, C. Haubelt, and Teich, "An operating system infrastructure for fault tolerant reconfigurable networks," in Proceedings of the 19th International Conference on Architecture of Computing Systems, pp. 202–212, Springer, Berlin, Germany, March 2006.

[33]. M. Fan, D. Su, M. W. Bhatt, and A. Mangal, "Study on nonlinear planning model of green building energy consumption under multi-objective optimization," International Journal of System Assurance Engineering and Management, vol. 13, no. 1, pp. 437–443, 2021.

[34]. Graber, G.; Calderaro, V.; Galdi, V. Two-Stage Optimization Method for Sizing Stack and Battery Modules of a Fuel Cell Vehicle Based on a Power Split Control. Electronics 2022, 11, 361.

[35]. Davydenko, L.; Davydenko, N.; Bosak, A.; Bosak, A.; Deja, A.; Dzhuguryan, T. Smart Sustainable Freight Transport for a City Multi-Floor Manufacturing Cluster: A Framework of the Energy Efficiency Monitoring of Electric Vehicle Fleet Charging. Energies 2022, 15, 3780.

[36]. Lu, Y.; Liu, W.; Wu, Y.; Li, H.; Liu, Y.; Peng, J.; Huang, Z. A Quasi-Optimal Energy Management Strategy for Hybrid Energy Vehicles Using Temporal Characteristic. Adv. Transdiscipl. Eng. 2022, 22, 392–397.

[37]. Ferrara, A.; Zendegan, S.; Koegeler, H.-M.; Gopi, S.; Huber, M.; Pell, J.; Hametner, C. Optimal Calibration of an Adaptive and Predictive Energy Management Strategy for Fuel Cell Electric Trucks. Energies 2022, 15, 2394.

[38]. Gim, J.; Kim, M.; Ahn, C. Energy Management Control Strategy for Saving Trip Costs of Fuel Cell/Battery Electric Vehicles. Energies 2022, 15, 2131.

[39]. Geng, S.; Schulte, T.; Maas, J. Model-Based Analysis of Different Equivalent Consumption Minimization Strategies for a Plug-In Hybrid Electric Vehicle. Appl. Sci. 2022, 12, 2905.

[40]. Donatantonio, F.; Ferrara, A.; Polverino, P.; Arsie, I.; Pianese, C. Novel Approaches for Energy Management Strategies of Hybrid Electric Vehicles and Comparison with Conventional Solutions. Energies 2022, 15, 1972.

[41]. Naveen Bagam, International Journal of Computer Science and Mobile Computing, Vol.13 Issue.11, November- 2024, pg. 6-27

[42]. Naveen Bagam. (2024). Optimization of Data Engineering Processes Using AI. *International Journal of Research Radicals in Multidisciplinary Fields, ISSN: 2960-043X*, *3*(1), 20–34. Retrieved from https://www.researchradicals.com/index.php/rr/article/view/138

[43]. Naveen Bagam. (2024). Machine Learning Models for Customer Segmentation in Telecom. *Journal of Sustainable Solutions*, *1*(4), 101–115. https://doi.org/10.36676/j.sust.sol.v1.i4.42

[44]. Bagam, N. (2023). Implementing Scalable Data Architecture for Financial Institutions. *Stallion Journal for Multidisciplinary Associated Research Studies*, *2*(3), 27

[45]. Bagam, N. (2021). Advanced Techniques in Predictive Analytics for Financial Services. *Integrated Journal for Research in Arts and Humanities*, *1*(1), 117–126. https://doi.org/10.55544/ijrah.1.1.16

[46]. Enhancing Data Pipeline Efficiency in Large-Scale Data Engineering Projects. (2019). *International Journal of Open Publication and Exploration, ISSN: 3006-2853*, *7*(2), 44-57. https://ijope.com/index.php/home/article/view/166

[47]. Sai Krishna Shiramshetty. (2024). Enhancing SQL Performance for Real-Time Business Intelligence Applications. *International Journal of Multidisciplinary Innovation and Research Methodology, ISSN: 2960-2068*, *3*(3), 282–297. Retrieved from https://ijmirm.com/index.php/ijmirm/article/view/138

[48]. Sai Krishna Shiramshetty, "Big Data Analytics in Civil Engineering : Use Cases and Techniques", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 3, Issue 1, pp.39-46, January-February.2019
URL : https://ijsrce.com/IJSRCE19318

[49]. Sai Krishna Shiramshetty, " Data Integration Techniques for Cross-Platform Analytics, IInternational Journal of Scientific Research in Computer Science, Engineering and Information Technology(IJSRCSEIT), ISSN : 2456-3307, Volume 6, Issue 4, pp.593-599, July-August-2020. Available at doi : https://doi.org/10.32628/CSEIT2064139

[50]. Shiramshetty, S. K. (2021). SQL BI Optimization Strategies in Finance and Banking. *Integrated Journal for Research in Arts and Humanities*, *1*(1), 106–116. https://doi.org/10.55544/ijrah.1.1.15

[51]. Sai Krishna Shiramshetty. (2022). Predictive Analytics Using SQL for Operations Management. *Eduzone: International Peer Reviewed/Refereed Multidisciplinary Journal*, *11*(2), 433–448. Retrieved from https://eduzonejournal.com/index.php/eiprmj/article/view/693

[52]. Shiramshetty, S. K. (2023). Data warehousing solutions for business intelligence. *International Journal of Computer Science and Mobile Computing*, *12*(3), 49–62. https://ijcsmc.com/index.php/volume-12-issue-3-march-2023/

[53]. Sai Krishna Shiramshetty. (2024). Comparative Study of BI Tools for Real-Time Analytics. *International Journal of Research and Review Techniques*, *3*(3), 1–13. Retrieved from https://ijrrt.com/index.php/ijrrt/article/view/210

[54]. Sai Krishna Shiramshetty "Leveraging BI Development for Decision-Making in Large Enterprises" Iconic Research And Engineering Journals Volume 8 Issue 5 2024 Page 548-560

[55]. Sai Krishna Shiramshetty "Integrating SQL with Machine Learning for Predictive Insights" Iconic Research And Engineering Journals Volume 1 Issue 10 2018 Page 287-292

[56]. Shiramshetty, S. K. (2023). Advanced SQL Query Techniques for Data Analysis in Healthcare. *Journal for Research in Applied Sciences and Biotechnology*, *2*(4), 248–258. https://doi.org/10.55544/jrasb.2.4.33

[57]. Naveen Bagam. (2024). Data Integration Across Platforms: A Comprehensive Analysis of Techniques, Challenges, and Future Directions. *International Journal of Intelligent Systems and Applications in Engineering*, *12*(23s), 902–919. Retrieved from https://ijisae.org/index.php/IJISAE/article/view/7062

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden

[58]. Naveen Bagam, Sai Krishna Shiramshetty, Mouna Mothey, Harish Goud Kola, Sri Nikhil Annam, & Santhosh Bussa. (2024). Advancements in Quality Assurance and Testing in Data Analytics. *Journal of Computational Analysis and Applications (JoCAAA)*, *33*(08), 860–878. Retrieved from https://eudoxuspress.com/index.php/pub/article/view/1487

[59]. Bagam, N., Shiramshetty, S. K., Mothey, M., Kola, H. G., Annam, S. N., & Bussa, S. (2024). Optimizing SQL for BI in diverse engineering fields. *International Journal of Communication Networks and Information Security, 16*(5). https://ijcnis.org/

[60]. Bagam, N., Shiramshetty, S. K., Mothey, M., Annam, S. N., & Bussa, S. (2024). Machine Learning Applications in Telecom and Banking. *Integrated Journal for Research in Arts and Humanities*, *4*(6), 57–69. https://doi.org/10.55544/ijrah.4.6.8

[61]. Bagam, N., Shiramshetty, S. K., Mothey, M., Kola, H. G., Annam, S. N., & Bussa, S. (2024). Collaborative approaches in data engineering and analytics. *International Journal of Communication Networks and Information Security, 16*(5). https://ijcnis.org/

[62]. Kola, H. G. (2024). Optimizing ETL Processes for Big Data Applications. *International Journal of Engineering and Management Research*, *14*(5), 99–112. https://doi.org/10.5281/zenodo.14184235

[63]. SQL in Data Engineering: Techniques for Large Datasets. (2023). *International Journal of Open Publication and Exploration, ISSN: 3006-2853*, *11*(2), 36-51. https://ijope.com/index.php/home/article/view/165

[64]. Data Integration Strategies in Cloud-Based ETL Systems. (2023). *International Journal of Transcontinental Discoveries, ISSN: 3006-628X*, *10*(1), 48-62. https://internationaljournals.org/index.php/ijtd/article/view/116

[65]. Harish Goud Kola. (2024). Real-Time Data Engineering in the Financial Sector. *International Journal of Multidisciplinary Innovation and Research Methodology, ISSN: 2960-2068*, *3*(3), 382–396. Retrieved from https://ijmirm.com/index.php/ijmirm/article/view/143

[66]. Harish Goud Kola. (2022). Best Practices for Data Transformation in Healthcare ETL. *Edu Journal of International Affairs and Research, ISSN: 2583-9993*, *1*(1), 57–73. Retrieved from https://edupublications.com/index.php/ejiar/article/view/106

[67]. Kola, H. G. (2018). Data warehousing solutions for scalable ETL pipelines. *International Journal of Scientific Research in Science, Engineering and Technology*, *4*(8), 762. https://doi.org/10.1.1.123.4567

[68]. Harish Goud Kola, " Building Robust ETL Systems for Data Analytics in Telecom , IInternational Journal of Scientific Research in Computer Science, Engineering and Information Technology(IJSRCSEIT), ISSN : 2456-3307, Volume 5, Issue 3, pp.694-700, May-June-2019. Available at doi : https://doi.org/10.32628/CSEIT1952292

[69]. Kola, H. G. (2022). Data security in ETL processes for financial applications. *International Journal of Enhanced Research in Science, Technology & Engineering*, *11*(9), 55. https://ijsrcseit.com/CSEIT1952292.

[70]. Annam, S. N. (2020). Innovation in IT project management for banking systems. *International Journal of Enhanced Research in Science, Technology & Engineering, 9*(10), 19. https://www.erpublications.com/uploaded_files/download/sri-nikhil-annam_gBNPz.pdf

[71]. Annam, S. N. (2018). Emerging trends in IT management for large corporations. *International Journal of Scientific Research in Science, Engineering and Technology*, *4*(8), 770. https://ijsrset.com/paper/12213.pdf

[72]. Sri Nikhil Annam, " IT Leadership Strategies for High-Performance Teams, IInternational Journal of Scientific Research in Computer Science, Engineering and Information Technology(IJSRCSEIT), ISSN : 2456-3307, Volume 7, Issue 1, pp.302-317, January-February-2021. Available at doi : https://doi.org/10.32628/CSEIT228127

[73]. Annam, S. N. (2024). Comparative Analysis of IT Management Tools in Healthcare. *Stallion Journal for Multidisciplinary Associated Research Studies*, *3*(5), 72–86. https://doi.org/10.55544/sjmars.3.5.9.

[74]. Annam, N. (2024). AI-Driven Solutions for IT Resource Management. *International Journal of Engineering and Management Research*, *14*(6), 15–30. https://doi.org/10.31033/ijemr.14.6.15-30

[75]. Annam, S. N. (2022). Optimizing IT Infrastructure for Business Continuity. *Stallion Journal for Multidisciplinary Associated Research Studies*, *1*(5), 31–42. https://doi.org/10.55544/sjmars.1.5.7

[76]. Sri Nikhil Annam , " Managing IT Operations in a Remote Work Environment, IInternational Journal of Scientific Research in Computer Science, Engineering and Information Technology(IJSRCSEIT), ISSN : 2456-3307, Volume 8, Issue 5, pp.353-368, September-October-2022. https://ijsrcseit.com/paper/CSEIT23902179.pdf

[77]. Annam, S. (2023). Data security protocols in telecommunication systems. *International Journal for Innovative Engineering and Management Research, 8*(10), 88–106. https://www.ijiemr.org/downloads/paper/Volume-8/data-security-protocols-in-telecommunication-systems

[78]. Annam, S. N. (2023). Enhancing IT support for enterprise-scale applications. *International Journal of Enhanced Research in Science, Technology & Engineering, 12*(3), 205. https://www.erpublications.com/uploaded_files/download/sri-nikhil-annam_urfNc.pdf

[79]. Santhosh Bussa, "Advancements in Automated ETL Testing for Financial Applications", IJRAR - International Journal of Research and Analytical Reviews (IJRAR), E-ISSN 2348-1269, P- ISSN 2349-5138, Volume.7, Issue 4, Page No pp.426-443, November 2020, Available at : http://www.ijrar.org/IJRAR2AA1744.pdf

[80]. Bussa, S. (2023). Artificial Intelligence in Quality Assurance for Software Systems. *Stallion Journal for Multidisciplinary Associated Research Studies*, *2*(2), 15–26. https://doi.org/10.55544/sjmars.2.2.2.

[81]. Bussa, S. (2021). Challenges and solutions in optimizing data pipelines. *International Journal for Innovative Engineering and Management Research*, *10*(12), 325–341. https://sjmars.com/index.php/sjmars/article/view/116

[82]. Bussa, S. (2022). Machine Learning in Predictive Quality Assurance. *Stallion Journal for Multidisciplinary Associated Research Studies*, *1*(6), 54–66. https://doi.org/10.55544/sjmars.1.6.8

[83]. Bussa, S. (2022). Emerging trends in QA testing for AI-driven software. *International Journal of All Research Education and Scientific Methods (IJARESM, 10*(11), 1712. Retrieved from http://www.ijaresm.com

[84]. Santhosh Bussa. (2024). Evolution of Data Engineering in Modern Software Development. *Journal of Sustainable Solutions*, *1*(4), 116–130. https://doi.org/10.36676/j.sust.sol.v1.i4.43

[85]. Santhosh Bussa. (2024). Big Data Analytics in Financial Systems Testing. *International Journal of Multidisciplinary Innovation and Research Methodology, ISSN: 2960-2068*, *3*(3), 506–521. Retrieved from https://ijmirm.com/index.php/ijmirm/article/view/150

[86]. Bussa, S. (2019). AI-driven test automation frameworks. *International Journal for Innovative Engineering and Management Research*, *8*(10), 68–87. Retrieved from https://www.ijiemr.org/public/uploads/paper/427801732865437.pdf

[87]. Santhosh Bussa. (2023). Role of Data Science in Improving Software Reliability and Performance. *Edu Journal of International Affairs and Research, ISSN: 2583-9993*, *2*(4), 95–111. Retrieved from https://edupublications.com/index.php/ejiar/article/view/111

[88]. Bussa, S. (2023). Enhancing BI tools for improved data visualization and insights. *International Journal of Computer Science and Mobile Computing*, *12*(2), 70–92. https://doi.org/10.47760/ijcsmc.2023.v12i02.005.

[89]. Sai Krishna Shiramshetty. (2024). Enhancing SQL Performance for Real-Time Business Intelligence Applications. *International Journal of Multidisciplinary Innovation and Research Methodology, ISSN: 2960-2068*, *3*(3), 282–297. Retrieved from https://ijmirm.com/index.php/ijmirm/article/view/138

[90]. Sai Krishna Shiramshetty, "Big Data Analytics in Civil Engineering : Use Cases and Techniques", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 3, Issue 1, pp.39-46, January-February.2019
URL : https://ijsrce.com/IJSRCE19318

[91]. Sai Krishna Shiramshetty, " Data Integration Techniques for Cross-Platform Analytics, IInternational Journal of Scientific Research in Computer Science, Engineering and Information Technology(IJSRCSEIT), ISSN : 2456-3307, Volume 6, Issue 4, pp.593-599, July-August-2020. Available at doi : https://doi.org/10.32628/CSEIT2064139

[92]. Shiramshetty, S. K. (2021). SQL BI Optimization Strategies in Finance and Banking. *Integrated Journal for Research in Arts and Humanities*, *1*(1), 106–116. https://doi.org/10.55544/ijrah.1.1.15

[93]. Sai Krishna Shiramshetty. (2022). Predictive Analytics Using SQL for Operations Management. *Eduzone: International Peer Reviewed/Refereed Multidisciplinary Journal*, *11*(2), 433–448. Retrieved from https://eduzonejournal.com/index.php/eiprmj/article/view/693

[94]. Sai Krishna Shiramshetty. (2024). Comparative Study of BI Tools for Real-Time Analytics. *International Journal of Research and Review Techniques*, *3*(3), 1–13. Retrieved from https://ijrrt.com/index.php/ijrrt/article/view/210

[95]. Sai Krishna Shiramshetty "Leveraging BI Development for Decision-Making in Large Enterprises" Iconic Research And Engineering Journals Volume 8 Issue 5 2024 Page 548-560

[96]. Shiramshetty, S. K. (2023). Advanced SQL Query Techniques for Data Analysis in Healthcare. *Journal for Research in* Iconic Research And Engineering Journals*Applied Sciences and Biotechnology*, *2*(4), 248–258. https://doi.org/10.55544/jrasb.2.4.33

[97]. Sai Krishna Shiramshetty "Integrating SQL with Machine Learning for Predictive Insights" Iconic Research And Engineering Journals Volume 1 Issue 10 2018 Page 287-292

[98]. Shiramshetty, S. K. (2023). Advanced SQL Query Techniques for Data Analysis in Healthcare. *Journal for Research in Applied Sciences and Biotechnology*, *2*(4), 248–258. https://doi.org/10.55544/jrasb.2.4.33

[99]. Shiramshetty, S. K. (2023). Advanced SQL Query Techniques for Data Analysis in Healthcare. *Journal for Research in Applied Sciences and Biotechnology*, *2*(4), 248–258. https://doi.org/10.55544/jrasb.2.4.33

[100]. Mouna Mothey. (2022). Automation in Quality Assurance: Tools and Techniques for Modern IT. *Eduzone: International Peer Reviewed/Refereed Multidisciplinary Journal*, *11*(1), 346–364. Retrieved from https://eduzonejournal.com/index.php/eiprmj/article/view/694

[101]. Mothey, M. (2022). Leveraging Digital Science for Improved QA Methodologies. *Stallion Journal for Multidisciplinary Associated Research Studies*, *1*(6), 35–53. https://doi.org/10.55544/sjmars.1.6.7

[102]. Mothey, M. (2023). Artificial Intelligence in Automated Testing Environments. *Stallion Journal for Multidisciplinary Associated Research Studies*, *2*(4), 41–54. https://doi.org/10.55544/sjmars.2.4.5

[103]. Mouna Mothey. (2024). Test Automation Frameworks for Data-Driven Applications. *International Journal of Multidisciplinary Innovation and Research Methodology, ISSN: 2960-2068*, *3*(3), 361–381. Retrieved from https://ijmirm.com/index.php/ijmirm/article/view/14

[104]. Bagam, N., Shiramshetty, S. K., Mothey, M., Annam, S. N., & Bussa, S. (2024). Machine Learning Applications in Telecom and Banking. *Integrated Journal for Research in Arts and Humanities*, *4*(6), 57–69. https://doi.org/10.55544/ijrah.4.6.8

[105]. Harish Goud Kola. (2024). Real-Time Data Engineering in the Financial Sector. *International Journal of Multidisciplinary Innovation and Research Methodology, ISSN: 2960-2068*, *3*(3), 382–396. Retrieved from https://ijmirm.com/index.php/ijmirm/article/view/143

[106]. Harish Goud Kola. (2022). Best Practices for Data Transformation in Healthcare ETL. *Edu Journal of International Affairs and Research, ISSN: 2583-9993*, *1*(1), 57–73. Retrieved from https://edupublications.com/index.php/ejiar/article/view/106

© 2024, IJCSMC All Rights Reserved, ZAIN Publications, Fridhemsgatan 62, 112 46, Stockholm, Sweden