PRINCIPLES OF CHEMICAL ENGINEERING

Dr. ADWIN JOSE P
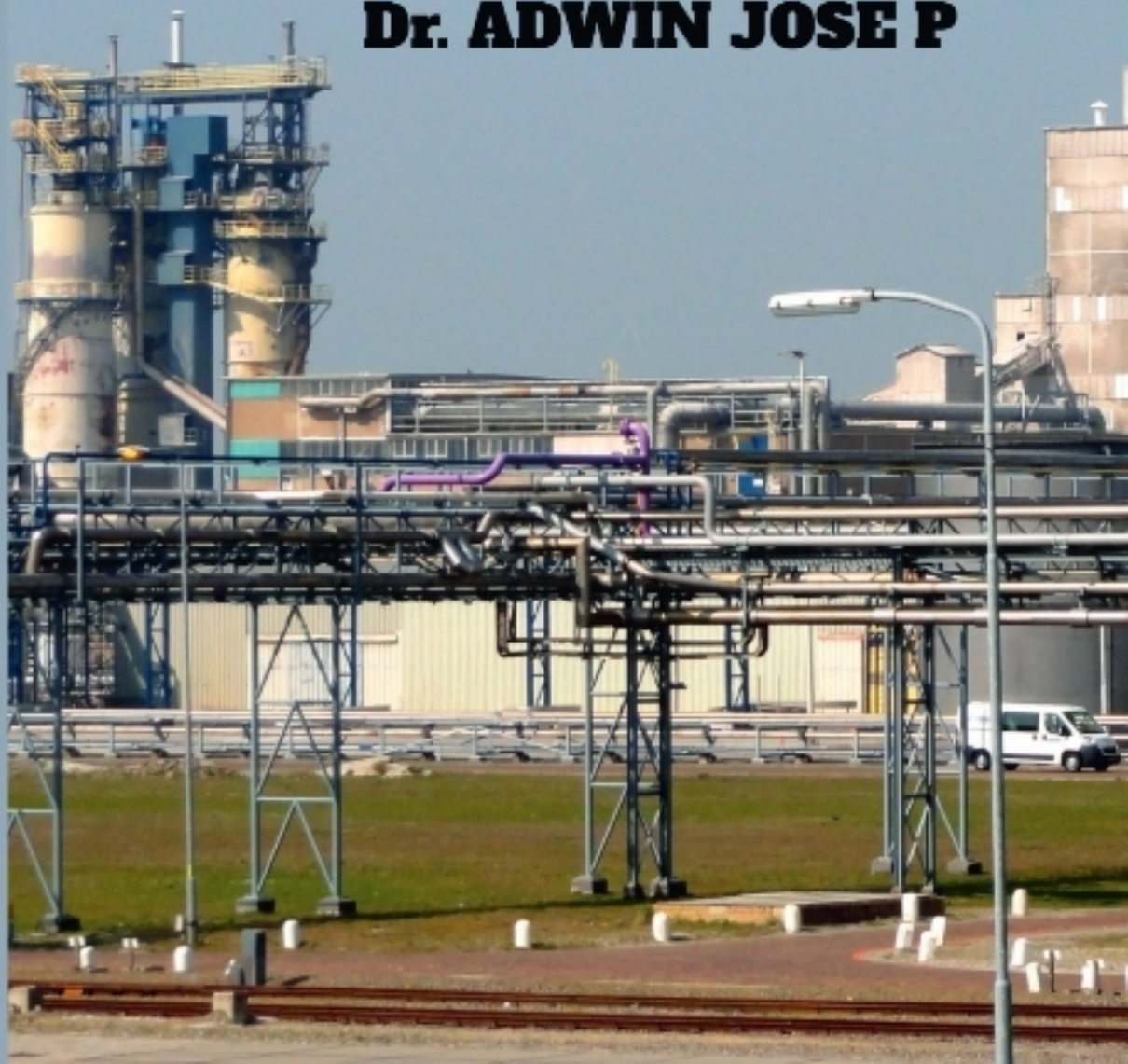
PRINCIPLES OF CHEMICAL ENGINEERING

A GUIDE TO CHEMICAL ENGINEERING STUDENTS

DR. ADWIN JOSE P

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I

CHEMICAL PROCESS INDUSTRIES

CHEMICAL PROCESS INDUSTRIES
INTRODUCTION

Any definition or description of the chemical process industry is always incomplete. Most process in the chemical industry involves a chemical change.

The chemical change includes chemical reactions and physiochemical changes. Mechanical changes are not considered the part of chemical process but it is essential to later chemical changes.

Example: The manufacture of plastic polyethylene using ethylene involves a chemical process. But molding and fabrication of the plastic resin into final shapes for consumer products would not be considered as chemical process.

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COSMETIC AND MEDICAL APPLICATIONS OF CHITOSAN COMPOUNDS
A Simple Guide For Reseachers

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COSMETIC AND MEDICAL APPLICATIONS OF CHITOSAN COMPOUNDS

A SIMPLE GUIDE TO ALL RESEARCHERS

DR. ADWIN JOSE P

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CHAPTER ONE

INTRODUCTION

The development of green technology, side effects and environmental issues associated with products from chemical sources make more and more researchers inclined towards synthesizing medicinal products or cosmetic products from biological sources like plants or animals. Recently, cosmetics from marine resources have emerged as a very effective, low cost, and easily synthesized alternative. Alginate, fucoidans, phlorotannin, and flucoxanthin are obtained from brown algae seaweeds, and carrageenan and mycosporine like amino acids (MAAs) from red algae seaweeds, and ulvans from green algae seaweed. Other marine compounds include glycogen from mussels, aluminum silicate from sea mud, squalene from shark, chitin and chitosan from crustacean shells.

Copolymerization of N-acetyl glucosamine and glucosamine yields chitin. When chitin undergoes deacetylation, the resulting N-deacetylated derivative is called chitosan. Natural chitin is available from some fungi and crustaceans. Chitosan is highly soluble in an aqueous medium. It has two hydroxy functional groups and one amino functional group which readily reacts with other chemical constituents and yields a new derivative. Chitosan derivatives are also bio-friendly materials characterized by their biodegradability, bioadhesiveness, non-toxicity, renewability, and biocompatibility. Cosmetic chitosan is also being used as a therapeutic agent in dental care, skincare, and in other personal care materials.

Cosmetics are generally defined as substances which are prepared to clean and protect external body parts, correct and enhance body odors, modify body appearance, and keep the body in good condition. Cosmetic materials are commonly used in the hair system, lips, nails, epidermis, external genital organs, mucous membrane of the oral cavity, and teeth [1]. Cosmetics are commonly used to decorate the body and are usually applied from the outside. Theyare not beingused to cure and treat diseases.

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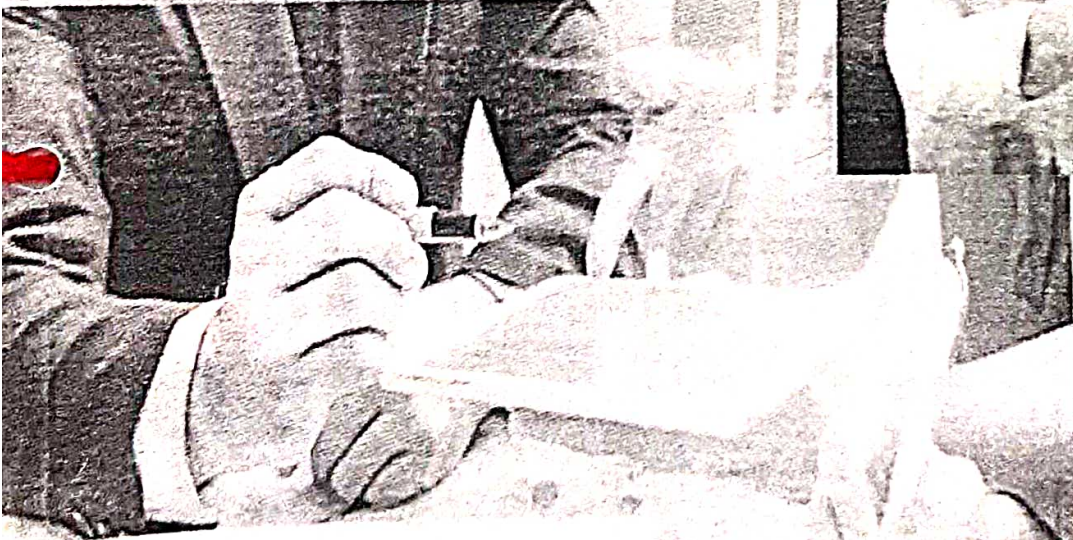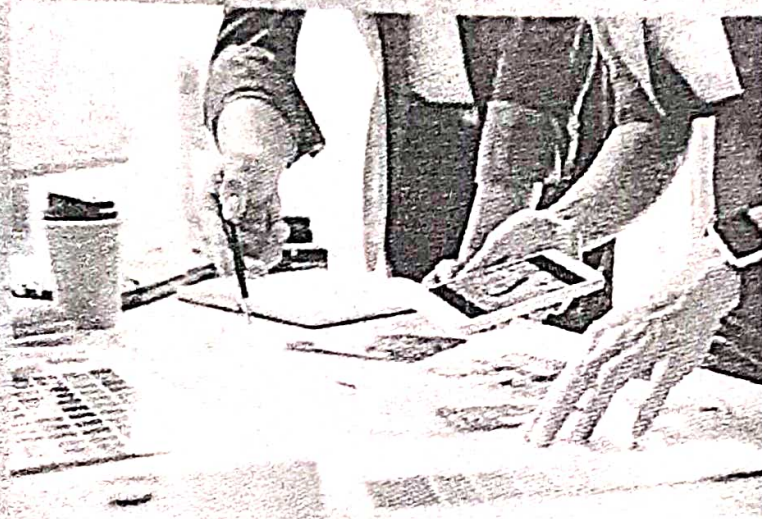
Dr. R. Karthi

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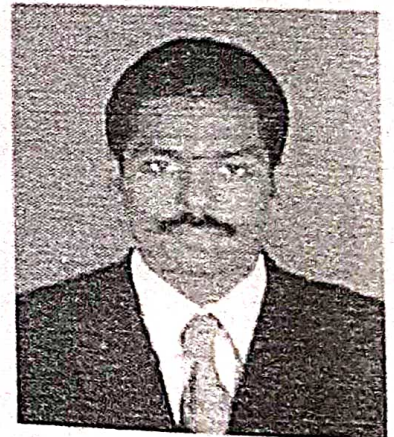
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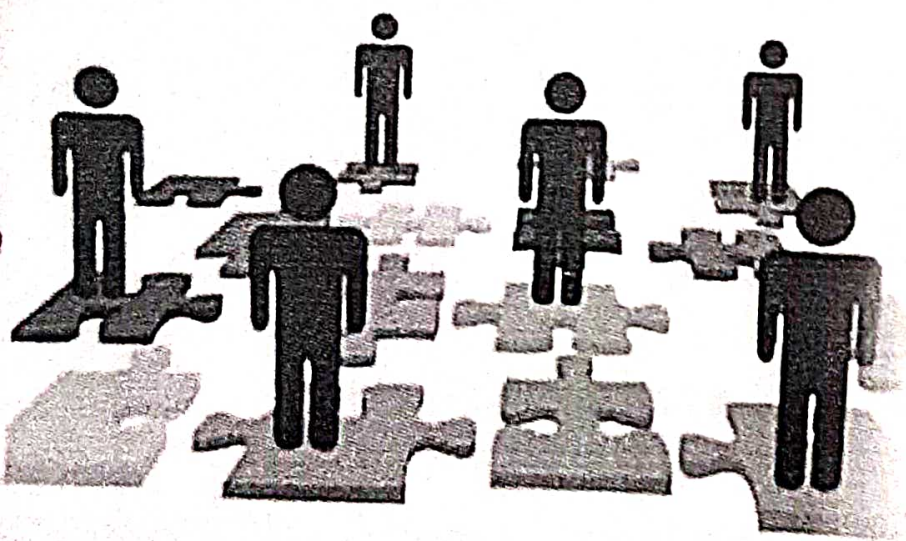
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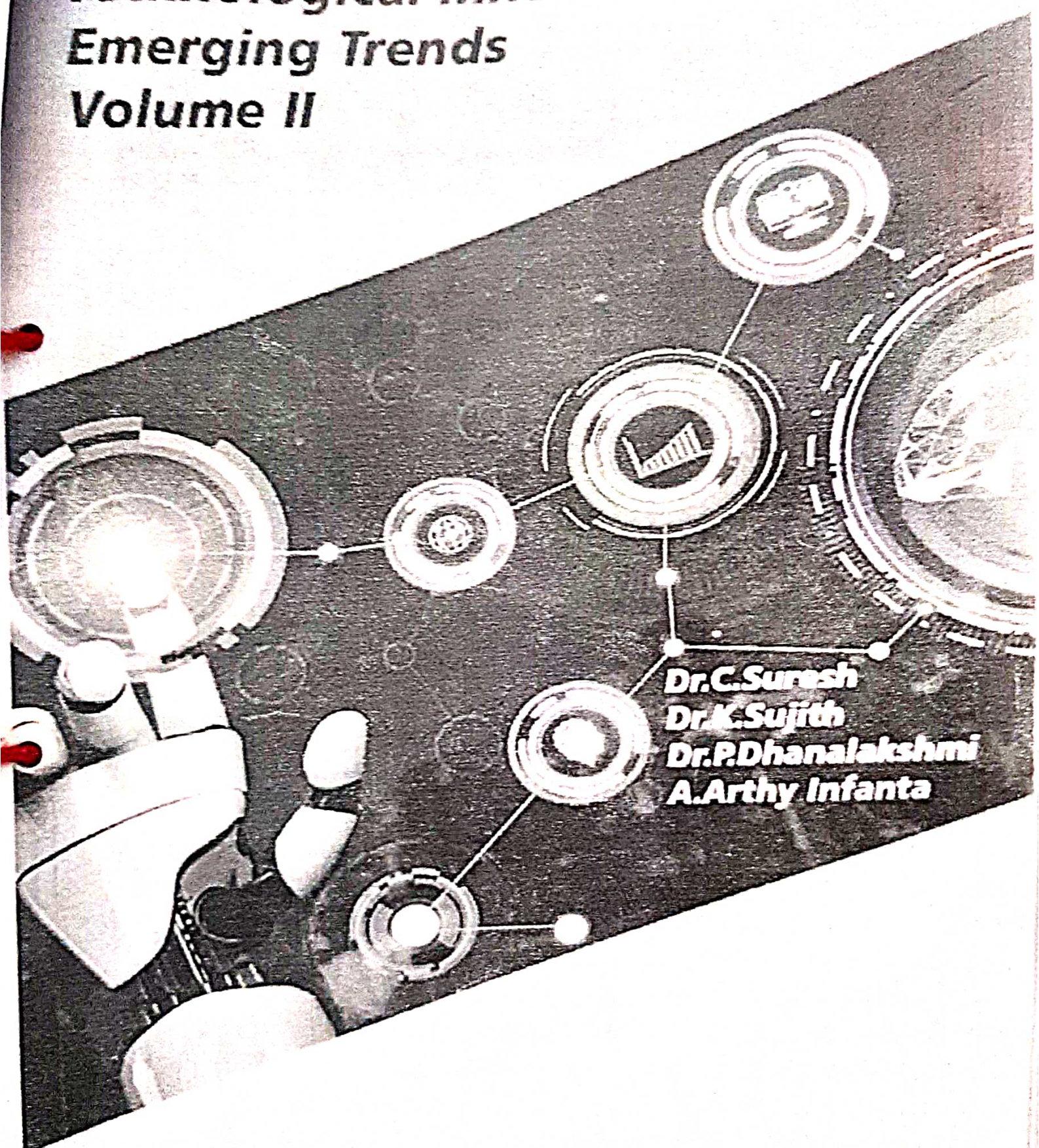
Business Environment & Technological Innovation – Emerging Trends Volume II

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Abstract

Block chain technology and the cryptocurrency are most important finance in the modern investment world. Many youngsters are started to learn cryptocurrency and in what way it is different from fiat currency. However, another avenue to invest their hard earned money for multiple returns. Investor must know how cryptocurrency works in Block chain technology, transferred and currency traded before investing on it. Though their investment made by various investors in different countries, but few countries like India does not accept the cryptocurrency and also not encourage younger to invest on it. The reason behind the poor welcome of cryptocurrency India is no regulation body and decentralized currency transaction move by persons. So the investors must thoroughly aware about the crypto blockchain, miners, token and various crypto currencies used in digital world.

Keywords: cryptocurrency, blockchain, miners, token, bitcoin, ethereum

Introduction

Satoshi Nakamoto described about the implementation of bitcoin in blockchain technology as a digital currency in 2008 Cryptocurrency decentralized digital money that's based on blockchain technology. There more than 6000 different crypto currencies in circulation including Bitcoin, Ethereum.

Cryptocurrency

Crypto currency is a digital payment system that doesn't rely on banks to transactions. It's a peer-to-peer system that can enable anyone anywhere and receive payments. Instead of being physical money carried and exchanged in the real world, cryptocurrency payments exist purely entries to an online database describing specific transactions. When cryptocurrency funds are transferred, the transactions are recorded in ledger. Cryptocurrency is stored in digital wallets. Cryptocurrency is name because it uses encryption to verify...

cryptocurrencies such as bitcoin ethereum than XRP, Tether, Polkadot and so on

Blockchain

A blockchain is an open, distributed ledger that records transactions in code. In practice, it's a little like a checkbook that's distributed across countless computers around the world. Transactions are recorded in "blocks" that are then linked together on a "chain" of previous cryptocurrency transactions. Blockchain is the underlying technology that many cryptocurrencies — like Bitcoin and Ethereum — operate on, but its unique way of secure, transparent, and transferring information has broader applications outside of cryptocurrency.

Blocks

Every chain consists of multiple blocks and each block has three basic elements

- The data in the block.

- A 32-bit whole number called a nonce. The nonce is randomly generated when a block is created, which then generates a block header hash

- The hash is a 256 bit number wedded to the nonce. It must start with a huge number of zeroes (i.e., be extremely small)

When the first block of a chain is created, a nonce generates the cryptographic hash. The data in the block is considered signed and forever tied to the nonce and hash unless it is mined

Miners

Miners create new blocks on the chain through a process called mining. In blockchain every block has its own unique nonce and hash but also references the hash of the previous block in the chain, so mining a block, especially on large chains. The average bitcoin transaction requires confirmations from miners that the block can be published and accepted. It takes minutes to a day or more to complete (Tanner, 2020). This approach is termed consensus to add blocks is also called "Proof of Work" Block Miners are trusted software to solve the incredibly complex math problem of finding nonce that generates an accepted hash. Because the nonce is only 32 bits and hash is 256, there are roughly four billion possible nonce-hash combinations that must be mined before the right one is found. When that happens miners have found the "golden nonce" and their block is added to the chain.

Making a change to any block earlier in the chain requires re-mining not just block with the change, but all of the blocks that come after it. This is why it's extremely difficult to manipulate blockchain technology. The security in tampering with blocks uses with the number of participants in the network because a successful attack would require hacking into all of the distributed ledger to change them all simultaneously. Also, it's "safety in math" since finding golden nonce requires an enormous time and computing power. When a block is successfully mined, the change is accepted by all of the nodes on the network and the miner is rewarded financially.

Impact of COVID-19 on
Technology, Social and Economic Domains
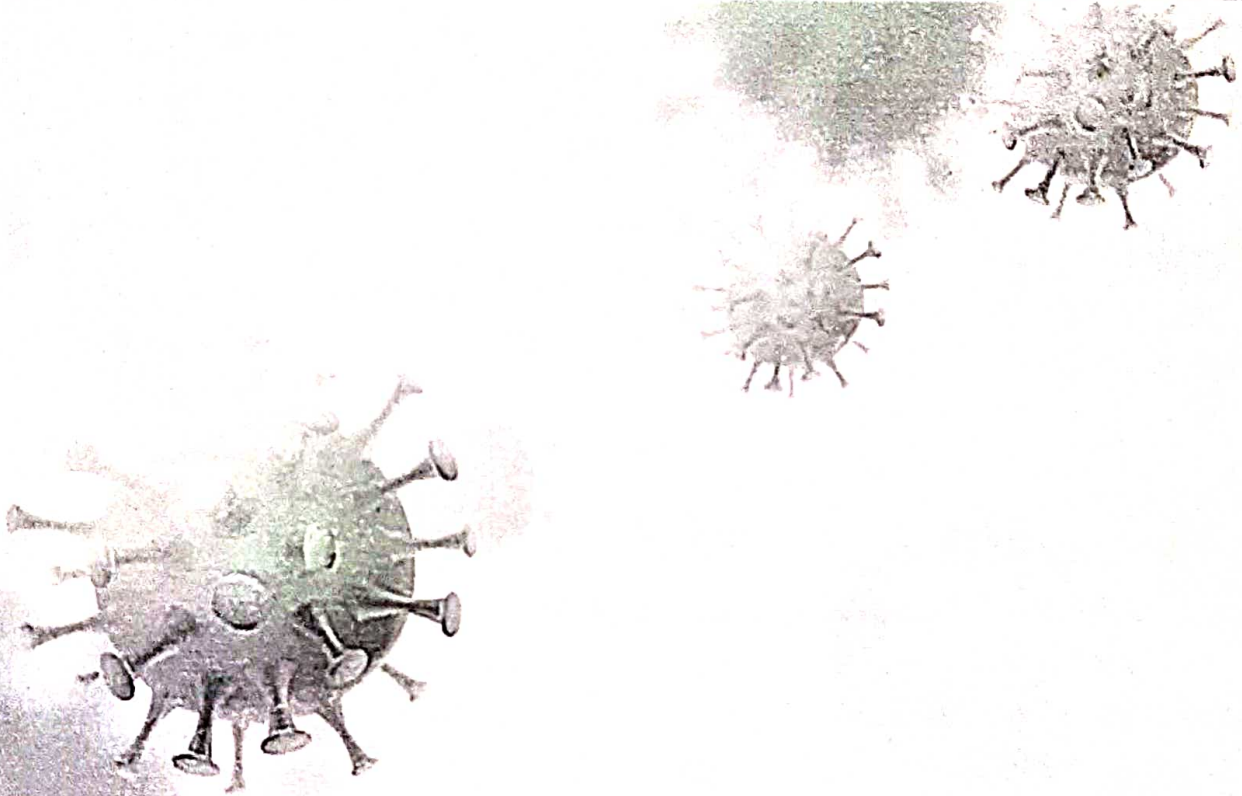
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IMPACT OF COVID-19 ON

TECHNOLOGY, SOCIAL, ECONOMIC DOMAINS

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PREFACE

As the Resource Person of the course 'Certificate in Quantitative Research Methodology' conducted by Great Minds and the Editor-in-Chief of this edited book titled "Impact of COVID-19 on Technology, Social and Economic Domains", I feel honored to write few words to the e-copy of the book.

The Corona crisis impacted not only Sri Lankan economic, educational sector but also global countries. Thus, Covid-19 pandemic has changed the teaching-learning process into online platform. It is the most important beneficial impact of it as social researches declare. With regard this, Great Minds suggested me to conduct an online research methodology course those who are interesting to write a research. As we expected the course was done successfully. It was decided to publish an edited book on the current issue around the world. In accordance with, we deiced to collect research articles to publish an edited book. At this moment, I am happy to state that more than 25 research articles have been received from local and international researchers from the theme. 22 research articles of them have selected to be added in the book. They explore the impacts of COVID-19 in different arguments. It shows the standard of the book.

I would like to congratulate all the researchers who submitted their effortful articles to make the book efficiently. Last but not least, I wish to express my gratitude to the associate editor M.S. Zunoomy who supported to publish this valuable book. I also wish to extend my thanks to reputed publisher Great Minds and to all who supported directly and indirectly during the different stages to publish the edited book.

Editor-in-Chief

WORDS BY THE PUBLISHER

The modern world respects research as the foundation of knowledge and science. Journey from the known to the unknown, is research. Research moves knowledge to the next frontier. Protects vitality of human civilization.

Great Minds is proud to have conducted a real-time training in research methodology for the first time in a very limited experienced Sri Lankan environment. Especially, we are doubly pleased, to have been able to conduct this training by an experienced resource person like F.H.A. Shibly.

The resource person is an expert in filtering out the essence of his knowledge and experience and imparts them to students. The energy he has in traveling along with the nature of the students and guiding them is incredible. The curiosity and inspiration found in the 4 students (participated in this course) is the sign says that they will become the future knowledge resources of our country. Gives hope that they will definitely build a new research culture in Sri Lankan soil.

As the result of this joint effort, resource person F.H.A. Shibly has authored 22 different research efforts. Great Minds would like to express its deepest gratitude to the resource person who successfully completed the project by all his effort and to the students who contributed. My thanks go to all the co-directors and coordinators of the Great Minds who contributed to the success of this initiative.

- Rafeek M. Thaha

நவீன உலகம் ஆய்வை அறிவினதும் அறிவியலினதும் அடிநாதமாக மதிக்கிறது. அறிந்ததிலிருந்து அறியாததை நோக்கிய பயணமே ஆய்வாகும். இது அறிவை அடுத்த எல்லை நோக்கி நகர்த்துகிறது. மனித நாகரீகத்தின் உயிர்த் துடிப்பைப் பாதுகாக்கின்றது.

ஆய்வனுபவம் மிகவும் குறைந்த இலங்கைச் சூழலில் முதன்முதலாக ஆய்வு முறையியல் (Research Methodology) நிகழ்நிலைப் பயிற்சியொன்றை நடத்தக்கிடைத்தமையிட்டு Great Minds பெருமிதமடைகிறது. அதிலும் குறிப்பாக எப்.எச்.ஏ. ஷிப்லி போன்ற அனுபவமிக்க வளவாளர் மூலம் இப்பயிற்சிநெறியை நடத்தக் கிடைத்தமை எமக்கு இரட்டிப்பு மகிழ்ச்சி.

வளவாளர் மாணவர்களுக்கு தனது அறிவினதும் அனுபவத்தினதும் சாரத்தை வடித்தெடுத்துப் புகட்டுவதில் கைதேர்ந்தவர். மாணவர்களின் இயல்புடன் இணைந்து பயணித்து அவர்களை வழிநடத்துவதில் அவருக்கிருக்கும் ஆற்றல் அலாதியானது. நான்கு மாணவர்களிடம் காணக்கிடைக்கின்ற (இப்பயிற்சிநெறியில் கலந்துகொண்ட) ஆர்வமும் உத்வேகமும் எமது நாட்டின் எதிர்கால அறிவு வளங்களாக வலம்வருவார்கள் என்பதைக் கட்டியம் கூறுகிறது. இலங்கை மண்ணில் புதியதொரு ஆய்வுக் கலாசாரத்தை (Research Culture) நிச்சயம் கட்டியெழுப்புவார்கள் என்ற நம்பிக்கையைத் தருகிறது.

இக்கூட்டு முயற்சியின் விளைவாகவே வளவாளர் தேசிய, சர்வதேச மட்டத்தில் எழுதப்பட்ட 22 ஆய்வுகளை நூலுருப்படுத்தியுள்ளார். தனது முழு முயற்சியால் இப்பணியை வெற்றிகரமாக நிறைவு செய்த வளவாளர் ஷிப்லி அவர்களுக்கும், ஆய்வுகளை சமர்ப்பித்தவர்களுக்கும் Great Minds தனது ஆழ்ந்த நன்றிகளைத் தெரிவித்துக் கொள்கின்றது. இம்முயற்சி வெற்றிபெற பங்களித்த Great Minds இனுடைய சக பணிப்பாளர்கள், இணைப்பாளர்கள் அனைவருக்கும் எனது நன்றிகள் உரித்தாகட்டும்.

- ரபீக் எம். தாஹா

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CHALLENGING POSITION OF INDIA'S ECONOMY AND MITIGATION ACTION TAKEN BY GOVERNMENT – A CRITICAL ANALYSIS IN ECONOMIC PERSPECTIVE

DR.R.KARTHI [1] & DR.P.JAMUNA DEVI [2]

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Abstract- The Indian economy is facing another hit due to this unexpected and uninvited pandemic throughout the word. It was really a shock to the Indian economy and government struggles to protect the economy and the citizens of the country. To protect the people from the covid19, the government initiated sudden lockdown which affected the economy heavily. Many organized sector locked their industries and stopped the employees come to factory. Migrant workers started to move to their hometown due to unemployment issues. There was a heavy loss to the industries such as hospitality, airlines, tourism, automobile, real estate, construction and more. The government vaccinated people to protect from the virus and recover the India economy.

Keywords: covid19, Indian economy, migrant workers, inflation, interest rate, GDP

I. Introduction

The unforeseen COVID 19 pandemic has made lot of difficulties in the lives of the world. Many lost their lives and job opportunities, which drastically changed the economic status of the family. Huge disruptions on social and economic positions of the people are at danger of falling into shortage of food, while many children were malnourished. Millions of the industries are in trouble of making their business successful and give opportunities for the employees. Nearly 10 billion employees lost their jobs and social status. Families from unorganized sector are having difficulties in survival of running their day to day life. The vulnerable position of unorganized and informal workers leads to lack of social protection, indefinite jobs and poor quality health care. The countrywide shutdown has brought an immediate end to almost all economic activities. The instability of demand and supply powers is continuing even after the lifting of the lockdown. The Indian economy will need time to return to its normal state. India's growth fell to 3.1 percent in the fourth quarter of the fiscal year 2020, according to the Ministry of Statistics[1]. During continuous lockdown, families suffered to feed to their wards and earn money for day to day expenses. The scrupulous effort taken by the government through educating people against the impact of covid19 and vaccinated them made a little relief from the haunting behaviour of covid19.

India's Economic Position before Covid19 Impact The government reworked downwards the economic growth rate for 2019-20 to 4 per cent from 4.2 per cent which is predicted earlier, mainly due to reduction in non primary sectors like production and formation [2]. "In 2018-19 the GDP growth rate was 6.5 per cent and the 2019-20 was 4.0 per cent according to National Statistical Office. Compare to 2018-19, the period of 2019-20 was relatively lesser growth in the areas like constructions, financial services, automobile, textile and constructions.

THE TRAJECTORY

*Third Revised Estimates; #Second Revised Estimates; @First Revised Estimates
Source: Ministry of Statistics & Programme Implementation

During 2019-20, the growth rates of the primary sector (comprising agriculture, forestry, fishing and mining and quarrying), secondary sector (comprising manufacturing, electricity, gas, water supply and other utility services, and construction) and tertiary sector (services) have been estimated as 3.3 per cent, (-)1.1 per cent and 7.2 per cent as against a growth of 2.2 per cent, 5.8 per cent, and 7.2 per cent, respectively, in the previous year. Nominal net national income at current prices for 2019-20 stands at Rs 179.94 trillion as against Rs 167.05 trillion in 2018-19, showing a growth of 7.7 per cent as against a rise of 10.3 per cent in the previous year. Per capita income i.e. per capita net national income at current prices is estimated at

A CONCEPTUAL FRAMEWORK ON THE IMPACT OF COVID 19 ON TECHNOLOGY

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Abstract- A pandemic caused by the novel corona virus (COVID-19) is causing an unparalleled condition for the world's health services. Health, local communities, and government are harmfully affected by the COVID-19 pandemic. In addition, on January 21, 2020, the WHO urgent situation Committee confirmed a global health emergency because of rising numbers of COVID-19 case warning from countries abroad. The arrival of technology has spurred noteworthy changes in many aspects of our lives and enhanced the replace of information, the presentation of data, and the organization of medical possessions through telemedicine. The Covid-19 pandemic has led to a predictable rush forward in the use of digital technologies due to the social distancing norms and countrywide lockdowns. People and organizations all over the world had to adjust to new ways of work and life.

Key words: *Pandemic, local communities, technology, telemedicine, predictable, distancing norms.*

I. INTRODUCTION

A raise in digitalization is most important organizations and educational institutions to move to work-from-home. Block chain technology will become important and will entail research on design and regulations. Place of work scrutinize and techno stress matter will become well-known with an increase in digital presence. Online fraud is likely to grow, the length of with investigate on managing security. The parameter of the internet, a key reserve, will be essential post-pandemic. With the increase of the pandemic, approximately all regions have implemented lockdowns, end down performance that need human gathering and interactions - including colleges, schools, malls, temples, offices, airports, and railway stations. The lockdown has resulted in the majority people taking to the internet and internet-based services to communicate, interrelate, and take on with their job responsibilities from home. Internet services have seen rises in usage from 40 % to 100 %, compared to pre-lockdown levels. Video-conferencing services like Zoom have seen a ten times increase in usage, and content delivery.

Use of Information systems and networks:

The lockdowns across countries have entailed a go up in the use of in order systems and networks, with huge changes in practice patterns and usage behaviour. Workers are adjusting to new "normals" - with meetings leaving completely online, office work shifting to the home, with new emerging patterns of work. These changes have come across most organizations, whether in business, society, or government. The changes have also come abruptly, with hardly any time for organizations and community to plan for, get ready and put into practice new setups and preparations; they have had to regulate, try, trial, and find habits that did not survive previous to. In order and skill sector has managed to stay pandemic data up to date. For example, using community media to encourage public health operation is very effective.

There are a few pressure concerned with the consciousness of social media about the COVID-19 pandemic, such as wounded, pandemic diagnosis, and treatment options like COVID-19 vaccines or COVID-19 medicines given to the patients. All these factors physically and mentally created extra fear and nervousness within the public. This resulted in common confusion, dread buying of home stuff, hoarding of essential commodities by the traders, price increase, violence on the streets, discriminations, conspiracy thinking, etc.

Technological Companies:

Pandemics and epidemics are well thought-out to be threatening the human race frequently. However, large technical companies are working hard to decrease the spread of mistaken information. Google, YouTube, Instagram, and Facebook, for example, have worked diligently to straight the public to the most up-to-date, demonstrable information accessible through the WHO website.

Fifth-generation connectivity technologies and high-speed Internet with its attendant benefits were launched by meeting technologies such as mobile, cloud, and robots. Artificial intelligence, in exacting, has exposed to have a significant role in promoting physical condition, representative immunization techniques connecting understanding viral protein structure.

Based on the COVID-19 pandemic obtainable swelling rate data, it is quite multifaceted to decide whether SOPs have been practiced. The pandemic grows exotically and exponentially at a critical stage which is extreme for human computation to understand and analyze.

EXECUTIVE DECISION MAKING DURING COVID-19 WITH TOPSIS METHOD, RECIPROCAL MATRICES WITH PAIRWISE COMPARISONS

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ABSTRACT: Problem-solving and decision-making are just different aspects of the same multi-stage goal-oriented cognitive process. Proof of this hypothesis by comparing stage by stage both the decision-making and problem-solving prescribed strategies and the description protocols. If indeed problem-solving and decision-making processes are homological, scientist, studying the same process from different perspectives, might be able to learn from each other and their dialogue may be facilitated through the common vocabulary are suggested here. The core of operations research is the development of approaches for optimal decision making. A prominent class of such problems is multi-criteria decision making (MCDM). The typical MCDM problem deals with the evaluation of a set of alternatives in terms of a set of decision criteria. This concepts provides a comprehensive survey of some methods for eliciting data for MCDM problems and also for processing such data.

KEYWORDS: *Problem-solving, Decision-making, Algorithm, Strategy, COVID 19,TOPSIS METHOD*

1. INTRODUCTION

The review of literature reveals that contemporary accounts of the relationship between problem solving (PS) and decision-making (DM) are contradictory and confusing. I present that PS and DM refer to the same process. Here I prove by comparing these processes stage by stage. Problem-solving is often considered to be based upon application of an algorithm, while decision making is considered to be based upon experience and intuition.

The division between "algorithmic" and "naturalistic" or experience-based thinking cannot serve as a basis of distinction between problem-solving and decision-making, as problems are often dealt with haphazardly and decisions are often made methodically, and vice versa. In fact, algorithms for problem-solving and decision-making bear striking resemblance.

Moreover, it is demonstrated that "naturalistic" problem-solving and decision- making patterns, both productive and unproductive, are similar.This chapter consists of the extension of the TOPSIS for group decision making under fuzzy environment with multi attribute decision making, Classification, Weighted sum model, Weighted product model, Revised Analytic Hierarchy process,COVID-19 and also consists a Framework for executive decision making during COVID-19 with TOPSIS method, reciprocal matrices with pairwise comparisons and Conclusion. It concludes with a list of suggested definitions of the concepts relating to PS and DM.

2. LITERATURE REVIEW

Regarding the question of the relationship between problem-solving (PS) and decision-making (DM), no option has been eliminated from the current scholarly discourse. The full range of answers - from "they are the same" to "they have nothing in common" - all have their champions. Some claim that they overlap and argue about where the true division lies. Others claim that one is part of another or the other way around. In numerous articles, PS and DM related terms are interchangeable (Sadler and Zeidler, 2005; Lee and Grace, 2012; Papadouris, 2012).

Cenkseven-Onder and Colakkadioglu (2013) present a survey of different perspectives on the relationship between PS and DM which are still relevant today. The authors note that some researchers argue that problem-solving and decision-making processes share similarities; thus, these concepts must be used together (Adair, 2010; Ivey et al., 1993; Churney, 2001). According to another popular opinion, decision-making and problem- solving are entirely different (Baron and Brown, 1991; Elstein and Schwartz, 2002; Isen, 2001). PS-oriented and DM-oriented researchers perceive these concepts and their interrelation differently. In a series of works dedicated to social PS, D'Zurilla (D'Zurilla and Goldfried, 1971; D'Zurilla and Chang, 1995; Nezu, D'Zurilla and Nezu, 2012) recognizes DM, or selecting the best solution out of many, as one of the five stages of PS. The conflict theory of decision making (Janis and Mann, 1977) sees systematic search for information, careful consideration of all viable alternatives and the unhurried, non- impulsive making of the final decision, in other word, PS, as one of five DM-patterns.

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GREAT MINDS

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Editor-in-Chief

WORDS BY THE PUBLISHER

The modern world respects research as the foundation of knowledge and science. Journey from the known to the unknown, is research. Research moves knowledge to the next frontier. Protects vitality of human civilization.

Great Minds is proud to have conducted a real-time training in research methodology for the first time in a very limited experienced Sri Lankan environment. Especially, we are doubly pleased, to have been able to conduct this training by an experienced resource person like F.H.A. Shibly.

The resource person is an expert in filtering out the essence of his knowledge and experience and imparts them to students. The energy he has in traveling along with the nature of the students and guiding them is incredible. The curiosity and inspiration found in the 4 students (participated in this course) is the sign says that they will become the future knowledge resources of our country. Gives hope that they will definitely build a new research culture in Sri Lankan soil.

As the result of this joint effort, resource person F.H.A. Shibly has authored 22 different research efforts. Great Minds would like to express its deepest gratitude to the resource person who successfully completed the project by all his effort and to the students who contributed. My thanks go to all the co-directors and coordinators of the Great Minds who contributed to the success of this initiative.

- Rafeek M. Thaha

நவீன உலகம் ஆய்வை அறிவினதும் அறிவியலினதும் அடிநாதமாக மதிக்கிறது. அறிந்ததிலிருந்து அறியாததை நோக்கிய பயணமே ஆய்வாகும். இது அறிவை அடுத்த எல்லை நோக்கி நகர்த்துகிறது. மனித நாகரீகத்தின் உயிர்த் துடிப்பைப் பாதுகாக்கின்றது.

ஆய்வனுபவம் மிகவும் குறைந்த இலங்கைச் சூழலில் முதன்முதலாக ஆய்வு முறையியல் (Research Methodology) நிகழ்நிலைப் பயிற்சியொன்றை நடத்தக்கிடைத்தமையிட்டு Great Minds பெருமிதமடைகிறது. அதிலும் குறிப்பாக எப்.எச்.ஏ. ஷிப்லி போன்ற அனுபவமிக்க வளவாளர் மூலம் இப்பயிற்சிநெறியை நடத்தக் கிடைத்தமை எமக்கு இரட்டிப்பு மகிழ்ச்சி.

வளவாளர் மாணவர்களுக்கு தனது அறிவினதும் அனுபவத்தினதும் சாரத்தை வடித்தெடுத்துப் புகட்டுவதில் கைதேர்ந்தவர். மாணவர்களின் இயல்புடன் இணைந்து பயணித்து அவர்களை வழிநடத்துவதில் அவருக்கிருக்கும் ஆற்றல் அலாதியானது. நான்கு மாணவர்களிடம் காணக்கிடைக்கின்ற (இப்பயிற்சிநெறியில் கலந்துகொண்ட) ஆர்வமும் உத்வேகமும் எமது நாட்டின் எதிர்கால அறிவு வளங்களாக வலம்வருவார்கள் என்பதைக் கட்டியம் கூறுகிறது. இலங்கை மண்ணில் புதியதொரு ஆய்வுக் கலாசாரத்தை (Research Culture) நிச்சயம் கட்டியெழுப்புவார்கள் என்ற நம்பிக்கையைத் தருகிறது.

இக்கூட்டு முயற்சியின் விளைவாகவே வளவாளர் தேசிய, சர்வதேச மட்டத்தில் எழுதப்பட்ட 22 ஆய்வுகளை நூலுருப்படுத்தியுள்ளார். தனது முழு முயற்சியால் இப்பணியை வெற்றிகரமாக நிறைவு செய்த வளவாளர் ஷிப்லி அவர்களுக்கும், ஆய்வுகளை சமர்ப்பித்தவர்களுக்கும் Great Minds தனது ஆழ்ந்த நன்றிகளைத் தெரிவித்துக் கொள்கின்றது. இம்முயற்சி வெற்றிபெற பங்களித்த Great Minds இனுடைய சக பணிப்பாளர்கள், இணைப்பாளர்கள் அனைவருக்கும் எனது நன்றிகள் உரித்தாகட்டும்.

- ரபீக் எம். தாஹா

CONTENTS

Chapter-08

CHALLENGING POSITION OF INDIA'S ECONOMY AND MITIGATION ACTION TAKEN BY GOVERNMENT – A CRITICAL ANALYSIS IN ECONOMIC PERSPECTIVE

DR.R.KARTHI [1] & DR.P.JAMUNA DEVI [2]

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Abstract- The Indian economy is facing another hit due to this unexpected and uninvited pandemic throughout the word. It was really a shock to the Indian economy and government struggles to protect the economy and the citizens of the country. To protect the people from the covid19, the government initiated sudden lockdown which affected the economy heavily. Many organized sector locked their industries and stopped the employees come to factory. Migrant workers started to move to their hometown due to unemployment issues. There was a heavy loss to the industries such as hospitality, airlines, tourism, automobile, real estate, construction and more. The government vaccinated people to protect from the virus and recover the India economy.

Keywords: covid19, Indian economy, migrant workers, inflation, interest rate, GDP

I. Introduction

The unforeseen COVID 19 pandemic has made lot of difficulties in the lives of the world. Many lost their lives and job opportunities, which drastically changed the economic status of the family. Huge disruptions on social and economic positions of the people are at danger of falling into shortage of food, while many children were malnourished. Millions of the industries are in trouble of making their business successful and give opportunities for the employees. Nearly 10 billion employees lost their jobs and social status. Families from unorganized sector are having difficulties in survival of running their day to day life. The vulnerable position of unorganized and informal workers leads to lack of social protection, indefinite jobs and poor quality health care. The countrywide shutdown has brought an immediate end to almost all economic activities. The instability of demand and supply powers is continuing even after the lifting of the lockdown. The Indian economy will need time to return to its normal state. India's growth fell to 3.1 percent in the fourth quarter of the fiscal year 2020, according to the Ministry of Statistics[1]. During continuous lockdown, families suffered to feed to their wards and earn money for day to day expenses. The scrupulous effort taken by the government through educating people against the impact of covid19 and vaccinated them made a little relief from the haunting behaviour of covid19.

India's Economic Position before Covid19 Impact The government reworked downwards the economic growth rate for 2019-20 to 4 per cent from 4.2 per cent which is predicted earlier, mainly due to reduction in non primary sectors like production and formation [2]. "In 2018-19 the GDP growth rate was 6.5 per cent and the 2019-20 was 4.0 per cent according to National Statistical Office. Compare to 2018-19, the period of 2019-20 was relatively lesser growth in the areas like constructions, financial services, automobile, textile and constructions.

THE TRAJECTORY

*Third Revised Estimates; #Second Revised Estimates; @First Revised Estimates
Source: Ministry of Statistics & Programme Implementation

During 2019-20, the growth rates of the primary sector (comprising agriculture, forestry, fishing and mining and quarrying), secondary sector (comprising manufacturing, electricity, gas, water supply and other utility services, and construction) and tertiary sector (services) have been estimated as 3.3 per cent, (-)1.1 per cent and 7.2 per cent as against a growth of 2.2 per cent, 5.8 per cent, and 7.2 per cent, respectively, in the previous year. Nominal net national income at current prices for 2019-20 stands at Rs 179.94 trillion as against Rs 167.05 trillion in 2018-19, showing a growth of 7.7 per cent as against a rise of 10.3 per cent in the previous year. Per capita income i.e. per capita net national income at current prices is estimated at

A CONCEPTUAL FRAMEWORK ON THE IMPACT OF COVID 19 ON TECHNOLOGY

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Abstract- A pandemic caused by the novel corona virus (COVID-19) is causing an unparalleled condition for the world's health services. Health, local communities, and government are harmfully affected by the COVID-19 pandemic. In addition, on January 21, 2020, the WHO urgent situation Committee confirmed a global health emergency because of rising numbers of COVID-19 case warning from countries abroad. The arrival of technology has spurred noteworthy changes in many aspects of our lives and enhanced the replace of information, the presentation of data, and the organization of medical possessions through telemedicine. The Covid-19 pandemic has led to a predictable rush forward in the use of digital technologies due to the social distancing norms and countrywide lockdowns. People and organizations all over the world had to adjust to new ways of work and life.

Key words: *Pandemic, local communities, technology, telemedicine, predictable, distancing norms.*

I. INTRODUCTION

A raise in digitalization is most important organizations and educational institutions to move to work-from-home. Block chain technology will become important and will entail research on design and regulations. Place of work scrutinize and techno stress matter will become well-known with an increase in digital presence. Online fraud is likely to grow, the length of with investigate on managing security. The parameter of the internet, a key reserve, will be essential post-pandemic. With the increase of the pandemic, approximately all regions have implemented lockdowns, end down performance that need human gathering and interactions - including colleges, schools, malls, temples, offices, airports, and railway stations. The lockdown has resulted in the majority people taking to the internet and internet-based services to communicate, interrelate, and take on with their job responsibilities from home. Internet services have seen rises in usage from 40 % to 100 %, compared to pre-lockdown levels. Video-conferencing services like Zoom have seen a ten times increase in usage, and content delivery.

Use of Information systems and networks:

The lockdowns across countries have entailed a go up in the use of in order systems and networks, with huge changes in practice patterns and usage behaviour. Workers are adjusting to new "normals" - with meetings leaving completely online, office work shifting to the home, with new emerging patterns of work. These changes have come across most organizations, whether in business, society, or government. The changes have also come abruptly, with hardly any time for organizations and community to plan for, get ready and put into practice new setups and preparations; they have had to regulate, try, trial, and find habits that did not survive previous to. In order and skill sector has managed to stay pandemic data up to date. For example, using community media to encourage public health operation is very effective.

There are a few pressure concerned with the consciousness of social media about the COVID-19 pandemic, such as wounded, pandemic diagnosis, and treatment options like COVID-19 vaccines or COVID-19 medicines given to the patients. All these factors physically and mentally created extra fear and nervousness within the public. This resulted in common confusion, dread buying of home stuff, hoarding of essential commodities by the traders, price increase, violence on the streets, discriminations, conspiracy thinking, etc.

Technological Companies:

Pandemics and epidemics are well thought-out to be threatening the human race frequently. However, large technical companies are working hard to decrease the spread of mistaken information. Google, YouTube, Instagram, and Facebook, for example, have worked diligently to straight the public to the most up-to-date, demonstrable information accessible through the WHO website.

Fifth-generation connectivity technologies and high-speed Internet with its attendant benefits were launched by meeting technologies such as mobile, cloud, and robots. Artificial intelligence, in exacting, has exposed to have a significant role in promoting physical condition, representative immunization techniques connecting understanding viral protein structure.

Based on the COVID-19 pandemic obtainable swelling rate data, it is quite multifaceted to decide whether SOPs have been practiced. The pandemic grows exotically and exponentially at a critical stage which is extreme for human computation to understand and analyze.

EXECUTIVE DECISION MAKING DURING COVID-19 WITH TOPSIS METHOD, RECIPROCAL MATRICES WITH PAIRWISE COMPARISONS

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- Rafeek M. Thaha

நவீன உலகம் ஆய்வை அறிவினதும் அறிவியலினதும் அடிநாதமாக மதிக்கிறது. அறிந்ததிலிருந்து அறியாததை நோக்கிய பயணமே ஆய்வாகும். இது அறிவை அடுத்த எல்லை நோக்கி நகர்த்துகிறது. மனித நாகரீகத்தின் உயிர்த் துடிப்பைப் பாதுகாக்கின்றது.

ஆய்வனுபவம் மிகவும் குறைந்த இலங்கைச் சூழலில் முதன்முதலாக ஆய்வு முறையியல் (Research Methodology) நிகழ்நிலைப் பயிற்சியொன்றை நடத்தக்கிடைத்தமையிட்டு Great Minds பெருமிதமடைகிறது. அதிலும் குறிப்பாக எப்.எச்.ஏ. ஷிப்லி போன்ற அனுபவமிக்க வளவாளர் மூலம் இப்பயிற்சிநெறியை நடத்தக் கிடைத்தமை எமக்கு இரட்டிப்பு மகிழ்ச்சி.

வளவாளர் மாணவர்களுக்கு தனது அறிவினதும் அனுபவத்தினதும் சாரத்தை வடித்தெடுத்துப் புகட்டுவதில் கைதேர்ந்தவர். மாணவர்களின் இயல்புடன் இணைந்து பயணித்து அவர்களை வழிநடத்துவதில் அவருக்கிருக்கும் ஆற்றல் அலாதியானது. நான்கு மாணவர்களிடம் காணக்கிடைக்கின்ற (இப்பயிற்சிநெறியில் கலந்துகொண்ட) ஆர்வமும் உத்வேகமும் எமது நாட்டின் எதிர்கால அறிவு வளங்களாக வலம்வருவார்கள் என்பதைக் கட்டியம் கூறுகிறது. இலங்கை மண்ணில் புதியதொரு ஆய்வுக் கலாசாரத்தை (Research Culture) நிச்சயம் கட்டியெழுப்புவார்கள் என்ற நம்பிக்கையைத் தருகிறது.

இக்கூட்டு முயற்சியின் விளைவாகவே வளவாளர் தேசிய, சர்வதேச மட்டத்தில் எழுதப்பட்ட 22 ஆய்வுகளை நூலுருப்படுத்தியுள்ளார். தனது முழு முயற்சியால் இப்பணியை வெற்றிகரமாக நிறைவு செய்த வளவாளர் ஷிப்லி அவர்களுக்கும், ஆய்வுகளை சமர்ப்பித்தவர்களுக்கும் Great Minds தனது ஆழ்ந்த நன்றிகளைத் தெரிவித்துக் கொள்கின்றது. இம்முயற்சி வெற்றிபெற பங்களித்த Great Minds இனுடைய சக பணிப்பாளர்கள், இணைப்பாளர்கள் அனைவருக்கும் எனது நன்றிகள் உரித்தாகட்டும்.

- ரபீக் எம். தாஹா

CONTENTS

Chapter-08

CHALLENGING POSITION OF INDIA'S ECONOMY AND MITIGATION ACTION TAKEN BY GOVERNMENT – A CRITICAL ANALYSIS IN ECONOMIC PERSPECTIVE

DR.R.KARTHI [1] & DR.P.JAMUNA DEVI [2]

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Abstract- The Indian economy is facing another hit due to this unexpected and uninvited pandemic throughout the word. It was really a shock to the Indian economy and government struggles to protect the economy and the citizens of the country. To protect the people from the covid19, the government initiated sudden lockdown which affected the economy heavily. Many organized sector locked their industries and stopped the employees come to factory. Migrant workers started to move to their hometown due to unemployment issues. There was a heavy loss to the industries such as hospitality, airlines, tourism, automobile, real estate, construction and more. The government vaccinated people to protect from the virus and recover the India economy.

Keywords: covid19, Indian economy, migrant workers, inflation, interest rate, GDP

I. Introduction

The unforeseen COVID 19 pandemic has made lot of difficulties in the lives of the world. Many lost their lives and job opportunities, which drastically changed the economic status of the family. Huge disruptions on social and economic positions of the people are at danger of falling into shortage of food, while many children were malnourished. Millions of the industries are in trouble of making their business successful and give opportunities for the employees. Nearly 10 billion employees lost their jobs and social status. Families from unorganized sector are having difficulties in survival of running their day to day life. The vulnerable position of unorganized and informal workers leads to lack of social protection, indefinite jobs and poor quality health care. The countrywide shutdown has brought an immediate end to almost all economic activities. The instability of demand and supply powers is continuing even after the lifting of the lockdown. The Indian economy will need time to return to its normal state. India's growth fell to 3.1 percent in the fourth quarter of the fiscal year 2020, according to the Ministry of Statistics[1]. During continuous lockdown, families suffered to feed to their wards and earn money for day to day expenses. The scrupulous effort taken by the government through educating people against the impact of covid19 and vaccinated them made a little relief from the haunting behaviour of covid19.

India's Economic Position before Covid19 Impact The government reworked downwards the economic growth rate for 2019-20 to 4 per cent from 4.2 per cent which is predicted earlier, mainly due to reduction in non primary sectors like production and formation [2]. "In 2018-19 the GDP growth rate was 6.5 per cent and the 2019-20 was 4.0 per cent according to National Statistical Office. Compare to 2018-19, the period of 2019-20 was relatively lesser growth in the areas like constructions, financial services, automobile, textile and constructions.

THE TRAJECTORY

*Third Revised Estimates; #Second Revised Estimates; @@First Revised Estimates
Source: Ministry of Statistics & Programme Implementation

During 2019-20, the growth rates of the primary sector (comprising agriculture, forestry, fishing and mining and quarrying), secondary sector (comprising manufacturing, electricity, gas, water supply and other utility services, and construction) and tertiary sector (services) have been estimated as 3.3 per cent, (-)1.1 per cent and 7.2 per cent as against a growth of 2.2 per cent, 5.8 per cent, and 7.2 per cent, respectively, in the previous year. Nominal net national income at current prices for 2019-20 stands at Rs 179.94 trillion as against Rs 167.05 trillion in 2018-19, showing a growth of 7.7 per cent as against a rise of 10.3 per cent in the previous year. Per capita income i.e. per capita net national income at current prices is estimated at

A CONCEPTUAL FRAMEWORK ON THE IMPACT OF COVID 19 ON TECHNOLOGY

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Abstract- A pandemic caused by the novel corona virus (COVID-19) is causing an unparalleled condition for the world's health services. Health, local communities, and government are harmfully affected by the COVID-19 pandemic. In addition, on January 21, 2020, the WHO urgent situation Committee confirmed a global health emergency because of rising numbers of COVID-19 case warning from countries abroad. The arrival of technology has spurred noteworthy changes in many aspects of our lives and enhanced the replace of information, the presentation of data, and the organization of medical possessions through telemedicine. The Covid-19 pandemic has led to a predictable rush forward in the use of digital technologies due to the social distancing norms and countrywide lockdowns. People and organizations all over the world had to adjust to new ways of work and life.

Key words: *Pandemic, local communities, technology, telemedicine, predictable, distancing norms.*

I. INTRODUCTION

A raise in digitalization is most important organizations and educational institutions to move to work-from-home. Block chain technology will become important and will entail research on design and regulations. Place of work scrutinize and techno stress matter will become well-known with an increase in digital presence. Online fraud is likely to grow, the length of with investigate on managing security. The parameter of the internet, a key reserve, will be essential post-pandemic. With the increase of the pandemic, approximately all regions have implemented lockdowns, end down performance that need human gathering and interactions - including colleges, schools, malls, temples, offices, airports, and railway stations. The lockdown has resulted in the majority people taking to the internet and internet-based services to communicate, interrelate, and take on with their job responsibilities from home. Internet services have seen rises in usage from 40 % to 100 %, compared to pre-lockdown levels. Video-conferencing services like Zoom have seen a ten times increase in usage, and content delivery.

Use of Information systems and networks:
The lockdowns across countries have entailed a go up in the use of in order systems and networks, with huge changes in practice patterns and usage behaviour. Workers are adjusting to new "normals" - with meetings leaving completely online, office work shifting to the home, with new emerging patterns of work. These changes have come across most organizations, whether in business, society, or government. The changes have also come abruptly, with hardly any time for organizations and community to plan for, get ready and put into practice new setups and preparations; they have had to regulate, try, trial, and find habits that did not survive previous to. In order and skill sector has managed to stay pandemic data up to date. For example, using community media to encourage public health operation is very effective.

There are a few pressure concerned with the consciousness of social media about the COVID-19 pandemic, such as wounded, pandemic diagnosis, and treatment options like COVID-19 vaccines or COVID-19 medicines given to the patients. All these factors physically and mentally created extra fear and nervousness within the public. This resulted in common confusion, dread buying of home stuff, hoarding of essential commodities by the traders, price increase, violence on the streets, discriminations, conspiracy thinking, etc.

Technological Companies:
Pandemics and epidemics are well thought-out to be threatening the human race frequently. However, large technical companies are working hard to decrease the spread of mistaken information. Google, YouTube, Instagram, and Facebook, for example, have worked diligently to straight the public to the most up-to-date, demonstrable information accessible through the WHO website.

Fifth-generation connectivity technologies and high-speed Internet with its attendant benefits were launched by meeting technologies such as mobile, cloud, and robots. Artificial intelligence, in exacting, has exposed to have a significant role in promoting physical condition, representative immunization techniques connecting understanding viral protein structure.

Based on the COVID-19 pandemic obtainable swelling rate data, it is quite multifaceted to decide whether SOPs have been practiced. The pandemic grows exotically and exponentially at a critical stage which is extreme for human computation to understand and analyze.

EXECUTIVE DECISION MAKING DURING COVID-19 WITH TOPSIS METHOD, RECIPROCAL MATRICES WITH PAIRWISE COMPARISONS

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ABSTRACT: Problem-solving and decision-making are just different aspects of the same multi-stage goal-oriented cognitive process. Proof of this hypothesis by comparing stage by stage both the decision-making and problem-solving prescribed strategies and the description protocols. If indeed problem-solving and decision-making processes are homological, scientist, studying the same process from different perspectives, might be able to learn from each other and their dialogue may be facilitated through the common vocabulary are suggested here. The core of operations research is the development of approaches for optimal decision making. A prominent class of such problems is multi-criteria decision making (MCDM). The typical MCDM problem deals with the evaluation of a set of alternatives in terms of a set of decision criteria. This concepts provides a comprehensive survey of some methods for eliciting data for MCDM problems and also for processing such data.

KEYWORDS: *Problem-solving, Decision-making, Algorithm, Strategy, COVID 19,TOPSIS METHOD*

1. INTRODUCTION

The review of literature reveals that contemporary accounts of the relationship between problem solving (PS) and decision-making (DM) are contradictory and confusing. I present that PS and DM refer to the same process. Here I prove by comparing these processes stage by stage. Problem-solving is often considered to be based upon application of an algorithm, while decision making is considered to be based upon experience and intuition.

The division between "algorithmic" and "naturalistic" or experience-based thinking cannot serve as a basis of distinction between problem-solving and decision-making, as problems are often dealt with haphazardly and decisions are often made methodically, and vice versa. In fact, algorithms for problem-solving and decision-making bear striking resemblance.

Moreover, it is demonstrated that "naturalistic" problem-solving and decision- making patterns, both productive and unproductive, are similar.This chapter consists of the extension of the TOPSIS for group decision making under fuzzy environment with multi attribute decision making, Classification, Weighted sum model, Weighted product model, Revised Analytic Hierarchy process,COVID-19 and also consists a Framework for executive decision making during COVID-19 with TOPSIS method, reciprocal matrices with pairwise comparisons and Conclusion. It concludes with a list of suggested definitions of the concepts relating to PS and DM.

2. LITERATURE REVIEW

Regarding the question of the relationship between problem-solving (PS) and decision-making (DM), no option has been eliminated from the current scholarly discourse. The full range of answers - from "they are the same" to "they have nothing in common" - all have their champions. Some claim that they overlap and argue about where the true division lies. Others claim that one is part of another or the other way around. In numerous articles, PS and DM related terms are interchangeable (Sadler and Zeidler, 2005; Lee and Grace, 2012; Papadouris, 2012).

Cenkseven-Onder and Colakkadioglu (2013) present a survey of different perspectives on the relationship between PS and DM which are still relevant today. The authors note that some researchers argue that problem-solving and decision-making processes share similarities; thus, these concepts must be used together (Adair, 2010; Ivey et al., 1993; Churney, 2001). According to another popular opinion, decision-making and problem- solving are entirely different (Baron and Brown, 1991; Elstein and Schwartz, 2002; Isen, 2001). PS-oriented and DM-oriented researchers perceive these concepts and their interrelation differently. In a series of works dedicated to social PS, D'Zurilla (D'Zurilla and Goldfried, 1971; D'Zurilla and Chang, 1995; Nezu, D'Zurilla and Nezu, 2012) recognizes DM, or selecting the best solution out of many, as one of the five stages of PS. The conflict theory of decision making (Janis and Mann, 1977) sees systematic search for information, careful consideration of all viable alternatives and the unhurried, non- impulsive making of the final decision, in other word, PS, as one of five DM-patterns.

Extension of the Topsis for Group Decision Making under Fuzzy Environment
Multi-Attribute Decision Making: A General Overview

BUSINESS INTELLIGENCE AND ITS APPLICATIONS

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BUSINESS INTELLIGENCE AND ITS APPLICATIONS

PREFACE

In a highly competitive and international economy, businesses thrive. Every day, new ideas are born. Products, methods, systems, and technology all quickly become obsolete. If companies do not embrace, they will be forced to transform. Business worries are swept aside by the developments before they can appreciate their ramifications. Businesses must upgrade themselves on a regular basis to keep up with changes, competition, and uncertainty.

Entrepreneurs must keep ahead of the curve and be proactive in responding to developments. It necessitates a leadership style that is both dynamic and effective. Management theories from the past are no longer useful. To battle all of the issues, CEOs and CFOs of businesses want superior Information Management systems, which are backed up by technology and effective strategies. Managers must improve their digital skills and develop new tactics that are appropriate for the present climate. Technically advanced systems are replacing traditional methods of managing Operations, Human Resources, Finance, and Marketing. Businesses have evolved to thrive in today's global marketplace.

The purpose of creating this E-book chapter is to bring together the perspectives of many authors, scholars, students, and academicians by allowing the authors to contribute their thoughts on this topic. For the book chapter "Business transformations through information, technology, and management," authors were requested to submit articles.

It was thrilling to witness the passionate response from writers from all around the country and from various universities. Because of the overwhelming response, we decided to divide the pieces into four e-books and categorise them according to their relevance.

We anticipate that, the efforts will be fruitful and that the compilation will be enjoyed by the readers. The e-book will provide an overview of the many points of view. It's a collection of articles from various sources. The collection will provide a broader view on the various aspects of corporate changes.

Revert back to us with your feedback to book.bi.chapter2022@gmail.com

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BUSINESS INTELLIGENCE AND IT'S APPLICATIONS
GREEN HRM

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WHAT IS HUMAN RESOURCE MANAGEMENT?

Human resource management is a tactical approach to managing individuals in a company or an organisation in such a way that they assist the firm acquire a competitive edge. Its goal is to optimise the employee's performance in support of a company's strategic goals. In other words, Human resource management (HRM) is the practise of recruiting, hiring, deploying, and managing personnel in a business. "Human Resources Management" is frequently abbreviated as HRM or just HR.

STAGES OF HUMAN RESOURCES MANAGEMENT

Human Resource Management is phased up into three stages:

1. Acquisition,

2. Development and

3. Termination.

Acquisition Phase:

This is the first of the phases in the process of human resources administration. This is the stage in which the applicants are interviewed and ultimately chosen for the post. Earlier in the process, there may have been a pool of individuals that had applied for the job that was being sought by the company. Filtering and analysing applications and resumes received by the human resources department results in the selection of the most qualified candidates from among the rest. Applicants who have passed the screening process will be contacted by a representative from the organization's

procedure, the personnel learns whether or not the applicant is interested in the position. During talk, people learn about each other's communication abilities and other similar things. If the human resources professionals are pleased with the performance of the applicant, they will maintain the individual's profile in a separate pool for future consideration. This procedure allows the more qualified applicants for the position in the company to be evaluated even further. Afterwards, the applicants are invited to participate in a face-to-face interview, during which the human resources personnel(s) conduct rounds of questioning to assess their knowledge, talent, skills, attitude, personalityand behavior, as well as their communication and language abilities, among other things. The applicant will be told that he or she has been chosen and will be given a start date when the interviewer has granted their approval.

Development Phase:

As soon as the applicant has been accepted into the organization, he or she becomes an official member of the group. Through the implementation of programmes, the organisation will assist its employees in advancing their skill and knowledge development goals.

Training can be of two types:

1. On the Job Training

2. Off the Job Training

The training programmes provided by the organisation support workers in turning their perceived knowledge into action in order to enhance productivity. Before and after the training, an assessment of employee performance will be undertaken to determine how effectively the workers have used the training programmes and how well their knowledge has been improved.

Termination Phase:

Termination from the employment can be of two types.

1. Termination of employment by the employer

2. Termination of employment by the employee

In the majority of cases, workers seek to end their association with their employer for a variety of reasons. There are a variety of causes, including but not limited to: career advancement, work

itisfaction, employee contentment, family reasons, employee relations, organizational policies, and so
in.

Employees are terminated by their employers on a rare occasion. Misconduct, unethical practices, sabotaging the organization's properties, wasting the organization's resources, intentionally working slowly, taking excessive breaks, taking excessive leaves, showing favouritism, gossiping about co-workers, stealing the organization's resources, sexual harassment, abuse, endangering co-workers, sharing the organization's resources with the outside world, lack of compliance with the organization's policy, and failure to perform job duties are all grounds for dismissal.

GREEN HRM

WHAT IS GREEN HRM?

In the context of human resources management, green human resources management (GHRM) can be defined as a set of policies, practises, and systems that encourage the green behavior of a company's employees in an effort to create an organization that really is environmentally sensitive, resource efficient, and socially responsible. As a result of the discussion concerning sustainable development and business sustainability, the notion of green human resource management developed as a formal academic topic.

GREEN HRM

Green Human Resource Management (Green HRM) is a relatively new important topic for exploration that encompasses all elements and practices of human resource management that are focused on achieving environmental sustainability as a goal. The goal is to achieve a balance between the objectives of businesses and those of society without sacrificing the objectives of businesses.

When it comes to environmental sustainability, a Green HR strategy guarantees that all of the work that takes place in a business is completely energy efficient, paperless, and ecologically friendly.

COMPONENTS OF GREEN HRM:

GREEN HRM

- VIRTUAL ADVERTISEMENT OF OPENINGS AND APPLICATION
- VIRTUAL RECRUITMENT AND SELECTION OF CANDIDATES
- VIRTUAL PERFORMANCE MANAGEMENT AND EVALUATION

- VIRTUAL EMPLOYEE DISCIPLINE MANAGEMENT
- VIRTUAL EMPLOYEE MAINTENANCE AND RELATIONS
- VIRTUAL ORIENTATION AND INDUCTION PROGRAMMES
- VIRTUAL LEARNING AND DEVELOPMENT

- VIRTUAL EMPLOYEE HEALTH AND SAFETY MANAGEMENT
- VIRTUAL LEADERSHIP MANAGEMENT
- VIRTUAL COMPENSATION AND REWARD MANAGEMENT
- VIRTUAL EMPLOYEE EMPOWERMENT AND PARTICIPATION

- VIRTUAL IMPLEMENTATION OF ENVIRONMENT FRIENDLY HR PRACTICES
- VIRTUAL IMPLEMENTATION OF GREEN STRATEGY AND GREEN STRATEGIC MANAGEMENT

VIRTUAL ADVERTISEMENT OF OPENINGS AND APPLICATION

A short advertisement on an online job site could be used to draw the attention of a job seeker with a link to a longer advertisement.Naukri, Monster, and Times Jobs, among other job portals, are a good source of information about current openings in organisations, and many organisations submit requirement alerts to those job portals as well. Many times, individuals may apply for eligible opportunities immediately from the online job platform where they found the information.

VIRTUALRECRUITMENT AND SELECTION OF CANDIDATES

Typically, recruiting takes place face-to-face, in a room, where an interviewer or a panel of interviewers conducts an interview with one interviewee (called as an applicant or a candidate before employment). The Traditional Interview Method is the name given to this method of interviewing.

When using this approach, a great deal of power is used, as is the printing of evaluation papers for each interviewer, filling out a candidate information form to tell the interviewers about themselves, and submitting resumes, among other things. There is indeed a lot of paperwork involved, and electricity is required for the interview room as well as the waiting area for the candidates.

Green human resource management turns the world upside down. In this case, everything takes place online. The applicant can partake in the interview from his or her house, from his or her vehicle, from a train station, or from anywhere else as long as he or she has access to a reliable internet connection and a suitable device. As opposed to traditional methods of applying for jobs, resumes are submitted online via job portals or the organization's career website. Because the interviewers assess

VIRTUAL EMPLOYEE EMPOWERMENT AND PARTICIPATION

It is necessary for management to transmit some decision-making authority in order for workers to feel confident that they are being trusted by their superiors. It is possible to promote employee participation in a number of ways, with the outcome being increased employee engagement in specific elements of your company as well as increased organisational efficiency.

Increased levels of employee involvement have been shown to be associated with higher levels of productivity, performance, and job satisfaction. Simply said, happy workers have a proven track record of increasing earnings and improving corporate success. As a result, virtual employee engagement concepts are an extremely important business strategy to consider.

VIRTUAL IMPLEMENTATION OF GREEN STRATEGY AND GREEN STRATEGIC MANAGEMENT

For every firm, whether public or private, governmental or commercial, a green strategy should be developed that complements the enterprise's existing business, operations, and asset plans, which are usually well understood and defined by the enterprise.

Those corporate methods that involve raising awareness about environmental concerns, refining company rules and procedures, and then launching creative initiatives that have lasting impact are known as "green management strategies."

VIRTUAL IMPLEMENTATION OF ENVIRONMENT FRIENDLY HR PRACTICES

Technological obsolescence, cultural and societal shifts, political regulations, and other factors all contribute to change. The external environment is comprised of those aspects that have an impact on an organization's human resources but are located outside of the organization's walls.Green human resource management may help to foster a culture of care for the well-being and health of our co-workers. Green human resource management may help to enhance the environment by recycling waste material, which helps to keep the environment clean and long-lasting. A sustainable environment improves the air quality and protects the public's health by reducing pollution.

In green HR, HRM policies are used to stimulate and support the sustainable use of resources and preserve the natural environment. Green HR focuses on the development, implementation and maintenance of all activities aimed at making staff members supportive and committed to sustainable goals.

RESEARCH TRENDS IN MEDICAL SCIENCES

Volume - 18

Chief Editor

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A Processing Method, a System and a Data Storage Medium Focused on Liver Cancer

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Chapter - 4

A Processing Method, a System and a Data Storage Medium Focused on Liver Cancer

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Abstract

The work discloses a method, system and storage medium to process data from liver cancer lesions. The method includes the following steps: collecting energy spectrum CT images of different phases from patients with liver cancer; preprocessing the energy spectrum CT images to obtain the preprocessing image; perform liver segmentation on the preprocessed image to image liver regions at different phases; perform images of liver regions in different phases; segment of liver cancer lesions in the images of the recorded liver regions. The work provides various imaging information by collecting energy spectrum computed tomography images of different phases of liver cancer patients, and then automatically aligns the images in arterial phase and venous phase in the pre-processing process, to reduce the registration difficulty. Finally, the liver area is segmented first, and then registration is performed to speed up the registration speed, so as to realize the function of accurately segmenting the liver cancer lesion area.

Keyword: CT images, liver cancer, U-N e t, mutual information

Introduction

The change in the demographic profile in India, called "aging" of the population, is associated with the transformation in people's relationships with their environments, thus altering the profile of morbidity and mortality. And so it has reduced the incidence of infectious diseases, shifting the focus of attention from the problems caused by diseases and deaths to chronic-degenerative diseases, causing a change in the repertoire of epidemiological surveillance. Liver cancer is highly complex to be diagnosed and treated, but it is not the most common cancer. In patients who had cancer at advanced stages, the five-year survival rate was only 15%. on the other hand, when this type of cancer is detected in the early stages, this survival

This book has been developed with the objective to emphasize on the importance of Universal Human Values. Effort to put forward for value education, self exploration of human being, through self exploration experience continuous happiness and prosperity. This book covers understanding Harmony in self to family order, to society and to nature & existence in practical manner.
This book will enhance the ability to live all the human beings with continuous happiness and prosperity through self realization.

Anand kumar Varma Sibyala
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Approaches to Universal Harmony

Happy Life

Anand kumar Varma Sibyala, Pirakasam A

Arjunan A
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Essentials of Ground Water Engineering

Ground Water Resources

This book has been developed with the intention to highlight the significance of Groundwater governing Equations and Characteristics of different aquifers. It covers Hydrogeological Parameters such as Water bearing Properties of Rock, Type of aquifers - Aquifer properties. Permeability, specific yield, transmissivity and storage co Methods of Estimation Norms, Steady-state flow, Darcy's Law, Groundwater Velocity, Dupuit Forchheimer, Steady Radial Flow into a Well and Well Hydraulics of Unste flow, Theis method, Jacob method, Chow's method, Law of Times, Theis Recovery, Bailer method, Slug method, tests, Image well theory, Partial penetrations of wells, losses, Specific Capacity and Safe yield, Collector well and Infiltration gallery. It contains the techniques for the development and management of groundwater. And a an efficient primary reference for groundwater quality and groundwater conservation.

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Operationalizing Multi-Cloud Environments pp 309–324

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Intelligent Workflow Adaptation in Cognitive Enterprise: Design and Techniques

Arunkumar Panneerselvam

Chapter │ First Online: 18 September 2021

408 Accesses │ **1** Citations

Abstract

Traditional businesses are transforming into cognitive business operations with convergence of technologies such as Cloud, Big Data, Artificial Neural Networks, and Machine Learning. As businesses all around the world become more dependable on technology and handle more data, the success of the business enterprises is greatly determined by the intelligent workflows that are automated, adaptable, and self-learning. Intelligent workflows play a vital

Industrial Engineering

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Computational analysis of provisional study on white layer properties by EDM vs. WEDM of aluminum metal matrix composites

Author:

Kathiresan M.,Theerkka Tharisanan R.,Pandiarajan P.

Publisher

Elsevier

Reference 48 articles.

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DIGITAL SYSTEM DESIGN

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DIGITAL SYSTEM DESIGN

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CHAPTER 2
DIGITAL LOGIC GATES

2.1 DIGITAL LOGIC GATES

A logic gate is a kind of electrical circuit or device that makes logical conclusions. The most popular logic gates used to make these judgments are OR, AND, NOT, NAND, and NOR gates. The NAND and NOR gates are referred to as universal gates. The exclusive-OR gate is another logic gate that may be built using the AND, OR, and NOT gates.

A logic gate has one or more inputs and one output. Only specific input combinations activate the output. Logic gates are the fundamental components of every digital circuit. Switches are another name for logic gates. TTL (Transistor Transistor Logic) circuits and CMOS circuits have mostly replaced switches with the development of integrated circuits. This section shows how to build basic gates using sample circuits.

•AND

•OR

•NOT

•BUF

•NAND

•NOR

•XOR

•XNOR

AND Gate

The AND gate conducts logical multiplication, often known as the AND function. The AND gate comprises two or more inputs and a single output. The AND gate's output is HIGH only when all of its inputs are HIGH (i.e., even if one input is LOW, Output will be LOW).

If X and Y are two inputs, then the output F is mathematically represented as F = X.

In this case, the AND operation is denoted by the dot (.). The truth table and AND gate symbol are shown in the figure below.

Symbol   Truth Table

X	Y	F(X.Y)
0	0	0
0	1	0
1	0	0
1	1	1

Fig 2.1 AND GATE

The figure below depicts a two-input AND gate using "diode-resistor" logic, where X and Y are inputs, and F is the output.
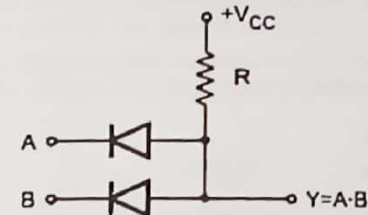
If X and Y are both 0, diodes D1 and D2 are forward biassed and conduct, pulling F low.

D2 is reverse biassed and does not conduct if X = 0 and Y = 1. However, since D1 is forward biassed, it conducts and pushes F down.

D1 is reverse biassed and thus does not conduct if X = 1 and Y = 0. However, since D2 is forward biassed, it conducts and pushes F down.

If X = 1 and Y = 1, diodes D1 and D2 are reverse biassed, and diodes are in the cut-off. Hence there is no voltage loss at F. As a result, F is HIGH.

OR Gate

The OR gate performs logical addition, also known as the OR function. The OR gate comprises two or more inputs and a single output. The output of an OR gate is HIGH only if either of its inputs is HIGH (i.e., even if one input is HIGH, Output will be HIGH).

If X and Y are two inputs, then the output F is mathematically represented as F = X+Y. In this case, the OR operation is denoted by the plus symbol (+). The truth table and OR gate symbol are shown in the figure below.

INTRODUCTION TO PIC MICROCONTROLLER

MR. S. SENTHILKUMAR
DR. RAJEEV KUMAR SHAKYA
DR. YOGENDRA NARAYAN
MR. BHASKAR ROY

INTRODUCTION TO PIC
MICROCONTROLLER

(for B.E/B.Tech)

TEXT BOOK

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TITLE OF THE TOPIC

PORTB INTERRUPT ON CHANGE :

An input change on PORTB sets flag bit RBIF. The interrupt can be enabled/disabled by setting/clearing enable bit RBIE.

WATCH DOG TIMER (WDT):

The Watchdog Timer is a free running on-chip RC oscillator which does not require any external components. This RC oscillator is separate from the RC oscillator of theOSC1/CLKIN pin. That means that the WDT will run, even if the clock on the OSC1/CLKIN and OSC2/CLKOUT pins of the device has been stopped, for example, by execution of a SLEEP instruction. During normal operation, a WDT time-out generates a device reset. If the device is in SLEEP mode, a WDT time-out causes the device to wake-up and continue with normal operation. The WDT can be permanently disabled by clearing configuration bit WDTE.

WDT PERIOD:

The WDT has a nominal time-out period of 18 ms, (with no pre scaler). The time-out periods vary with temperature, VDD and process variations from part to part (see DC specs).If longer time-out periods are desired, a prescaler with a division ratio of up to can be assigned to the WDT under software control by writing to the OPTION register. Thus timeout periods up to seconds can be realized. The CLRWDT and SLEEP instructions clear the WDT and the postscaler, if assigned to the

WDT, and prevent it from timing out and generating a device RESET condition. The TO bit in the STATUS register will be cleared upon a WDT time-out.WDT programming consideration is, It should also be taken in account that under worst case conditions (VDD = Min., Temperature = Max., max WDT prescaler) it may take several seconds before a WDT timeout occurs.

6. Selecting a PIC

Each type of PIC microcontroller provides a different combination of features, so that the most suitable can be selected for any given application. At the time of writing more than 140 are available, and increasing all the time. Some of the main selection criteria are:

- Number of I/O pins available
- Program memory size
- Program memory type (ROM, EPROM, Flash)
- EEPROM data memory
- Timers (8-bit or 16-bit), CCP
- Interrupt sources
- Analogue inputs (8-bit or 10-bit)
- Serial communication interfaces (USART, SPI, I2C, CAN)
- Internal oscillator
- In-circuit debugging
- Maximum clock speed

ELECTRONIC DEVICES

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CONTENTS

• Power Dissipation, Ptot: This FET standard provides the highest continuous power that the device may disperse. The power dissipation is usually free in the air or at a specific temperature at the base, usually 25 °C. The exact circumstances, whether in a heat sink or free air, depending on the device type and manufacturer. Power FETs are more likely to be detailed when they are stored atop a heat sink, while the free air condition applies to signal FETs.

FET datasheets include a host of various FET performance parameters and specifications. All are made in the different datasheets, which allow FET to be set correctly.

CHAPTER 5

POWER DEVICES AND DISPLAY DEVICES

5.1   UJT (UNI-JUNCTION TRANSISTOR)

Because it is a 2-layered, 3-terminal solid-state device, a uni-junction transistor is also known as a double-base diode.

Device for switching Because it contains just one junction, it is called a uni-junction device. The unique characteristic

This device's characteristic is that when it is triggered, the emitter current increases until an emitter power supply limits it.

Construction of UJT

UJT is a three-terminal, single-junction, two-layered device, and it is similar to a thyristor compared to transistors.

(a) Basic Structure   (b) Schematic Symbol   (c) Basic Arrangement

Unijunction Transistor
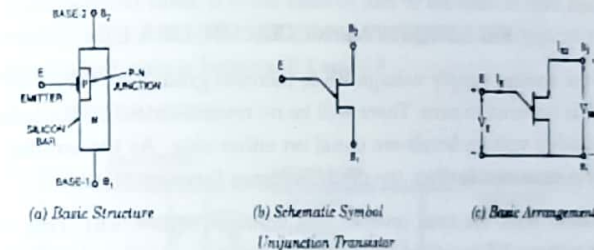
FIG 5.1 CONSTRUCTION OF UJT

As illustrated in the figure, the silicon bar contains two Ohmic connections designated base1 and base2. The function of the base and emitter differs from that of a bipolar transistor's base and emitter.

The emitter is of the P-type and heavily doped. An inter-base resistance is between B1 and B2 when the emitter is open-circuited. The emitter junction is typically situated closer to base B2 than base B1. As a result, the device is not symmetrical since most applications do not need electrical properties from symmetrical units.

Operation of a UJT   Assume that the emitter supply voltage is turned to zero. The intrinsic stand-off voltage then reverse-biases the emitter diode, as

Deepq: Residue analysis of localization images in large scale solid state physical environments

S. Manikandan, K. S. R. Radhika, M. P. Thiruvenkatasuresh, et al.

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Deepq: Residue Analysis of Localization Images in Large Scale Solid State Physical Environments

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Abstract. Deep Learning is the process to led machine learning, natural language processing and neural networks. The various deep learning models, computer vision systems and artificial intelligence services are used to study of various real time applications. Due to lack of computing resource the conventional neural network are produces delay in progress and reduce the GPUs performance and throughput. In this paper we review difference deep learning approaches with increases GPUs performance and apply various image processing classification and localization techniques. The high availability and GPUs performance can be verified by state-of-arts results using conventional deep learning methods.
Keywords: Deep Learning, Computer Vision, GPU Performance, Classification, Localization, CNN Model, DeepQ Process

INTRODUCTION

Deep learning is the major division of machine learning and neural networks. Learning are played important role in access and processing information and produce real time results. But the normal methods areaffects the throughput and GPUs performance. Deep learning process are includes the chip processing, dataset sizes, processing delays and performance [1]. Deep learning process has proven concept used in search engine, bio-informatics, robotics, industrial internet, multimedia applications, machine vision systems and game programming. In current scenario the conventional multi process environments leads compressed sensing and distributed multiuser sensing approaches [2]. The Bio-inspired computing is used to solve visual cortex, behaviours, small regions failures and multi-layer perception. The following figure 1 shows that the conventional neural network architecture and it produces the visual scheme annotation in each layers.
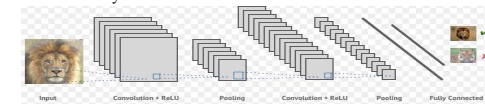
FIGURE 1.Conventional Neural Network – Deep Learn Model

The convolution and pool layers are used in conventional deep learning process for measuring local batches [3]. Each batch log collected by features of visual recognition inputs and processed by similar batches or predefined batch results. But this method could produce delayed in performance and reduced GPUs throughput[10]. The convolution layer shares the behaviours and regions specific results. The Pool layers produces after the result of convolution each logs recorded and used for decision making results. The Object recognition techniques applied in recent years for measuring online based trade marketing. Each log can be labelled for extracting features and fix the localization.Image annotation is important problem to set each localization values and it collect the information automatically and fix the artificial intelligence results. Natural Language processing and Computer Vision are dominating large number of public repositories.This paper describes following sections, section II describe various researches and literatures, section III handle deep learning process, section IV describes process and reviews and section V gives conclusion and future enhancements.

Show Path ⌄

Chapter
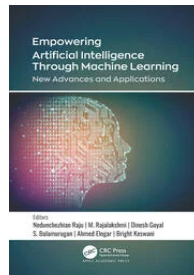
Artificial Intelligence in Education Using Gaming and Automatization with Courses and Outcomes Mapping

By S. Manikandan, M. Chinnadurai

Book   Empowering Artificial Intelligence Through Machine Learning (https://www.taylorfrancis.com/books/mono/10.1201/9781003055129/empowering-artificial-intelligence-machine-learning?refId=a2117d23-5a88-420a-bd5c-b3ccf286b6e7&context=ubx)

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Real-Time Video Tracking Framework With Moving Object Segmentation in Stream Data

101

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Abstract

Object tracking is an active application-oriented research topic. Analysis of video requires human operators to monitor human activities. This framework should be capable of detecting and tracking moving objects accurately. The unsupervised segmentation of moving objects affects the overall performance of an object tracking framework. The ideal aim of unsupervised segmentation method is to split the image into meaningful objects. In this proposed video tracking framework, initially, segmentation of the moving object with displacement vectors in an unsupervised manner is done. Using the displacement vector as a feature, the input frame segmentation is achieved with the Expectation–Maximization (E–M) technique. In this work, the E–M algorithm initialized with the number of objects present in the frame is obtained by clustering objects using the K-means clustering technique. The resulting objects obtained may contain shadows of the objects. Hence, shadow removal approach is used to remove shadows surrounding objects. Finally, the objects tracked using displacement vectors and the behaviour of objects are analyzed. The experiments on various datasets such as standard videos, surveillance videos, and nonstandard videos demonstrated, outperforms in single and multiple cases.

This is a preview of subscription content, log in to check access.

Notes

Acknowledgements

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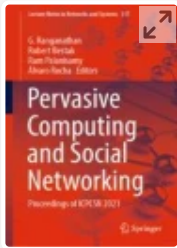
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Single-Round Cluster-Head Selection (SRCH) Algorithm for Energy-Efficient Communication in WSN

K. Rajammal & R. K. Santhia

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Abstract

Wireless sensor networks (WSNs) are emerging trends of communication technologies over the past two decades. They have been finding indispensable application in the fields of remote monitoring and control due to their inherent capability to be deployed in locations where human intervention or presence is undesirable. A challenging research issue in recent times in the area of WSNs is the energy optimization problem in WSN nodes. Nodes are provided with very limited battery power, and their frequent replacement is not possible. Hence, intelligent utilization of the available energy by nodes is the promising solution.

Clustering is one of the possible solutions toward the challenging energy optimization problem. A single-round cluster-head selection algorithm (SRCH) is proposed and implemented in this research paper. A *n*-tuple attribute is taken for considering the optimal cluster head which is able to coordinate and manage the entire communication process from source to destination. Extensive experimentation has been accomplished in this research to evaluate the efficiency of the proposed approach. Comparative analysis has been done against benchmark methods like LEACH, C-LEACH algorithms and superior performance in proposed SRCH is justified in this paper.

Keywords

Wireless sensor networks   **Energy optimization**

Clustering   **Cluster-head selection**

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Metaheuristic Based Resource Scheduling Technique for Distributed Robotic Control Systems

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Abstract: The design of controllers for robots is a complex system that is to be dealt with several tasks in real time for enabling the robots to function independently. The distributed robotic control system can be used in real time for resolving various challenges such as localization, motion controlling, mapping, route planning, etc. The distributed robotic control system can manage different kinds of heterogenous devices. Designing a distributed robotic control system is a challenging process as it needs to operate effactually under different hardware configurations and varying computational requirements. For instance, scheduling of resources (such as communication channel, computation unit, robot chassis, or sensor input) to the various system components turns out to be an essential requirement for completing the tasks on time. Therefore, resource scheduling is necessary for ensuring effective execution. In this regard, this paper introduces a novel chaotic shell game optimization algorithm (CSGOA) for resource scheduling, known as the CSGOA-RS technique for the distributed robotic control system environment. The CSGOA technique is based on the integration of the chaotic maps concept to the SGO algorithm for enhancing the overall performance. The CSGOA-RS technique is designed for allocating the resources in such a way that the transfer time is minimized and the resource utilization is increased. The CSGOA-RS technique is applicable even for the unpredicted environment where the resources are to be allotted dynamically based on the early estimations. For validating the enhanced performance of the CSGOA-RS technique, a series of simulations have been carried out and the obtained results have been examined with respect to a selected set of measures. The resultant outcomes highlighted the promising performance of the CSGOA-RS technique over the other resource scheduling techniques.

Keywords: Distributed robotic control system; resource scheduling; load balancing; resource utilization; metaheuristics; shell game optimization

1 Introduction

In the recent years, due to the high control performance, high reliability of the distributed control systems (DCS), low implementation costs, and reconfiguration flexibility, they have been extensively used in various areas. There are several benefits in utilizing a DCS in the robot collection procedures [1]. These systems are capable of controlling a wider range of heterogeneous devices and do so on greater physical distances. Such a scheme might be very modular and can therefore support multiple devices. The implementation and design of a DCS that works efficiently and effectively in various hardware configurations and computations may be a nontrivial task [2]. For instance, one of the most important consideration here is to ensure the accessibility of resources by the various components in the system (such as the computational units, communications channels, sensor inputs, robot chassis) for accomplishing their task efficiently [3]. Not all resources can adapt to several concurrent access requests at the same time, and several resources on the other hand can manage only a single request at a particular time instant. Another problem here is to define an appropriate procedure for the distribution of requests for the concerned resources inside the entire system. This procedure in a way ensures the balancing conditions of the computation and the resource loads and further confirms that none of the components in the system are charged beyond the defined levels. A DCS was established for handling the collection of small mobile robots possessing the required computing capabilities and restricted on-board sensing ranges [4]. Fig. 1 illustrates the overview of the robotic control model.
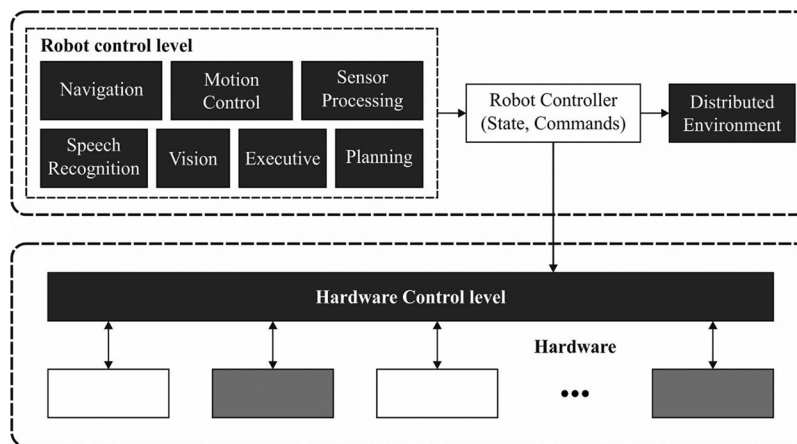
Figure 1: Overview of the robotic control system

The robots should be capable of working with teams: this ability assures that a large physical area could be surveyed by the robots and hence could provide a degree of redundancy by pointing out the robots that are either deactivated or the ones that are unable to complete their tasks on time. Moreover, the robots must function independently. Because of the weight and size constraints of the Scout's design, the computation hardware that is accessible on a Scout is constrained with a limitation of 2 8-bit microcontrollers [5]. For utilizing the processor resources, several tasks often run on a processor. The scheduling algorithms of this task not only affects the utilization of a processor but also controls the system's performance [6]. The optimum scheduling methodology opted for the multiprocessors is the NP hard, hence the heuristic algorithms are often adopted for the allocating tasks. A technique employed for scheduling the tasks in the distributed systems is the integration of the scheduling algorithms for the uniprocessor and the static task distribution algorithms [7]. Followed by which, the system would start functioning, whereas, the processor assigned tasks would be observed to remain unaltered. The algorithms are simpler and the offset of the scheduling algorithms are smaller. Another type of allocation algorithm is the dynamic

allocation algorithm. The tasks in this case might migrate to the processor during the run time of the system. The algorithms are capable of achieving the required optimal objective functions such as the control performance of system, processor utilization, and so on. However, the algorithms are observed to be highly complicated with bigger offsets and the foreseeability of the algorithms appear to be weak.

This study emphases on the dynamic allocation of resources during the runtime instead of analyzing the resource requests offline, it encourages for plan changes when the requests are not fulfilled. Especially, this method is appropriate for an unpredicted environment in which the resources should be assigned in a dynamic manner that cannot be anticipated before. Load schedule is thus determined as the procedure for balancing, providing, and allocating the load in DCS effectively. The primary objective is to decrease the transmission time and the overall cost acquired for scheduling the load in the scheme. The scheduling of the load is executed by different scheduling methods. The scheduling algorithm is determined based on the dynamic and static nature of the load. Also, they are categorized into the non-heuristic and the heuristic types. The Meta heuristic algorithm plays a significant role in scheduling the load through an appropriate search procedure. At present, to conquer the disadvantages, several scientists have resolved this challenge by utilizing the optimization algorithm. However, this methodology fails to achieve the required processing cost, completion time, and load related attributes efficiently. To combat this problem, a group of metaheuristic-based load scheduling algorithms have been proposed for the DCS robotic environments.

This paper introduces a novel chaotic shell game optimization algorithm (CSGOA) for resource scheduling called as the CSGOA-RS technique for the distributed robotic control system environment. The CSGOA technique is based on the integration of the chaotic maps concept to the SGO algorithm to enhance its overall performance. The CSGOA-RS technique has derived a fitness function involving three different parameters such as the make span, the reliability cost, and the mean flow time (MFT) for the allocation of resources in such a way that the resource utilization can be considerably improved. The CSGOA-RS technique is valid even for the unforeseen environment where the resources are to be allotted dynamically using the prior estimations. The performance of the CSGOA-RS technique can be examined under different aspects and the results can be discussed extensively.

2 Literature Review

Lee et al. [8] proposed the architecture for balancing the workload and the competency adjustments in the multirobot task distributions. Competency represents the capability of a robot for executing a task based on its cost and quality, and the workload balancing mechanism represents the allocation of workloads between the robots. This method considers the cost and quality of a robot for a task and thereby adjusts them according to the changes in the environment. For balancing the workload, this method uses the idea of subsidy to inspire the participation of the lesser active member of the robot teams. Experimental result demonstrates that this model could alter the competency levels according to the changes in the environment and allocate workloads between the robots in a balanced way. Goyal et al. [9] addressed the problem of energy utilization using the cloud platforms. The techniques and algorithms should be capable of reducing the schedule resources and power consumption levels for enhancing the efficacy of the server. Also, Load balancing appears to be a significant part of cloud technique as it encourages for balanced load allocations between the servers for satisfying the user requirements. This study has made use of various optimization methodologies such as the PSO, CSO, BAT, CSA, and WOA for balancing the load, energy efficacy, and resource scheduling for creating an effective cloud platform. Blankenburg et al. [10] proposed a distributed multi-robot control framework that addresses the above mentioned problems and accomplishes the succeeding participations: i) it permits for the online and dynamic distribution of robots to the various phases of the task, ii) it makes sure that the collaborative robot scheme would follow the

individual task constraints and iii) it permits for opportunistic, flexible task implementations in distinct environment conditions. This framework utilizes a distributed messaging scheme for allowing the robots to interact with each other. Every robot uses its team member and own state for monitoring the growth on a provided task and recognizes the appropriate subtask for executing an activation spreading methodology.

Zhu [11] proposed a solution to the fairness problems in multitype resource allocations for the multirobot methodologies possessing multiple resource requests. They employ DRF principles in this solution for 2 distinct schemes: STR-MRT and MTR-SRT. In STR-MRT, the robots can execute only individual tasks at a time, task is separable, and for accomplishing the entire set of tasks they would require an increased number of robots. In MTR-SRT, the robots are capable of executing multiple tasks at a time, tasks here are inseparable and the entire set of tasks can be accomplished by a single robot. Delgado et al. [12] offered a complete procedure in the event of realizing the OES on the basis of public domain real world operating systems on many low cost OES platforms. Their efficiency was compared and evaluated based on the interrupt response time, periodicity, scheduling ability, and task synchronization i.e., with respect to the critical metrics for determining the reliability and stability of the real-world regulators. Maoudj et al. [13] handled the growth of a DMAS for controlling and scheduling RFAC. In this technique, a method for solving the key challenge decision problems in RFAC was proposed and implemented. These problems are thus interrelated to the product operation scheduling features that relies on the sequencing and allocation aspects on the robots while fulfilling the robot and product based limitations under the make span minimization. The presented DMAS addresses this problem with the help of a cooperative methodology that is supported by 3 different types of independent control agents, namely, the local agent, the remote agent and the supervisory agent. Yuan et al. [14] proposed a G/G/1 queuing scheme for analyzing the efficiency of the server in DGC. Based on the single objective constraints the optimization problems are solved and formulated by a presented SBA, this is done for identifying the SBA that could minimize the energy cost of a DGC supplier by optimally assigning the tasks of heterogeneous applications amongst the various DGCs. It further specifies the running speed of the servers and the amount of power on the servers in every GC while confronting the respond time limitations of the tasks of each of the individual applications.

Gultekin et al. [15] proposed a second order cone programming formulation for detecting the Pareto efficient solutions. The conic formulation was capable of detecting the robotic schedules for the smaller cells with limited number of machines in moderate computational time durations. This approach could produce a huge set of accurate Pareto effective solutions in a shorter computation time. Wang et al. [16] addressed the multi robot task scheduling mechanism for 2 types of robots arising from the heterogeneous robotic order fulfillment system. The heterogeneous multi robot scheme consists of 2 kinds of robots with complementary and specialized abilities for achieving long cycle and multi-station order fulfilment tasks on a logistic network. Such problems are very complex due to the innate complex schedule constraint of the tasks and hence coupled based on the temporal–spatial relationships among the robots. This procedure would then be followed by the construction of a set-theoretic and mixed integer linear programming problem formulation mechanism, this essentially makes use of the coupled methodology instead of the decoupled methodologies for exploring the synergies among the heterogeneous robots, i.e., unlike the techniques proposed in the present studies.

Sun et al. [17] proposed 2 new robotic job shop scheduling methods using deadlock and robot motion considerations (RJSPDT). The presented method concurrently considers the scheduling of tack operations and motion of the robots with an aim of minimizing the make span. Two modeling methods have been employed here, namely, the conventional position and the new network based approaches i.e., stimulated by the aviation scheduling work. Fu et al. [18] focused on the online scheduling and charging approaches of the robots in warehouses using the unknown moving paths. Initially, the storage scenarios here would be abstracted to a grid methodology. Next, the shortest path algorithms would provide priority to the

robotic tasks based on the coordinate differences. Later, the minimal service quantity of the MC would be defined by the arbitrary simulations.

In He et al. [19], developed the distributed cooperative controllers for a selected set of scenarios. Here, certain aspects such as the manipulability enhancement, transport of the object, and obstacle avoidance are attained online with a new optimization-based methodology. As the local controllers don't require another robot for transmitting the method or for joining the space data, the systems appear flexible with communication costs. Fang et al. [20] used an interconnected undirected graph for describing the multiple redundant manipulator systems. In the existing studies, it is observed that some constraints include the convex set built for the joint physical limit, inequality constraints are derived for avoiding the obstacles, and equality constraints are derived for tracking the required paths. New distributed neurodynamic based algorithms are evolved for solving the complicated problems in real-world, hence it is necessary to have a central coordinator in the multirobot systems.

3 Background Information: System and Task Models

The control loop must be capable of transmitting the required control signals to the concerned process, it should effectively compute the control signals and acquire the required data from a physical procedure. Such functions have been found to influence one another forming loops, these loops are named as loop tasks as they represent a task in the system. As the period of these loop tasks tend to differ to a specific extent they would not be set prior to the initialization of the process [21]. DCS operates on several processors through a transmission network. Various processors are adapted in DCS for realizing different types of control tasks, therefore DCS is heterogeneous, i.e., the implementation time is distinct on distinct processors. Depending on this, the processor and loop task models have been provided below.

Definition 1. Loop tasks set in DCS indicates $S = \{\tau_1, \tau_2, \ldots, \tau_n\} (n \geq 2)$. Where $\tau_i \in S$ represents the ith loop task and is quintuple.

$$\tau_i = (C, T^{\min}, T^{\max}, T, \text{Pr}) \tag{1}$$

where C, $T_i^{\min}$, $T_i^{\max}$ and T represents the implementation time, the minimum sampling period, the maximum sampling period, and the sampling period of the loop task τ_i correspondingly. Pr implies the processor to which the loop task τ_i is assigned.

Definition 2. DCS is defined as a processor set Ω that operates on a network: $\Omega = \{\text{Pr}_1, \text{Pr}_2, \ldots, \text{Pr}_m\}$ $(m \geq 2)$, $\text{Pr}_i = (\rho, u)$, where ρ and u represents the processing ability coefficients and the utilization of the processor Pr_i correspondingly.

For a loop task, the implementation time vectors are presented as follows.

Definition 3. In DCS, $\tau_i.C$ is determined as a vector $\tau_i.C = [\tau_i.C(1), \tau_i.C(2), \ldots, \tau_i.C(m)]$, whereas $\tau_i.C(j)$ denotes the implementation time of the loop task τ_i on the processor Pr_j.

Definition 4. The processing ability coefficients represent the performance speed of the loop tasks on a processor. In heterogeneous DCS, processors are elected as regular processors, denoted as Pr_{nor}, and its processing ability coefficients are represented as one. The processing ability coefficients of Pr_i is given below

$$\text{Pr}_i.\rho = \frac{\tau_j.C.(\text{Pr}_{nor})}{\tau_j.C(i)} \tag{2}$$

Whereas $\tau_j.C(\text{Pr}_{nor})$ represents the implementation time of the loop task τ_j on a regular processor and $\tau_j.C(i)$ indicates the implementation time of the similar loop tasks on the processor Pr_i.

Definition 5. When each loop task in DCS completes before the assigned deadlines then the DCS can be categorized under the schedulable type.

This study is based on the following succeeding rules:

    i)   The required number of loop tasks and processors are to be set.
    ii) The deadline of the loop task is equivalent to their period.
    iii) Loop tasks are independent of one another.

4 The Proposed Model

In this study, an effective CSGOA-RS technique has been developed for scheduling the resources proficiently in the distributed robotic control system. The CSGOA-RS technique is intended to allot the resources in such a way that the transfer time is minimized and the resource utilization is increased. In addition, the CSGOA-RS technique has derived a fitness function involving three parameters namely the make span, the reliability cost, and the mean flow time (MFT) for the allocation of resources in such a way that the resource utilization is considerably improvised. The detailed working of the CSGOA-RS technique has been elaborated in the succeeding sections.

4.1 Design of CSGOA Technique

The shell game was inspired by inventing a novel optimization technique called as the Shell Game Optimization (SGO). Therefore, the subsequent statements are considered:

- During this game, one person would be assumed as the game operator.
- 3 shells and 1 ball would be assigned to an operator.
- All players would be provided with 2 opportunities for guessing the correct shell.

For the mathematical representation of the SGO algorithm, a set of N people would be considered as the game players. In Eq. (3), the place 'd' of a player 'i' would be demonstrated as x_i^d.

$$X_i = (x_i^1, \ldots, x_i^d, \ldots, x_i^n) \tag{3}$$

At this time, X_i is actually an arbitrary value to the problem variable. According to X_i, the value of the fitness function (FF) can be estimated for all the players. Fig. 2 illustrates the steps involved in the SGO techniques.

Step 1	→	Operator Provides the Shell and a Small Ball
Step 2	→	Operator Put the Ball Under one of the Shell and Ask the Player to Guess Under Which Shell the Ball is Hidden
Step 3	→	Each Player may Choose the Correct or Wrong Shell Depending on the Degree of Accuracy and Intelligence
Step 4	→	More Points are Awarded to the Player who Recognizes the Correct shell
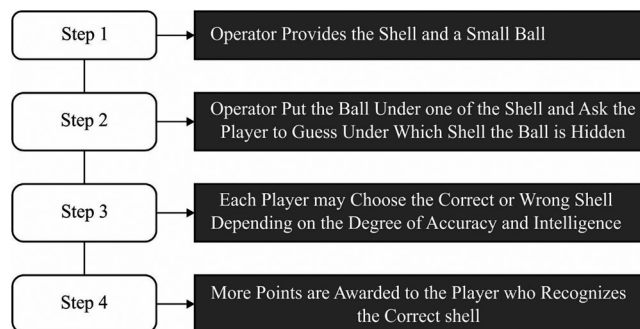
Figure 2: Steps involved in SGO algorithm

After computing the FF value for all the players, the game operator would select 3 shells in such a way that most of the shells are connected to the location of an optimum player, 2 other shells would be selected arbitrarily using Eq. (4).

$$game's\ operator: \begin{cases} shell_1 = ball = X_{best} \\ shell_2 = X_{k_1} \\ shell_3 = X_{k_2} \end{cases} \tag{4}$$

where X_{best} implies the place of minimal (in minimization issues) or maximal (in maximization issues) fitness, X_{k_1} and X_{k_2} are places of 2 members of the population. k_1 and k_2 represent the arbitrary numbers among [1-N] that are selected arbitrarily. After computing the FF and recognizing the shell for all the players, the aspects of intelligence and accuracy of the players would be estimated in this phase [22]. All the players would guess that the shell dependent upon the players are inspired based on the fitness accuracy and intelligence. The accuracy and intelligence normalization value is represented by Eq. (5).

$$AI_i = \frac{fit_i - fit(X_{worst})}{\sum_{j=1}^{N}[fit_j - fit(X_{worst})]} \tag{5}$$

where AI_i represents the accuracy and intelligent of the players i and X_{worst} refers to the place of minimal (in maximization issues) or maximal (in minimization issues) fitness levels.

At this point, the player would be prepared to guess the ball. The game is to be played with 3 shells and all the players would be provided with only 2 chances, the players can make use of the available 3 states of guesses. In the beginning state, an initial guess would be correct and the place of ball could be recognized easily. In the second state, the player making a wrong guess in the primary selective state can guess the place of the ball the second time. Finally, in the third state, when both the guesses of the player go wrong, the player turns out to be unsuccessful in recognizing the place of the ball. The guess vector detailed by G_v is inspired as in Eq. (6) for all the players.

$$G_v(x) = \begin{cases} state1: [1\ 0\ 0], & at\ first \\ state2: \begin{cases} [0.5\ 0.5\ 0] \\ 0.5\ 0\ 0.5 \end{cases}, & at\ second \\ state3: [0\ 0.5\ 0.5], & else \end{cases} \tag{6}$$

The probability of selecting most states to the shell selective is inspired by Eq. (7).

$$state = \begin{cases} state\ 1: if\ AI_i > r_{g1} \\ state2: if\ AI_i > r_{g2} \\ state3: else \end{cases} \tag{7}$$

where r_{g1} signifies the feasibly of a correct guess at the initial selective and r_{g2} indicates the feasibly of a correct guess the second time.

Eventually, the X_i vector that is considered as the place of the members of the population is upgraded with the Eqs. (8)–(11).

$$dx_{i,ball}^d = r_1 \times (ball - x_i^d) \times state\ (1,\ 1) \tag{8}$$

$$dx_{i,shell_2}^d = r_2 \times (shell_2^d - x_i^d) \times sign(fit_i - fit_{shell_2}) \times state(1,\ 2) \tag{9}$$

$$dx_{i,shell_3}^d = r_3 \times (shell_3^d - x_i^d) \times sign(fit_i - fit_{shell_3}) \times state(1,\ 3) \tag{10}$$

$$x_i^d = x_i^d + dx_{i,ball}^d + dx_{i,shell_2}^d + dx_{i,shell_3}^d \tag{11}$$

where r_i represents the arbitrary value in the range of [0 1], $dx_{i,ball}^d$, $dx_{i,shell_2}^d$, and $dx_{i,shell_3}^d$ are the movements of dimensional 'd' of the player 'i' according to $shell_1$, $shell_2$, and $shell_3$.

Algorithm 1: Pseudocose of SGO

Input: Random formation of the initial population

Output: The better optimum solution

Begin

Initialize the random formation of the primary population X_i

Compute the fitness value of the agent

Choose the ith member of 3 shells $X_{ishell1}$, $X_{ishell2}$, $X_{ishell3}$

Compute the Accuracy & Intelligence (AI)

Simulate the Guess state

Choose the dimensional of the ith member

Compute $X_{ishell1}$, $X_{ishell2}$, $X_{ishell3}$

Upgrade the place of dimension of the ith member

If each member is upgraded, go to step 10 else go to step 2

If termination condition is initiated

Attain the better optimal solution

End

Chaotic maps are efficient enough in enhancing the solution quality of the SGO algorithm in resolving the resource scheduling problems. Generally, chaos is a deterministic arbitrary technique that is non-linear, it is dynamic model that is non-periodic, non-converging, and bounded in nature. The nature of chaos is obviously arbitrary and unpredictable, and it can retain an element of regularity. The chaos utilizes the chaotic variables instead of the arbitrary variables. Many functions (chaotic maps) and some parameters (primary condition) are vital even for the longer systems. Furthermore, a huge number of distinct sequences are created easily by altering their primary conditions. Also, this sequence is deterministic and reproducible. In addition, it is extremely sensitive depending upon their primary conditions and parameters. An extensive variation of the distinct chaotic maps is accessible in the optimization domain. In this proposed work, 10 very extensively utilized chaotic maps have been employed [23]. The mathematical modulation of these chaotic maps thus utilized have been explained in the subsequent subsections. The chebyshev map has been expressed in Eq. (12).

$$u_{k+1} = \cos(Par.cos^{-1}u_k) \tag{12}$$

The circle map is a 1D map that is a member of the dynamical schemes on a circle and is initially determined by the Andrey Colmogorov. This map is determined as:

$$u_{k+1} = u_k + b - \left(\frac{Par}{2_{Par}}\right)\sin(2\pi u_k)mod(1) \tag{13}$$

This formula is created with chaotic numbers amongst (0, 1) by utilizing $Par = 0.5$ and $b = 0.2$. Par is employed in the form of control parameters. The formulas of the Gauss map are determined as:

$$u_{k+1} = \begin{cases} 0 & u_k = 0 \\ \dfrac{1}{u_k mod(1)} & \text{otherwise} \end{cases} \tag{14}$$

$$\frac{1}{u_k mod(1)} = \frac{1}{u_k} - \left[\frac{1}{u_k}\right] \tag{15}$$

This map also creates a chaotic sequence in (0, 1).The iterative chaotic map formula is expressed in Eq. (16).

$$u_{k+1} = abs\left(\sin\left(\frac{Par}{u_k}\right)\right) \tag{16}$$

where *Par* implies the adaptable parameter. The equation for the logistic map formula is provided in Eq. (17).

$$u_{k+1} = Par.u_k(1 - u_k) \tag{17}$$

where *Par* is the control parameter, which is set to 4 for generating numbers amongst 0 and 1. The family of the piecewise maps is expressed using Eq. (18).

$$u_{k+1} = \begin{cases} \dfrac{u}{Par} & 0 \leq u_k \leq Par \\ \dfrac{u_k - Par}{0.5 - Par} & Par \leq u_k \leq 0 = 5 \\ \dfrac{1 - P - u_k}{0.5 - Par} & 0.5 \leq u_k \leq 1 - Par \\ \dfrac{1 - u_k}{Par} & 1 - Par \leq u_k \leq 1 \end{cases} \tag{18}$$

where *Par* refers to the appropriate control parameter whose range is 0 and 0.5. The sine map is determined as:

$$u_{k+1} = \frac{a}{4}\sin(\pi u_k) \tag{19}$$

Par implies the control parameter containing values in the ranges 0 and 4. The singer map is considered as:

$$u_{k+1} = Par(7.86u_k - 23.31u_k^2 + 28.75u_k^3 - 13.302875u_k^4) \tag{20}$$

where *Par* represents the control parameter whose values lie in the range 0.9 and 1.08. The sinusoidal map is expressed as follows:

$$u_{k+1} = Par.u_k^2 \sin(\pi u_k) \tag{21}$$

where *Par* signifies the control parameter. In this case, the simplified formula of this map was utilized by employing *Par* = 2.3 and u_0 = 0.7 that is expressed as:

$$u_{k+1} = \sin(\pi u_k) \tag{22}$$

The formula of the tent map is demonstrated as:

$$u_{k+1} = \begin{cases} 2u_k & u_k < 0.5 \\ 2(1 - u_k) & u_k \geq 0.5 \end{cases} \tag{23}$$

4.2 Application of CSGOA Technique for Resource Scheduling

The CSGOA-RS technique derives a fitness function and is utilized for testing the quality of the solution [24]. The FF consist of the tri-objectives such as the RC, the MS, and the MFT. It is calculated in Eq. (24), whereas the weights W_1, W_2, & W_3 indicate the connotation of the objectives in the meta task scheduling problems.

$$Fitness = W_1\ Makespan + W_2\ Mean\ Flow\ Time + W_3\ Reliability\ Cost \tag{24}$$

The CSGOA-RS technique has tested the FF using the distinct weight values and hence concludes with the values of 0.4, 0.4 and 0.2 for the weights W_1, W_2, & W_3 respectively, it further provides the optimal results in the meta task scheduling problems.

Make span (MS)

It calculates the throughput of the distributed system, assume $C_{ij}(i\varepsilon\{1, 2, ..., n\}, j\varepsilon\{1, 2, ..., m\})$ represents the implementation time to perform the ith task in the jth processor and $W_j\ j\varepsilon\{1, 2, ..., m\}$ indicates the prior task of P_j. Based on the above-mentioned description, it is evaluated using Eq. (25):

$$MS = \max\left\{\sum_{ij} C_{ij} + W_j\right\} j\epsilon(1, 2, ..., m) \tag{25}$$

Mean flow time (MFT)

It measures the QoS of the distributed systems. The value of MFT is utilized for evaluating the flow time. Let k represent the overall amount of tasks allocated to the processor P_i and F_{ji} represent the executing time of the task T_j on a processor P_i, $(i\epsilon\{1, 2, ..., m\}, j\epsilon\{1, 2, ..., n\})$, the MFT can be estimated using the following Eqs. (26) and (27):

$$MFT = \frac{\sum_{i=1}^{m} M\_Flow i}{m} \tag{26}$$

$$M - Flow_i = \frac{\sum_{j=1}^{k} F_{ji}}{k_i} \tag{27}$$

Reliability cost (RC)

RC is the indicator of how reliable a provided system is if a set of tasks are allocated to it. It is indirectly proportionate to reliability. It is the summation of link reliability and processor reliability. The RC can be determined using Eq. (28), whereas $X(T_i) = j$ represents the task T_i that is assigned to P_j and λ_j indicates the failure rate of the processor P_j.

$$RC = \sum_{j=1}^{m} \sum_{X(T_i)=j} \lambda_j C_{ij}(T_i) \tag{28}$$

5 Results and Discussion

This section examines the resource scheduling performance of the CSGOA-RS technique in terms of different aspects. The results are inspected in terms of the following attributes, namely, the make span, the mean flow time, and the reliability cost. The experimental results have been investigated under varying number of instances and resources. A brief MS analysis of the CSGOA-RS technique takes place under distinct number of instances as represented in Tab. 1 and Fig. 3.

Table 1: Makespan, mean flow time analysis and reliability cost analysis of the CSGOA-RS model

No. of Instances	Make span			Mean flow time			Reliability cost		
	EDF	ACO	CSGOA-RS	EDF	ACO	CSGOA-RS	EDF	ACO	CSGOA-RS
c_lo_lo	13247	31229	41150	6264	7484	4653	0.187	0.140	0.128
c_lo_hi	25325	31331	41954	11762	35135	33300	0.462	0.442	0.430
c_hi_lo	11220	35182	47298	6086	7629	5738	0.182	0.227	0.172
c_hi_hi	17227	20331	31195	12127	24341	22139	0.466	0.491	0.451
i_lo_lo	25225	32161	43963	13287	23115	21840	0.306	0.441	0.295
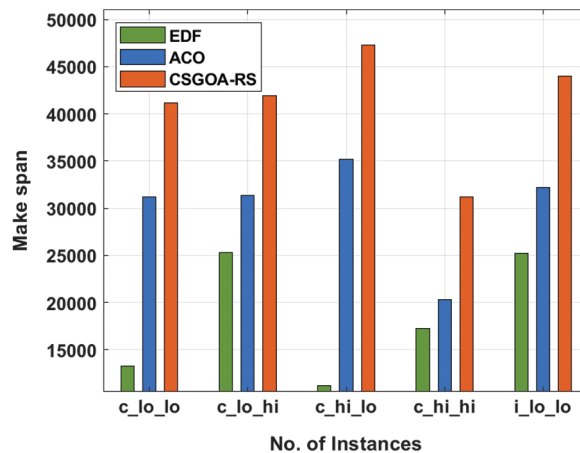
Figure 3: Make span cost analysis of the CSGOA-RS model

The simulation results point out the enhanced performance of the CSGOA-RS technique with that of the existing techniques with the maximum make span. For instance, with c_lo_lo instances, the CSGOA-RS technique has accomplished an increased MS of 41150 whereas the EDG and ACO algorithms have resulted in a reduced MS of 13247 and 31229. Simultaneously, with c_hi_lo instances, the CSGOA-RS technique has accomplished an increased MS of 47298 whereas the EDG and ACO algorithms have resulted in a reduced MS of 11220 and 20331. Concurrently, with i_lo_lo instances, the CSGOA-RS technique has accomplished an increased MS of 43963 whereas the EDG and ACO algorithms have resulted in a reduced MS of 25225 and 32161.

A brief MFT analysis of the CSGOA-RS technique takes place under distinct number of instances as portrayed in Tab. 1 and Fig. 4. The simulation outcomes thus point out the enhanced performance of the CSGOA-RS technique with that of the existing techniques with the maximum make span. For instance,

with c_lo_lo instances, the CSGOA-RS technique has accomplished an increased MFT of 4653 whereas the EDG and ACO algorithms have resulted in a reduced MFT of 6264 and 7484.
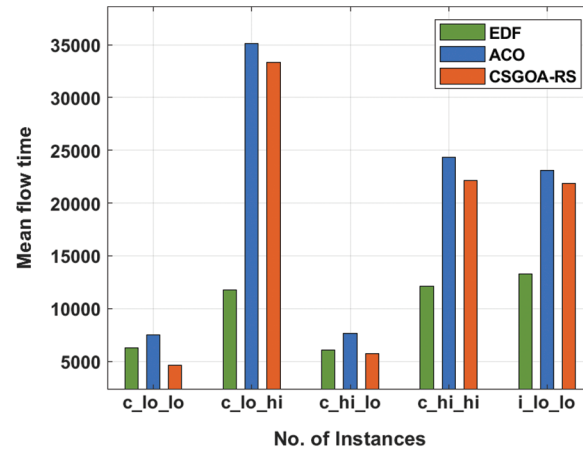
Figure 4: Mean flow time analysis of the CSGOA-RS model

Simultaneously, with c_hi_lo instances, the CSGOA-RS technique has accomplished an increased MFT of 5738 whereas the EDG and ACO algorithms have resulted in a reduced MFT of 6086 and 7629. Concurrently, with i_lo_lo instances, the CSGOA-RS technique has accomplished an increased MFT of 21840 whereas the EDG and ACO algorithms have resulted in a reduced MFT of 13287 and 23115. A reliability cost analysis of the CSGOA-RS technique with the other techniques has been represented in Tab. 1 and Fig. 5. The experimental outcomes thus demonstrate that the CSGOA-RS technique has gained effectual outcomes with the RC values. For instance, with the instance of c_lo_lo, the CSGOA-RS technique has offered a lower RC value of 0.128 whereas the EDF and ACO algorithms have obtained higher RC values of 0.187 and 0.140 respectively.
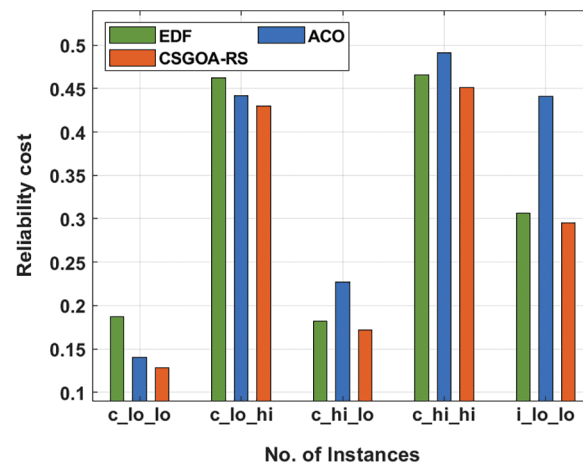
Figure 5: Reliability cost analysis of CSGOA-RS model

Eventually, with the instance of c_hi_lo, the CSGOA-RS technique has offered a lower RC value of 0.172 whereas the EDF and ACO algorithms have obtained higher RC values of 0.182 and 0.227 respectively. Meanwhile, with the instance of i_lo_lo, the CSGOA-RS technique has offered a

lower RC value of 0.295 whereas the EDF and ACO algorithms have obtained a higher RC value of 0.306 and 0.441 respectively. A detailed SR analysis of the CSGOA-RS technique with the other existing techniques takes place under a distinct number of processors and resources as represented in Tab. 2 and Fig. 6. Fig. 6a investigates the SR analysis of the CSGOA-RS technique with the EDG and the ACO algorithms with two processors and varying resources. The figure thus portrays that the CSGOA-RS technique has resulted in effective performance with the maximum SR under varying resources.

Table 2: Comparative analysis of the CSGOA-RS model in terms of SR

No. of Resources	Number of Processor = 2			Number of Processor = 3			Number of Processor = 5		
	EDF	ACO	CSGOA-RS	EDF	ACO	CSGOA-RS	EDF	ACO	CSGOA-RS
2	100	100	100	100	100	100	100	100	100
4	84	86	90	80	85	92	82	84	94
6	20	30	42	45	60	70	50	53	75
8	12	35	40	20	30	50	24	35	55
10	6	20	35	2	20	35	3	24	40

For instance, with 4 resources, the CSGOA-RS technique has gained improved outcomes with a higher SR of 90% whereas the EDF and ACO algorithms have obtained a decreased outcome of 84% and 86% respectively. Similarly, with 10 resources, the CSGOA-RS method has reached the maximum result with a higher SR of 35% whereas the EDF and the ACO algorithms have achieved a minimum result of 6% and 20% correspondingly. Fig. 6b examines the SR analysis of the CSGOA-RS approach with the EDG and the ACO algorithms with three processors and different resources. The figure depicts that the CSGOA-RS technique has resulted in effective performance with the maximum SR under varying resources. For example, with 4 resources, the CSGOA-RS approach has reached the maximum outcome with the superior SR of 92% whereas the EDF and the ACO algorithms have reached a decreased outcome of 80% and 85% correspondingly. In addition, with 10 resources, the CSGOA-RS technique has gained improved outcomes with the superior SR of 35% whereas the EDF and the ACO methodologies have obtained a lesser outcome of 2% and 20% correspondingly.

Fig. 6c demonstrates the SR analysis of the CSGOA-RS technique with the EDG and the ACO methods with five processors and varying resources. The figure thus portrays that the CSGOA-RS technique has resulted in effective performance with the maximal SR under varying resources. For instance, with 4 resources, the CSGOA-RS technique has gained enhanced outcomes with the higher SR of 94% whereas the EDF and the ACO methodologies have achieved a decreased outcome of 82% and 84% correspondingly. At the same time, with 10 resources, the CSGOA-RS approach has gained higher outcomes with a higher SR of 40% whereas the EDF and the ACO algorithms have reached a decreased outcome of 3% and 24% respectively. A comprehensive ECU analysis of the CSGOA-RS approach with the other recent methodologies takes place under different number of processors and resources as represented in Tab. 3 and Fig. 7.
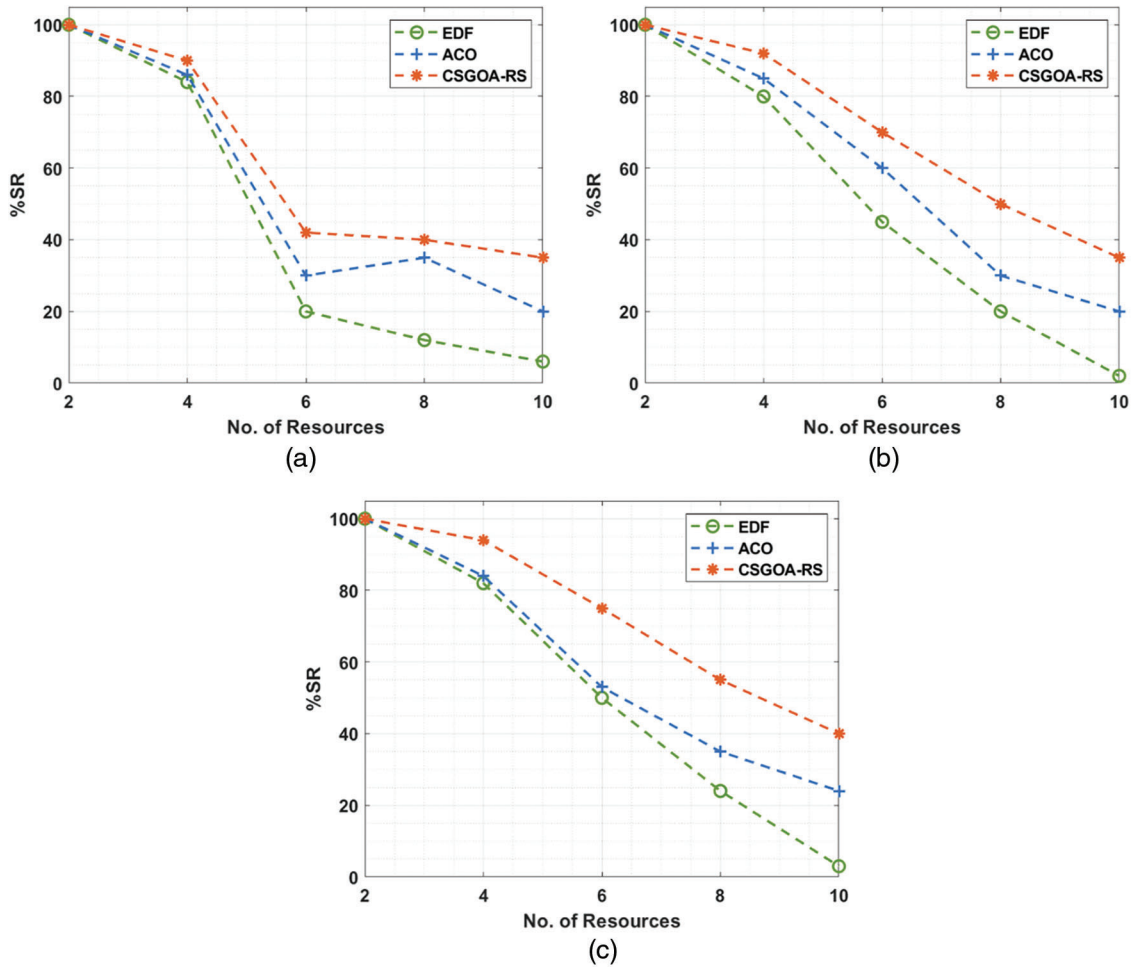
Figure 6: Comparative analysis of the CSGOA-RS model in terms of SR (a) 2 processors, (b) 3 processors, and (c) 5 processors

Table 3: Comparative analysis of the CSGOA-RS model in terms of ECU

	%ECU								
No. of Resources	Number of Processor = 2			Number of Processor = 3			Number of Processor = 5		
	EDF	ACO	CSGOA-RS	EDF	ACO	CSGOA-RS	EDF	ACO	CSGOA-RS
2	50	50	50	50	50	50	50	50	50
4	75	75	76	60	60	63	63	63	65
6	60	70	74	20	38	45	20	25	40
8	21	45	50	10	22	30	5	20	35
10	4	18	25	2	18	32	1	37	39
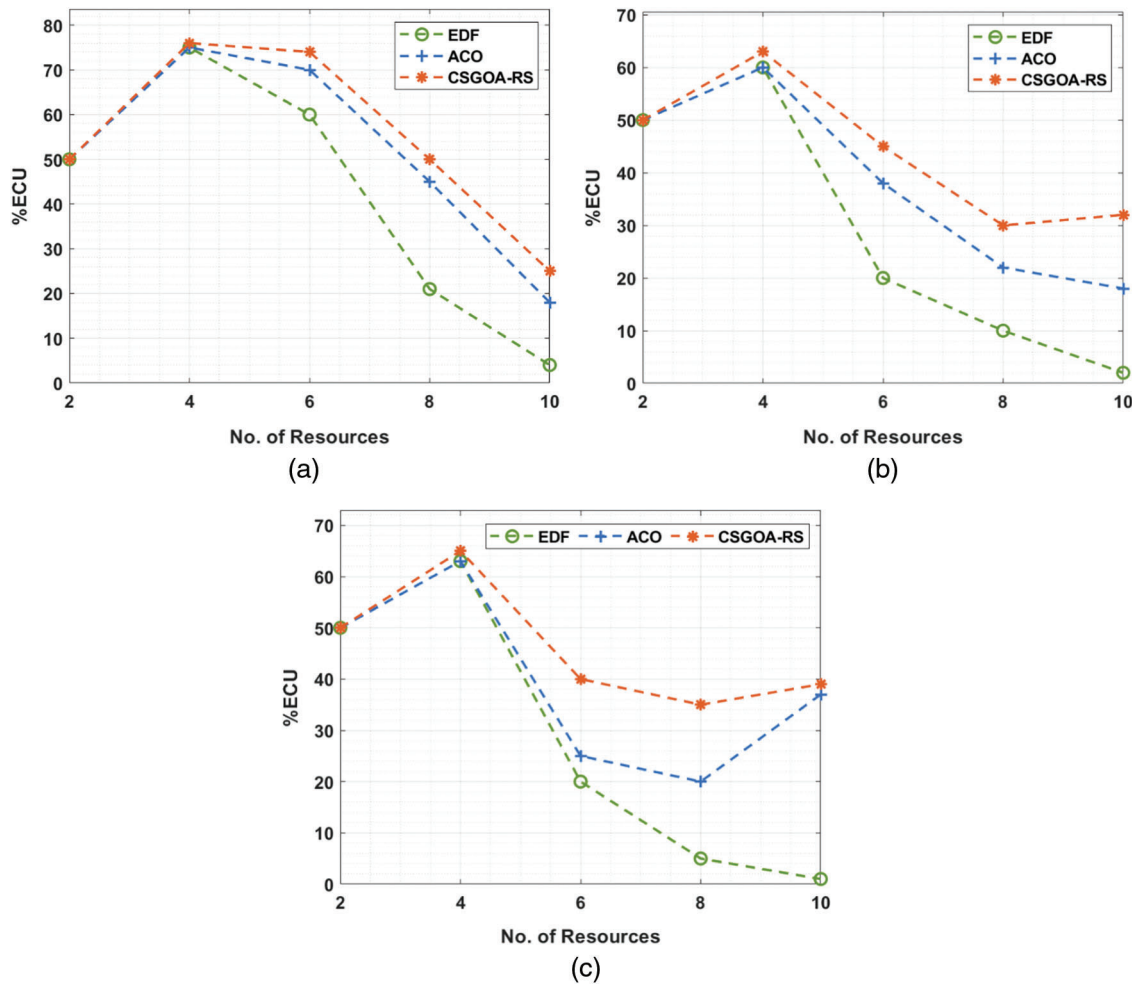
Figure 7: Comparative analysis of the CSGOA-RS model in terms of ECU

Fig. 7a examines the ECU analysis of the CSGOA-RS method with that of the EDG and the ACO algorithms with two processors and varying resources. The figure thus demonstrates that the CSGOA-RS method has resulted in effectual efficiency with the maximal ECU under varying resources. For example, with 4 resources, the CSGOA-RS technique has attained enhanced results with the superior ECU of 76% whereas the EDF and the ACO algorithms have obtained a decreased outcome of 75% and 75% correspondingly. At the same time, with 10 resources, the CSGOA-RS technique has obtained enhanced results with the maximum ECU of 25% whereas the EDF and the ACO algorithms have gained a reduced outcome of 4% and 18% correspondingly.

Fig. 7b inspects the ECU analysis of the CSGOA-RS approach with the EDG and the ACO techniques with three processors and varying resources. The figure thus demonstrates that the CSGOA-RS method has resulted in efficient performance with enhanced ECU under varying resources. For instance, with 4 resources, the CSGOA-RS technique has gained improved outcomes with a higher ECU of 63% whereas the EDF and the ACO algorithms have obtained a decreased outcome of 60% and 60% respectively. Also, with 10 resources, the CSGOA-RS method has gained enhanced outcomes with an increased ECU of 32% whereas the EDF and the ACO algorithms have obtained a minimal outcome of 2% and 18% correspondingly. Fig. 7c showcases the ECU analysis of the CSGOA-RS technique with the

EDG and the ACO algorithms with five processors and different resources. The figure thus exhibits that the CSGOA-RS method has resulted in effective performance with the higher ECU under distinct resources. For example, with 4 resources, the CSGOA-RS technique has gained improved outcomes with a higher ECU of 65% whereas the EDF and the ACO algorithms have obtained a decreased outcome of 63% and 63% correspondingly.

Finally, with 10 resources, the CSGOA-RS approach has gained improved outcomes with a higher ECU of 39% whereas the EDF and ACO methodologies have gained minimal results of 1% and 37% correspondingly. By observing the details of the result analysis, it is clearly understood that the CSGOA-RS technique has gained effective performance due to the fitness function that involves the following three parameters namely the make span, the reliability cost, and the MFT for the allocation of resources.

6 Conclusion

This paper has developed an effective CSGOA-RS technique for scheduling the resources proficiently in the distributed robotic control system. The CSGOA-RS technique is primarily designed for allocating the resources in such a way that the transfer time is minimized and resource utilization is increased. The CSGOA-RS technique has derived a fitness function involving three parameters namely the make span, the reliability cost, and the mean flow time (MFT) for the allocation of resources in such a way that the resource utilization can be considerably improved. The integration of the chaotic map concepts into the SGO algorithm significantly boosts the overall performance of the CSGOA technique. The performance of the CSGOA-RS technique can be examined under different aspects and the results of the same can be discussed extensively. The experimental results showcased the significant outcomes of the proposed CSGOA-RS technique over the other existing techniques. In future, the CSGOA-RS technique can be extended to the design of load balancers and route planning techniques for the distributed robotic control system.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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Evolutionary Algorithm Based Adaptive Load Balancing (EA-ALB) in Cloud Computing Framework

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Abstract: In the present decade, the development of cloud computing framework is witnessed for providing computational resources by dynamic service providing methods. There are many problems in load balancing in cloud, when there is a huge demand for resources. The objective of load balancing is to equilibrate the cloud server computations for avoiding overloading problems. On addressing the issue, this paper develops a new model called Evolutionary Algorithm based Adaptive Load Balancing (EA-ALB) for enhancing the efficacy and user satisfaction of cloud services. Efficient Scheduling Scheme for the virtual machines using machine learning algorithm is proposed in this work. Initially, process of K-means clustering is used for computing optimal min-max rates and then, local search capability for solving the load balancing problems in cloud model is determined with the incorporation of Evolutionary Algorithm. The results show that the proposed model achieves better results in terms of load balancing factors, Virtual Machine (VM) migration, energy consumption and so on, when compared to the existing model.

Keywords: Evolutionary algorithm; load balancing; cloud computing; virtual machine (VM); clustering; load estimation

1 Introduction

In the present scenario, cloud computing is very much popular due to the capability to offer seamless computing services with the on-demand based model [1]. The cloud models provide resources to the physical machines in the form of VMs, based on the user requirements. Each virtual machine executes its own OS and obtains their resources from their host physical machine. Moreover, the services are provided based on the Service Level Agreement (SLA) with the consumers. In the process of resource provision, there may cause SLA violations and may decrease the model effectiveness [2].

For handling this problem, it is significant for the cloud providers to use the cloud resources effectively. For attaining that, load balancing operations are performed in cloud by migrating virtual machines from overloaded physical machines to idle machine. The load balancing models [3–5] combines the varied resource utilizations by selecting virtual machines for migrations and determines the appropriate host physical machines. In this process, each resource is allotted with some weight for determining the load

rate of physical machines and their capacities, the process of VM migration is carried out accordingly. By allocating varied resources with predefined weight rates, the models ignore the distinctive cloud feature, may cause, time complexities and over resource consumption in the physical machines. Moreover, the cloud virtual machines use varied resources to provide different services with varied resource intensities. As the cloud jobs are varied from consumers to consumers, and also varied based on time, the over utilization problem in the physical machine also varied on time.

Fig. 1 clearly depicts the sample scenario, which has four physical machines (PM1, PM2, PM3 and PM4). PM4 is overloaded with 3 virtual machines. Since the CPU is overloaded, based on the resource intensity measures, virtual machine (VM1) is considered to be the best to migrate, since, it shows higher intensity. PM1 is considered as the best host for VM1. Moreover, the main objective of the proposed model is to effectively reduce the migration numbers in the process of load balancing. Additionally, cost effectiveness also considered the service time, bandwidth and so on [6,7]. Typically, load balancing is a method to provide balanced workload between the cloud servers. Moreover, load balancing technique involves in optimizing the resource usage, cost effectiveness, increase throughput and provide cost effectiveness. The main objective of the proposed work is to provide cost and time effectiveness with the load balancing model between virtual machines. Based on the features of green scheduling, this work analyzed the load balancing methods of cloud framework based on,

    i)   Server Workload Forecasting
    ii)   Selection of VMs
    iii)   Selection of Target Server
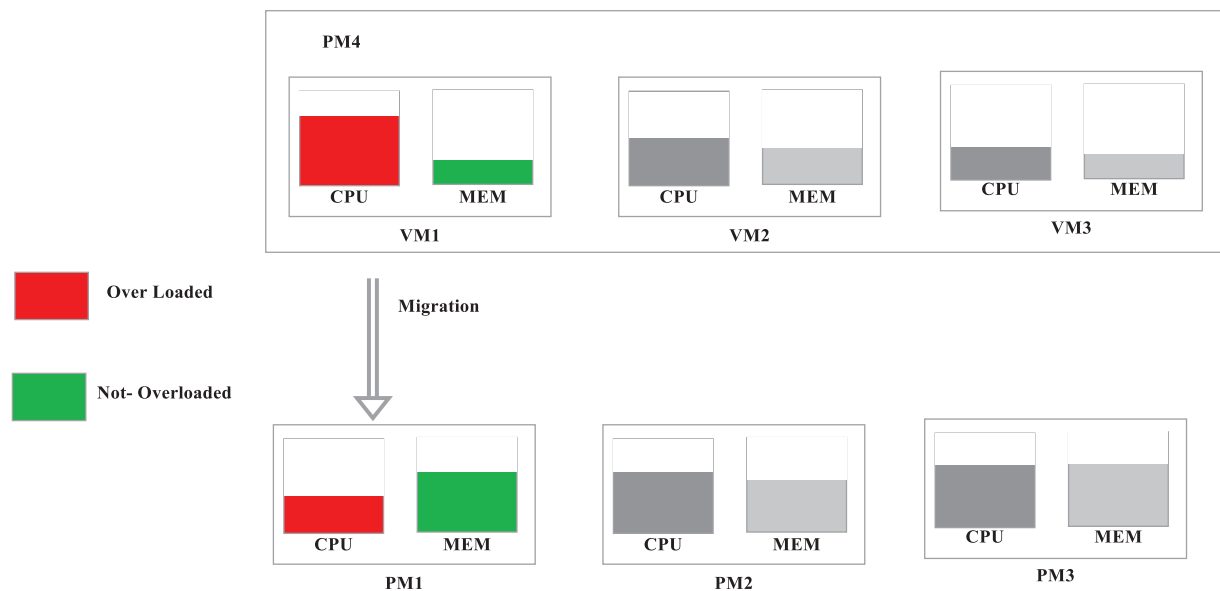
Figure 1: Virtual machine migration in cloud model

And the contributions of the proposed Evolutionary Algorithm based Adaptive Load Balancing (EA-ALB) are listed as follows:

    i)   The objective of the work is to determine the accurate CPU utilization of Cloud servers based on the aforementioned factors
    ii)   Incorporated K-Means Clustering (KMC) for finding the VMs with minimal migration, performance interferences and traffic.

iii)   The Local Search Capability in enhanced with the Modified Evolutionary Algorithm (MEA). And the VM determined by KMC is migrated to the destination server to provide efficient load balancing.

The remainder of this work is organized as follows, Section 2 explains about the related works developed previously for solving load balancing problems in cloud. The complete work process with the flow diagram is explained in Section 3. The results and discussions with comparisons are provided in Section 4. Finally, the work is concluded in the Section 5 with some ideas for future work.

2 Related Works

Myriad works are proposed in recent times for handling cloud resources effectively by performing dynamic load balancing. The authors of [8] provided the basics of cloud computing, components, features, benefits and disadvantages. Additionally, the work discussed about the conceits of virtualization, cloud services and cloud security methods are also discussed in the work. In cloud framework, the load balancing techniques are performed as [9–11]

i)   Centralized Load Balancing
ii)   Distributed Load Balancing

In Centralized Load Balancing, the central node involves in the process of resource allocation and de-allocation. On the other hand, in distributed load balancing, multiple machines act as the coordinator and perform the process of resource allocation. Furthermore, several scheduling methodologies such as, First Come First Serve (FCFS), Round Robin and other load balancing techniques such as Ant Colony Optimization (ACO), Max-Min, etc., are involved in solving the problems on cloud resource management and provisioning [12,13].

Load balancing model provided in [14] determines to maximize the load balancing across the physical machines. Load memory rate is defined, when the CPU load is partitioned by their memory utilization to evaluate its resource utilization. And equal weights are assigned for resources, which may be inappropriate for varied time slots in each physical machine. In [15] the authors have discussed about the related works that are derived for managing the virtual machines in an efficient manner. An efficient virtual machine placement methods has been proposed in [16] for cost effectiveness in cloud data center. In [17] the performances of virtual machines are considered for taking the migration decision and resource provisioning.

Load balancing methodology for distributed cloud models is provided in [18] by moving the files to light servers. Moreover, PROTEUS is the technique developed in [19] for bandwidth allocation for cost effectiveness in cloud named FairCloud. Nevertheless, the model concentrated only on bandwidth. So, it is not efficient for processing load balancing in physical machines. The authors of [20] defined a migration process of virtual machine sample as a task set that execute at the PM of sender and receiver to evaluate the migration time and the resource utilization. Some models provided methodologies to deal load balancing on single resources as [21] for storage based resources and bandwidth based resource management in [22,23]. For enhancing the network security, traffic pattern based virtual machine migration model has been proposed in [24]. Further, in [25] AppAware model has been proposed for inter virtual machine dependencies and the primary factors of network topology to replace machines.

An algorithm for dynamic resource provisioning in data center for efficient resource utilization is proposed in [26]. In the model, the idle server is turned off for resource efficiency. In [27] for attaining throughput optimization, a cloud resource allocation model has been proposed. In the model, stochastic model of cloud cluster, where the tasks are allotted based on the virtual machine requests. But, the model is minimal in throughput, which used Best-Fit algorithm for scheduling. Cloudscale [28] model has been proposed for providing online based resource provisioning to accomplish dynamic resource allocation.

The review works in [29,30] provides valuable source of data on load balancing methods and materials in cloud computing environment.

3 Proposed Model

In the cloud model, the load balancing of servers is processed based on the number of Virtual Machines, VM Migration, memory, traffic flow and the server capacity. The server load condition is non-linear and periodic to certain level. In the proposed model, K-means clustering algorithm which is integrated with evolutionary algorithm for efficient load balancing between machines in cloud environment. In typical KMC algorithm, the following issues are noted.

    i)   The process of k-value selection using KMC is hard to determine
    ii) In clustering, time and iterations are increased because of various reasons.
    iii) When there is a huge dataset, time complexity may cause

Considering the issues, this paper derives an efficient KMC based on the cluster-center and the k-value for determining the appropriate min-max.

3.1 Implementation of KMC in Proposed Model

The operations of KMC in determining the Min-Max includes k-value selection and Cluster-Center (CC) selection.

3.1.1 K-Value Selection

In the proposed work, the VMs in the cloud model is categorized based on three factors, such as,

    i)   Load of the Server Machine
    ii) VM migration cost
    iii) Performance Interference

Moreover, the virtual machines clustering are provided as, three dimensional structure. Cost can be further considered as, low and high and further, the performance also considered as low and high, respectively. The server load is noted as, over load, under load and mediate load and their corresponding descriptions are given in Tab. 1.

Table 1: VM categorization

VM samples	Server load	Cost	Performance interference
1	Under	Low	Low
2	Mediate	Low	Low
3	Over	Low	Low
4	Under	Low	High
5	Mediate	Low	High
6	Over	Low	High
7	Under	High	Low
8	Mediate	High	Low
9	Over	High	Low
10	Under	High	High
11	Mediate	High	High
12	Over	High	High

3.1.2 Process of CC Selection

In KMC, initial cluster center (CC) is selected in random manner from the k-number of samples. When the selection process is instable, the derived solution is not optimal. Hence, the proposed model derives the optimal solution by CC selection to reduce the iteration numbers by increasing the distance between the initial CC. In the process of min-max selection of CC, initial CC is selected in random manner and given as CC_0. Following, the distance between CC_0 and each other sample point is calculated, in which the sample at shortest distance is taken as CC_1 and the sample at longer distance is noted as CC_2. The algorithm is presented in Tab. 2 for finding optimal solution with KMC.

Table 2: Algorithm for optimal solution using KMC in EA-ALB

Input: Samples $S = \{y_1, y_2, \ldots \; y_n\}$ and 'k' be the cluster num

Output: Initial $CC = \{cc_0, cc_1, \ldots \; cc_{k-1}\}$

1. Begin

2. Max_distance = 0

3. for i = 0, i < n, i++

4. for j = 0, i < n, i++

5. Calculate

$$Distance(i, j) = \|y_i - y_j\| \tag{1}$$

6. if $Distance(i, j) > Max\_distance$, then #n

7. Max_distance = Distance(i, j), $cc_0 = y_i$, $cc_1 = y_j$

8. end if

9. end for

10. end for

11. for j = 1, j < k − 1, j++

12. for i = 0, i < n, i++

13. $Distance_{(i, 0)} = \|y_i - cc_0\|$, $Distance_{(i, 1)} = \|y_i - cc_1\|$, ..., $Distance_{(i, j)} = \|y_j - cc_j\|$

14. End for

15. $cc_{j+1} = \max[\min(Distance_{(i, 0)}, \quad Distance_{(i, 1)}, \quad \ldots Distance_{(i, j-1)})]$

16. End for

17. End

3.2 Adaptive Load Balancing Process

In the proposed model, the conventional differential evolution model is enhanced for improving the search ability. The process is employed to VM migration to make it more effective with respect to the aforementioned factors along with energy efficiency. For deriving optimal solutions, the fitness function is derived based on the following steps.

i) The traffic flow generated in the process of VM migration is based on the routing and memory. Here, the fitness function (FF) based on the traffic flow is given as,

$$\text{traffic flow}_{FF} = \sum_{i=1}^{n} dt_i \times len_{r(i)} \tag{2}$$

where, 'dt_i' denotes the size of data transmission of VM, during migration, '$len_{r(i)}$' denotes the length of routes between VMs based on their topology, between the source and target and the formula is given as,

$$len_{r(i)} = \left\{ \left\{ \begin{array}{ll} 3 \times 2, & \text{route link through core VM} \\ 2 \times 2, & \text{route link through aggregate VM} \\ 1 \times 2, & \text{route link through edge VM} \end{array} \right\} \right. \tag{3}$$

ii) Secondly, the FF based migration cost is derived based on the memory of the machine and the network bandwidth. The optimal solution is considered one which derives with minimal migration cost which is given as,

$$\text{Migration Cost (MC)} = \sum_{i=1}^{n} 0.1 \times \sum_{t_0}^{t_0 + t_{VM_i}} CPU_{VM_i} \tag{4}$$

where, 't_0' denotes the initiation time of VM migration, 't_{VM_i}' represents the total VM time and 'CPU_{VM_i}' denotes the CPU utilization of machines. And, the formula is given as,

$$t_{VM_i} = \frac{Mem_{VM_i}}{BW_{VM_i}} \tag{5}$$

where, 't_{VM_i}' denotes the time taken for migration, 'Mem_{VM_i}' represents the memory size and, the network bandwidth given as BW_{VM_i}.

iii) Further, the FF is computed based on the performance interference after the completion of VM migration. And the determined value is considered to be minimal, which is calculated as,

$$PI_{FF} = 1 - r^{\frac{T_i^{VM} - T_i}{T_i}} \tag{6}$$

From the above equation, 'T_i' denotes the running time of VM of 'i' th server.

iv) Energy Efficiency based FF derivation is processed in the fourth step, where optimal solution is considered as, $EE_{FF} = Min (EE_i)$ and the computation is presented below.

$$EE_i = \sum_{t(i)=1}^{t(n)} P(v_i(t_j)) \tag{7}$$

Here '$v_i(t_j)$' denotes the CPU utilization and the power consumption is given as, '$P(v_i(t_j))$' and the formula is given below.

$$P_i(v) = r_i \times P_i^{maxi} + (1 - r_i) \times P_i^{maxi} \times v_i \tag{8}$$

Hence, the energy efficient optimized solution is derived with the following formula, presented in (9).

$$OF = m_1 EE_{FF} + m_2 traffic\ flow_{FF} + m_3\ MC + m_4 PI_{FF} \tag{9}$$

And in (9) m_1, m_2, m_3 and m_4 are the balancing parameters on each derivation and their summation results unit value. Those factors can be adjusted to impact the other factors in determining the fitness function.

3.3 Incorporation of EA in Cloud Resource Allocation

In this process, the population_size is defined as, 'M' and the number of VM migrations is given as 'N' and the servers are given as 'S' and the inbetween links are in 'l' length. The placement of VM is provided as [1, S] with the maximal number of 'r' iterations. Further, the factor of mutation rate is given as, $\delta \in [0, 2]$ and the factor for crossover probability is provided as $C_p \in [0, 1]$. Hence, the 1st generation of ith VM is computed as,

$$x_r(0) = (x_{1j}^r(0),\ x_{2j}^r(0),\ \ldots,\ x_{ij}^r(0),\ \ldots,\ x_{mj}^r(0)) \tag{10}$$

In the above equation, $x_r(0)$, $(r = 1, 2, \ldots m)$, represented that k^{th} VM of 0th generation is required to be migrated and $x_{1j}^r(0)$, $((i = 1, 2\ldots, m; j = 1, 2, \ldots r)$ denotes the migration of ith VM is to the jth placement. And the computation is given as,

$$x = x_{j-min} + random(0,\ 1) \times (x_{j-max} - x_{j-min}) \tag{11}$$

From the above equation, the minimal and maximal vectors rates are provided with the mapping of [1, S]. Further, based on the evolutionary algorithm, the different VM patterns with randomly generated population 'e' are given as $x_{t_1}(e)$, $x_{t_2}(e)$ and $x_{t_3}(e)$. Here, the mutation operations are processed to create new population and the differential scaling factor is derived as,

$$scaling\ factor = \delta(x_{t_1}(e) - x_{t_2}(e)) \tag{12}$$

In the above equation, $(x_{t_1}(e) - x_{t_2}(e))$ denotes the differential scaling factor and considering the weights, the VM migration is stated as,

$$u_t(e+1) = x_{t_3} + scaling\ factor \tag{13}$$

Here, the newly produced individual is given as, '$u_t(e+1)$'. Further, the crossover operations are introduced to enhance the population diversity. Therefore, the new generations $v_t(e+1)$ and the older ones $x_{t_1}(e)$ are muted together to frame the new individuals as,

$$v_t(e+1) = (v_{1j}^r(e+1),\ v_{2j}^r(e+1),\ \ldots,\ v_{ij}^r(e+1),\ \ldots,\ v_{mj}^r(e+1)) \tag{14}$$

The formula for cross over is given as,

$$v_{ij}^r(e+1) = \begin{cases} u_{ij}^r(e+1),\ random\ (i) \leq C_p = random\ (r) \\ x_{ij}^r(e),\ random\ (i) > C_p \neq random\ (r) \end{cases} \tag{15}$$

Here, $random\ (i)$ is denoted as the random number between 0 to 1 and $random\ (r) \in [1, M]$. Then, new cycle is started for the selection function and the FF of the cross over results $v_t(e+1)$ is compared with the older individual $x_{t_1}(e)$ and the FF is given as,

$$x_t(e+1) = \begin{cases} v_t(e+1),\ FF(v_t(e+1)) > FF(x_t(e)) \\ (x_t(e),\ Others \end{cases} \tag{16}$$

In the above equation, *FF(x)* denotes the fitness function of the individual, which is newly generated. The computed fitness values are compared and the better solution is provided for the iteration process to find next generation. The algorithm is presented in Tab. 3. From the above experimentation, it is determined that the convergence speed of the proposed model is efficient and faster than the traditional models. Moreover, in the process of cross-over mutation, the algorithm is enhanced with adding a local search event and the algorithm is provided in Tab. 4. The above operation in local search determines the optimal situation, which may result in migrating, when overload happens. Based on the results of the algorithm, the resources are allotted to the tasks.

Table 3: Algorithm for EA in cloud resource allocation

Input: population_size is M, number of VM migrations is 'N, server is, 'S' and maximal iterations 'r', factor of mutation rate $\delta \in [0, 2]$ and factor for crossover probability $C_p \in [0, 1]$

Output: Optimal Solution set for VM migration

1. Begin

2. No .of iterations, e = 0,

3. Declare Positive Integer i = 1; j = 1

4. for i = 0;i < S; i++

5. for j = 0;j < N;j++

6. $x = x_{j-min} + random(0, 1) \times (x_{j-max} - x_{j-min})$

7. End For

8. End For

9. while $(e \leq r)$

10. Selection of random items $x_{t_1}(e)$, $x_{t_2}(e)$ and $x_{t_3}(e)$ as weight 'δ'

11. Generation of new individuals with Mutation

12. new individuals, $v_t(e + 1) = (v_{1j}^r(e + 1) \quad v_{2j}^r(e + 1) \quad \ldots \quad v_{ij}^r(e + 1) \quad \ldots \quad v_{mj}^r(e + 1))$

13. if FF $(v_t(e + 1)) > FF(x_{t_1}(e))$

14. $x_{t_1}(e + 1) = v_t(e + 1)$

15. else

16. $x_{t_1}(e + 1) = x_{t_1}(e)$

17. End if

18. e = e + 1

19. Local Search Optimization is presented in Tab. 3

20. End While

21. Return Optimal Solution Set for VM migration

22. End

Table 4: Local search optimization in VM migration in cloud

Input: No. Of local iterations 'L', local search event 'α', population_size M, population factor $x_i(e)$, size_reduction parameter β

Output: better VM for next generation

Begin

While $(i < M)$

While $(i < L)$

Random Variable Δx, $\Delta x \epsilon [-\alpha_t, \alpha_t]$

$x_{new}(e) = x_i(e) + \Delta x$

If $(G(x_{new}(e)) = true$ and $G(x_i(e)) = False)$

$x_i(e) = x_{new}(e)$

End if

If $(G(x_{new}(e)) = true$ and $G(x_i(e)) = True)$

If $(FF(x_i(e)) < FF(x_{new}(e)))$

$x_i(e) = x_{new}(e)$

End if

End if

$\alpha_t = \alpha_t * \beta$

$r = r + 1$

end while

$i = i + 1$

end while

End

---

4 Results and Discussions

This section presents the results and discussions to prove the efficacy of the proposed model. The model is evaluated using the simulation software called CloudSim. And the results are compared with the existing models such as, First Come First Serve (FCFS), Ant Colony Optimization (ACO) and PROTEUS. The simulation parameters and the domain values are presented in the following Tab. 5. Moreover, the evaluations are carried out based on the factors such as, cost effectiveness, traffic flow and CPU utilization for measuring the overall model efficiency.

Fig. 2 presents the results for migration cost evaluations for cloud resource allocations, their corresponding values are given in Tab. 6, in which costs are denoted with units and the proposed model is cost effective than the compared works. The average migration cost of the proposed EA-ALB is 554.42, which is minimal than other models. The Fig. 3 depicts the performance interference based results on model evaluations. The results are carried out based on the execution time. From the results, it is evidenced that the model is efficient than the other models and the obtained results are presented in Tab. 7.

Table 5: Simulation parameters

Parameters	Values
Server based parameters	
Server MIPS	1.8 to 3.0 GHz
Memory size	4–16 GB
Bandwidth	1000 Mbit/s
Hard disk size	50–320 GB
VM based parameters	
VM MIPS	0.5 to 2.5 GHz
Memory size	613–1740 MB
Bandwidth	100 Mbit/s
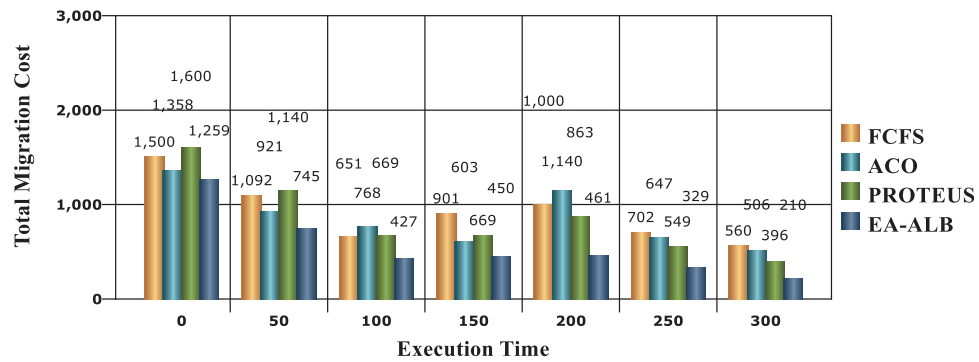
Figure 2: Migration cost *vs.* execution time

Table 6: Results for migration cost

Models	0	50	100	150	200	250	300
FCFS	1,500	1,092	651	901	1,000	702	560
ACO	1,358	921	768	603	1,140	647	506
PROTEUS	1,600	1,140	669	669	863	549	396
EA-ALB	1,259	745	427	450	461	329	210
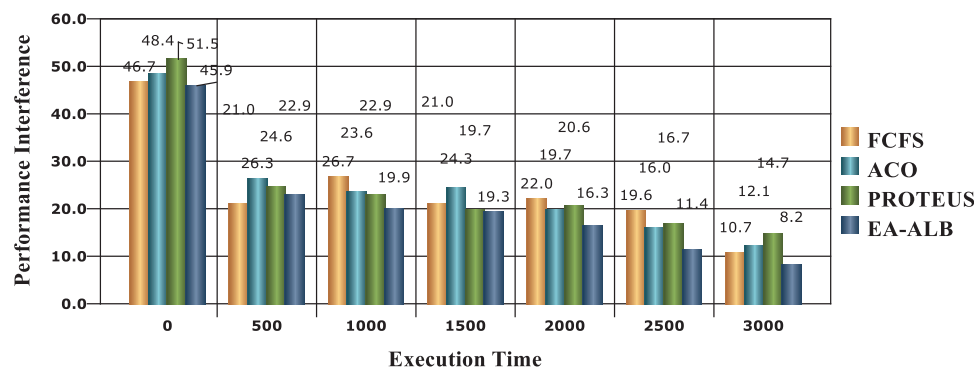
Figure 3: Execution time *vs.* performance interference

Table 7: Results for performance interference

Models	0	500	1000	1500	2000	2500	3000
FCFS	46.7	21.0	26.7	21.0	22.0	19.6	10.7
ACO	48.4	26.3	23.6	24.3	19.7	16.0	12.1
PROTEUS	51.5	25.0	23.0	19.7	21.0	16.7	15.0
EA-ALB	46.0	23.0	20.0	19.0	16.0	11.0	8.0

Traffic Flow based results are provided in Tab. 8 and their relevant comparison graph is given in Fig. 4. Further, Tab. 9 contains the values obtained for VM migration based analysis and their graph comparisons are given in Fig. 5. And the data center utilization based results are presented in Fig. 6 and the obtained values are given in Tab. 10. The evaluation for traffic flow is processed with respect to the execution time and the utilization based analysis is performed with number of tasks. In analyzing, VM migrations, it is the significant factor in evaluating the resource allocation model. The best solution is determined with the efficient incorporation of KMC with EA in the proposed work that effectively performs VM migration, by which load balancing is achieved.

Table 8: Traffic flow based results

Models	0	500	1000	1500	2000	2500	3000
FCFS	522	916	1,770	1,557	1,261	1,441	981
ACO	816	881	1,721	2,294	1,539	1,622	1,212
PROTEUS	522	1,031	1,999	2,361	1,721	1,409	1,490
EA-ALB	455	851	1,589	1,439	1,261	999	768
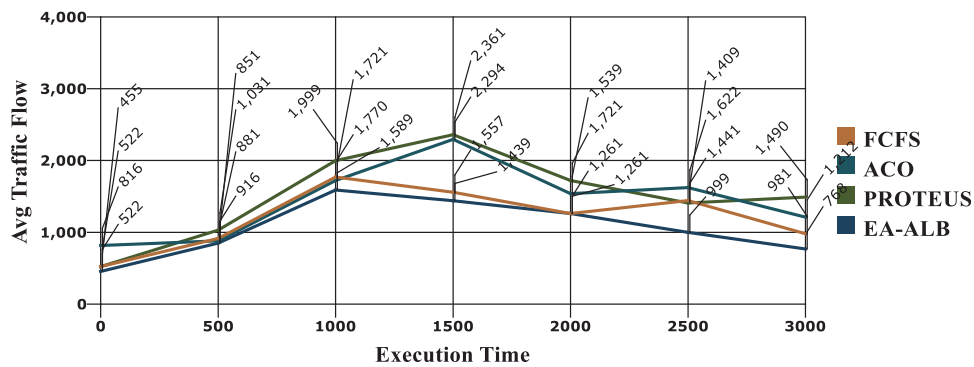
Figure 4: Average traffic data and execution time

Table 9: Average traffic flow based analysis

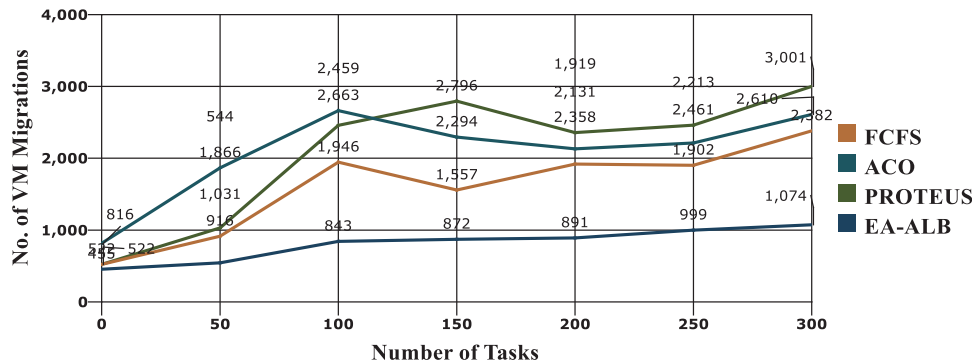| Models	0	50	100	150	200	250	300
FCFS	522	916	1,946	1,557	1,919	1,902	2,382
ACO	816	1,866	2,663	2,294	2,131	2,213	2,610
PROTEUS	522	1,031	2,459	2,796	2,358	2,461	3,001
EA-ALB	455	544	843	872	891	999	1,074

Figure 5: Comparisons for average time flow
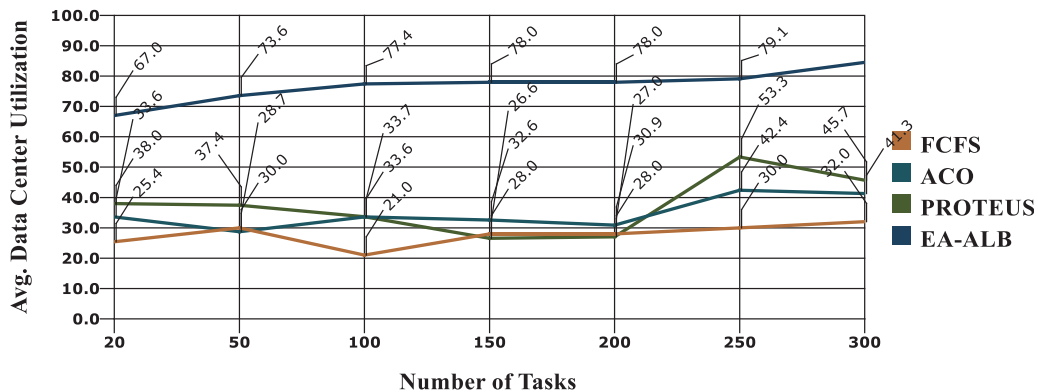
Figure 6: Average data center utilization based results

Table 10: CPU utilization

Models	20	50	100	150	200	250	300
FCFS	25.4	30.0	21.0	28.0	28.0	30.0	32.0
ACO	34.0	29.0	34.0	33.0	31.0	42.0	41.0
PROTEUS	38.0	37.0	34.0	27.0	27.0	53.0	46.0
EA-ALB	67.0	74.0	77.0	78.0	78.0	79.0	85.0

5 Conclusion and Future Work

For the process of efficient migration of virtual machines in Cloud computing process, this paper proposes a new model called EA-ALB. The model integrates the efficiency of KMC in determining best solution and the Evolutionary Algorithm for load balancing. The proposed model effectively predicts the resource utilization by machines, in which the min-max algorithm is used for finding the cluster centers. The model evaluation is carried out based on the factors such as cost effectiveness, CPU utilization, migration effectiveness and traffic flow. It is evidenced from the results that the proposed model achieves minimal cost, traffic flow and interference than other compared works. And the utilization is maximal, that is, the model effectively utilizes the machines about 95%, where load balancing is effectively achieved with the proposed model.

In Future, as the load balancing in cloud has a greater research scope, the potential applicability can be expanded for large scale cloud models. Methods can be developed to measure the algorithm's efficacy in applying it on a real life case to attain better results and routine.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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