1st International Congress on Computer Science, Engineering and Information Technology (ICSITY 2022)

PROCEEDINGS BOOK

29-30 SEPTEMBER 2022
WARSAW/POLAND

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1st International Computer Science, Engineering and Information Technology Congress (ICSITY 2022)

PROCEEDINGS BOOK

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CONGRESS PROGRAM

29-30 SEPTEMBER 2022
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CONGRESS PROGRAM

With **14 papers** prepared by **31 academics/researchers** from **20 institutions** and **12 countries**.
Total Participant: 40
Presentations will be in Turkish (All Dialects), German, Arabic, English, Italian, French, Persian. There are 2 virtual conference rooms.
The congress was organized according to Turkey time. To calculate the time for your country:
The World Clock — Worldwide
For presentations, zoom ID and links will be shared with participants before the congress

29 September 2022 Thursday 09:45-10:00	**Topic: 1st International Computer Science, Engineering and Information Technology Congress (ICSITY 2022), 29-30 September 2022** **29 September 2022 09:45 a.m. Istanbul** **Topic: ICSITY 2022** **Time: Sep 29, 2022 10:00 AM Istanbul** **Join Zoom Meeting** **https://us06web.zoom.us/j/86001789562?pwd=clFyUElDMTNuNVVncVdhSitBRko3UT09** **Meeting ID: 860 0178 9562** **Passcode: 072019**
	Chair **Prof. Dr. Sandeep Kumar Gupta** AMET Business School, AMET University Chennai/India **Prof. Dr. Anjali Awasthi** Concordia University Research Chair CIISE- EV 7.636, Concordia University,Montreal/Canada
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29 September 2022 Thursday 10:00-12:30	**Keynote Speakers** **Prof. Dr. Sehl Mellouli**, Professor and Deputy Vice-Rector Université Laval, Canada **Assoc. Prof. Arpan Kumar Kar,** Indian Institute of Technology Delhi, India **Dr. Ahmed M. Fakhrudeen,** College of Computer Science and Information Technology University of Kirkuk **Ts. Dr. Megat Al Imran Yasin,** Visiting Scholar University of Central Lancashire Preston United Kingdom **Lecturer, Engr Shamsher Khan**- University of Engineering and Technology/ Pakistan
12:30-13:00	Coffee Break- Lunch
13:00-15:00	Online Sessions
30 September 2022 Friday 10:00-12:30	Online Sessions **Topic: 1st International Computer Science, Engineering and Information Technology Congress (ICSITY 2022)** **Time: September 30, 2022 10:00 a.m. Istanbul** **Topic: ICSITY 2022 30.09.2022** **Time: Sep 30, 2022 10:00 AM Istanbul** **Join Zoom Meeting** **https://us06web.zoom.us/j/88088859663?pwd=VEZXd3RacXBBS1Q3MmNGd0pWQ0FZdz09** **Meeting ID: 880 8885 9663** **Passcode: 020782** Closing Session

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Room-I	Thursday, 29 September 2022	Moderator
	13:00-15:00	Novriest Umbu Walangara NAU
Room-II	Friday, 30 September 2022	Moderator
	10:00-12:30	Serdar DOVUSKAYA

Thursday, 29 September 2022 - Room I

Room -I	Thursday, 29 September 2022 13:00-15:00	Moderator	Novriest Umbu Walangara Nau

1. **Lilly R., Jayasurya R., B. Charith, Anoop LIGY George & Sandeep Kumar GUPTA,** Estimation of water levels in three different phases of underground tunnel construction, India
2. **Divyaranjani RAMADOSS, Dr. Sandeep Kumar GUPTA & Rishith VISHAL,** An Analysis on Ship Routing and Scheduling Problems in Liner Shipping, India
3. **Chikezie Kennedy KALU, Prof. Baozhen DAI, Olani Bekele SAKILU & Simeon EBHOTA,** Novel Hybrid-Relay Cooperative Communications Technique for Agriculture, China
4. **ENGR Shamsher KHAN, Shamsher KHAN, Tanzeela SAIJAD, Sanaullah,** Minimization of Waste in Printing Sector of Pharmaceutical Industry Using Lean Manufacturing, Pakistan
5. **Prof. Dr. Sehl MELLOULI,** AI for Governments: Case Studies
6. **Hikmat HASANOV& Ismayil ZEYNALOV-** The use of satellite data in the detection of radioactive fallout on the territory of Azerbaijan, Azerbaijan
7. **Dr. Ahmed M. FAKHRUDEEN-**Towards Realization of Spectrum Sharing of Cognitive Radio Networks

Friday, 30 September 2022

Room-II

Room-II	**30 September 2022**	**Moderator**
	10:00-12:30	**Serdar DOVUSKAYA**

Friday, 30 September 2022 - Room-II

Room-II	**Friday, 30 September 2022 10:00-12:30**	**Moderator**	**Serdar DOVUSKAYA**

1. **Volkan KAYA & Ismail AKGUL,** Recognition and Classification of Vegetable Types in Agricultural Areas Using the Mobilenet Model Structure, Türkiye
2. **Hamdi AYKAS & Irem DUZDAR ARGUN,** Düzce Province Electricity Energy Demand Forecast, Türkiye
3. **Nurgül AYKAS & Irem DUZDAR ARGUN,** Düzce Province Natural Gas Demand Forecast, Türkiye
4. **Ertugrul DOGANSAHIN, Eser SERT & Muhammed YILDIRIM**, Sulfur Analysis in Apricot with Deep
5. **Ömer Galip PINAR**, Yerel Yönetimlerde Elektronik İhale (E-İhale) Süreçleri ve Yapı Bilgi Modellemesi (Bim) Entegrasyonu, Türkiye
6. **Mehmet KARAKOC**-The Importance of Discrete Mathematics Topics in the Education and Teaching of Computer Science and Engineering, Türkiye
7. **Kevser SAHINBAS**, Customer Segmentation with Data from Various Markets Using K-Means Clustering, Türkiye
8. **Megat Al Imran YASIN, Wendy JITOS &Yusuf DURACHMAN**-The Application of MySejahtera in Decision Making by the Ministry of Health, Malaysia in the Battle Against Covid-19 Pandemic

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AI for Governments: CASE STUDIES

Prof. Dr.Sehl Mellouli

Department of Information

Systems Université Laval, Canada


Medya2.m4a

Introduction

- We need an Artificial Intelligence with a « citizen-centered approach to growth »
- How can AI bridge the gap between Citizens and Geovernments?
- People are more and more using social media to express their opinions about the different services that their governments are delivering.
- It becomes important for policy-makers to have the necessary tools to extract this valuable knowledge in a comprehensive way and that they may consider in their decision-making processes.

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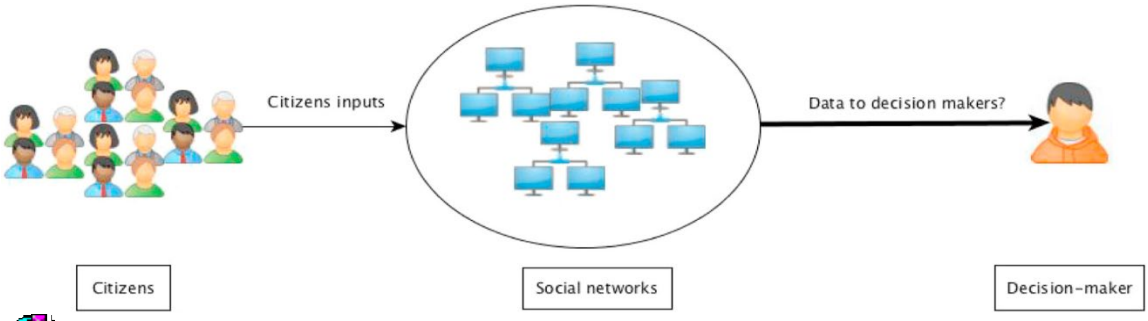

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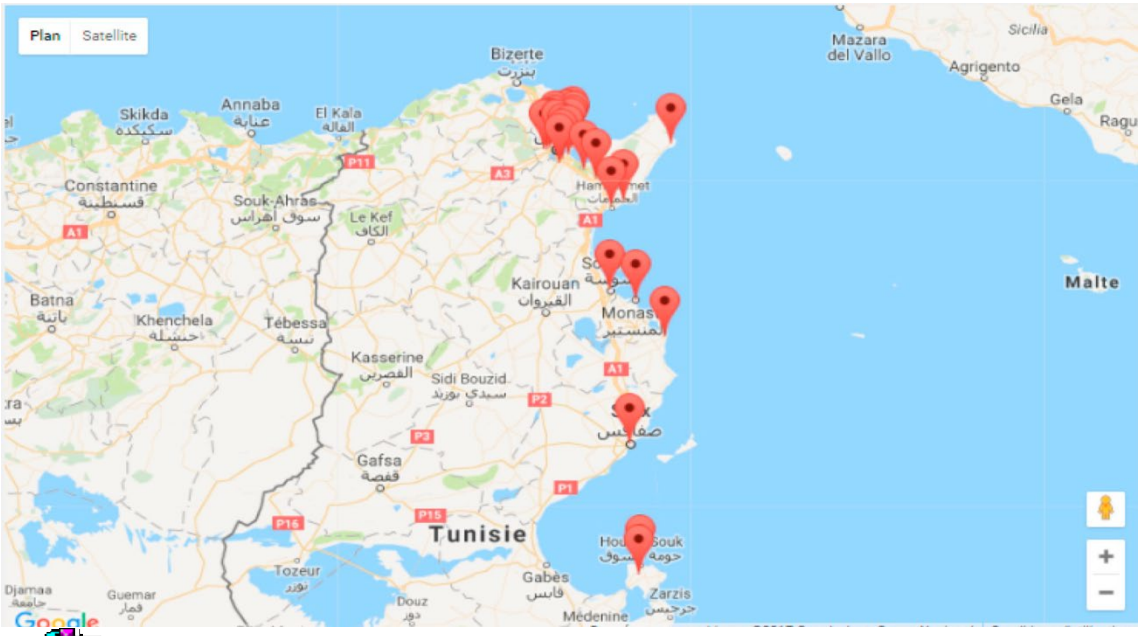
Case Study 1



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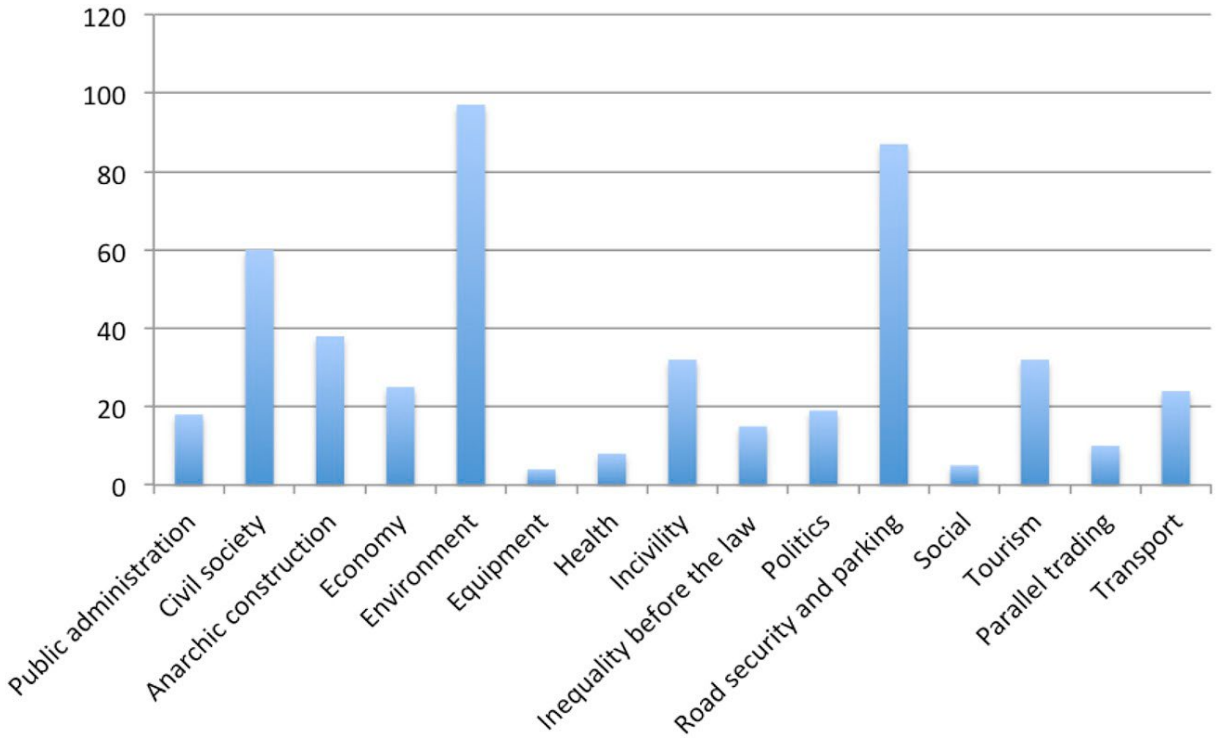
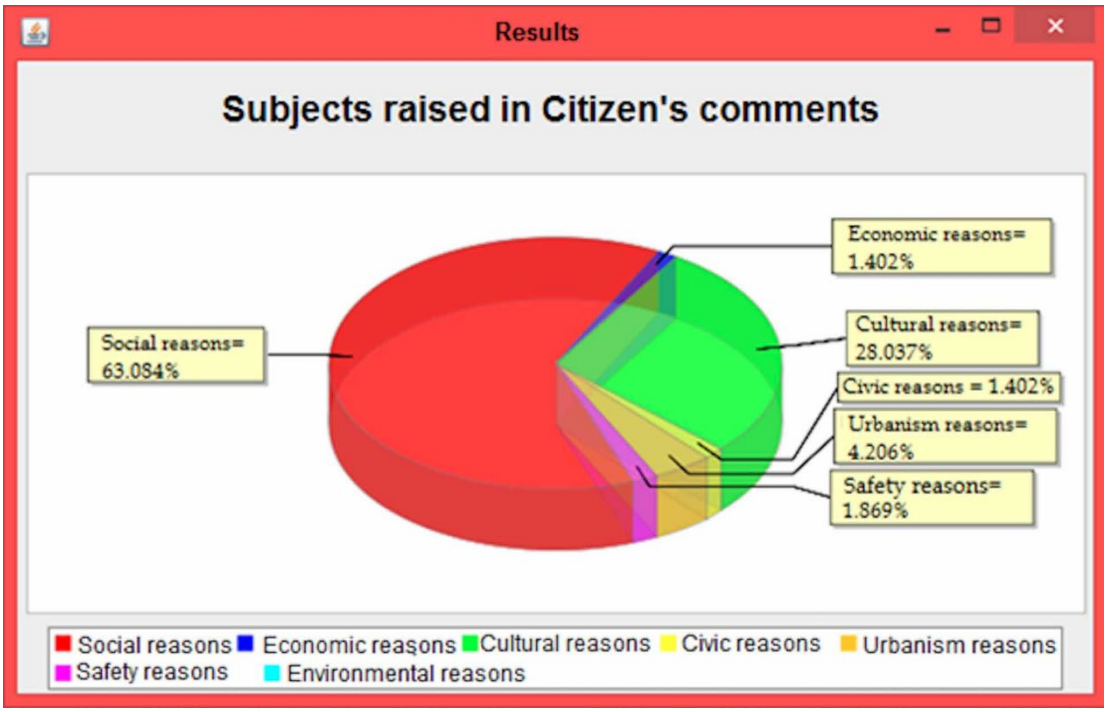
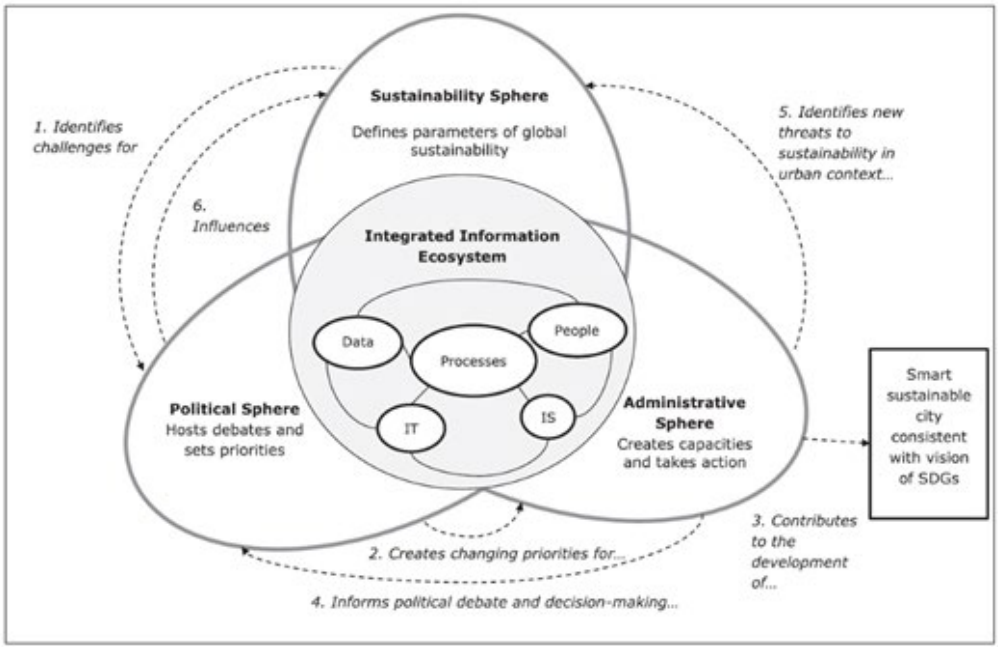
Case Study 1



Case Study 2



Discussion



Next steps

- More theories to understand how to build and use AI solutions in Governments
- Ethical issues need to be considered in AI solutions
- To what extent can be the data analysis reliable for policy-makers?
- To what extent is the data representative of citizens opinions?

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Towards Realization of Spectrum Sharing of Cognitive Radio Networks

Dr. Ahmed M. Fakhrudeen

College of Computer Science and Information Technology University of Kirkuk, Iraq

Abstract

Cognitive Radio Network (CRN) is a promising network that aims to improve the utilization of the wireless spectrum by enabling unlicensed (secondary) users to reuse the underutilized bands. CRN utilization of residual spectrum bands of Primary (licensed) Networks (PNs) must avoid harmful interference to the users of PNs and other overlapping CRNs. Numerous Internetwork spectrum sharing frameworks have been proposed in the literature; however, spectrum sharing among overlapping CRNs presents significant challenges: 1) Overcrowded CRNs, 2) Inter-cell interference, 3) Two or more CRNs move to utilize the same channel simultaneously, and 4) Primary User Emulation Attack (PUEA). In this presentation, I will explain one of the promising solutions to realize CRNs coexistence called the CRNs management framework, CogMnet. The framework verification demonstrates that tackling CRNs coexistence will avoid a dramatic end for these promising networks.

Keywords: Cognitive Radio Network (CRN), CRNs management, CogMnet, Networks (PNs).

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Estimation of Water Levels in Three Different Phases of Underground Tunnel Construction

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Abstract

In this paper, we have made an attempt to compare the minimum and maximum values of water levels in the three phases of underground tunnel construction. The construction underground metro rail corridor was taken as study area. The water level data was collected and observed for different time periods. The water level data which was collected and observed were divided into three phases of construction. The datas of post monsoon and pre monsoon water levels from 2009-2011 are considered as before construction. The datas from 2012-2015 are considered as during the construction and the datas of post monsoon and pre monsoon levels from 2016- 2017 are taken after the construction. In this the datas from 2009-2015 are collected for the wells around the underground corridors from water resources centres as secondary datas. But the data from 2016-2017 are collected from the primary wells which are located around the underground corridors. The minimum and maximum values of post monsoon and pre monsoon water levels in the three phases of construction are compared to find the impact of the tunnel construction.

Keywords: Water Level, Underground corridor, Tunnel, pre monsoon, post monsoon

I. Introduction

The tunnel construction below the surface of the soil has been a part of urbanization in view of reducing the traffic conditions in Chennai is a indeed one. But the tunnel construction deep below the ground surface has its own disadvantages. It lowers the water table, changes the aquifer properties, affects the flow system and modifies the pressure distribution in the soil

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system. The overdrafting of water during the tunnel construction cause a major draw down in the water table condition.All these factors makes this study to be unavoidable.

II.Study Area

Chennai metro rail corridor was taken as study area. It is located with the latitude of 13.0827° N, and longitude of 80.2707° E. The Survey of India toposheet was georeferenced and digitized to delineate the study area around the metro rail corridors. The study area includes the water shed boundaries such as Buckingham canal in the east and adyar and coovum river in the southern part. The study area map is shown in the Figure 1.

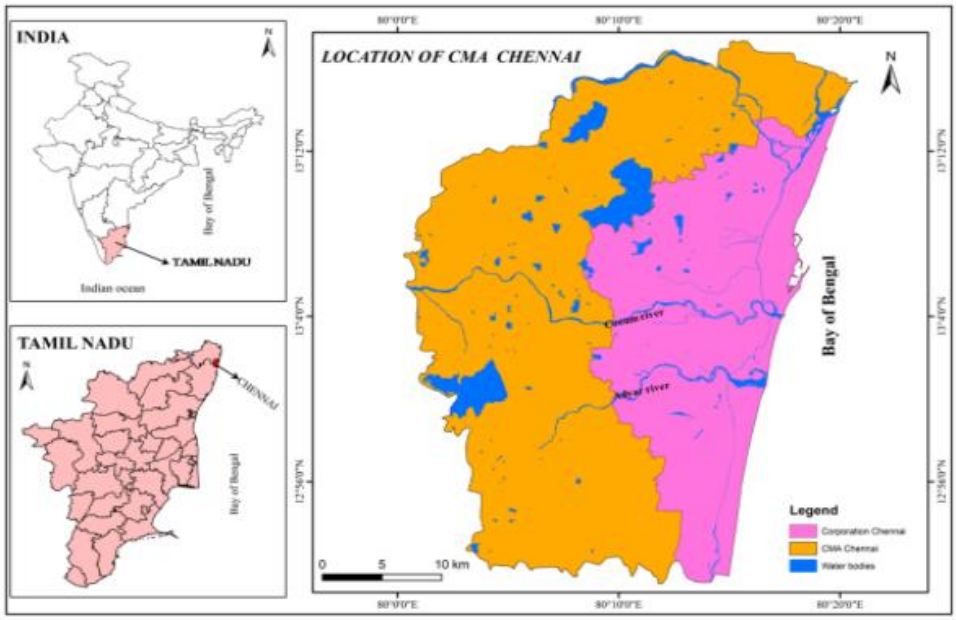

Figure 1 Index map of study area

III. Collection of Data

The water level data which are collected are separated into three phases before, during and after the tunnel construction. The post monsoon and pre monsoon values of water level above mean sea level are taken for comparison. Three years (2009, 2010, and 2011) of data were taken to study the water level pattern before the tunnel construction. The tunneling process fully started in a stretch from 2012 and the construction attained the completion by 2015.Hence those period 2012-2015 are considered as during tunnel construction phase. The years 2016-2017 are considered as the data for after the construction. For both before and during the construction

phase secondary wells are taken. For after the construction phase primary datas which are taken for two years is used. Datas which are separated for the above mentioned three phases are given in the Table 1, Table 2 and Table 3.

Table 1. Pre-monsoon and Post-monsoon values of water levels (m) above mean sea level before tunnel construction

S. No	Location	Latitude	Longitude	Elev (m)	2009		2010		2011	
					Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon
1	Tandiarpet	13.1272	80.2900	12	10.1	9.1	8.1	6.0	8.8	7.3
2	Vepery	13.0853	80.2607	12	6.8	3.4	6.8	7.3	6.9	9.9
3	Chepauk	13.0633	80.2812	13	9.2	8.5	9.2	8.4	10.4	8.7
4	Saidapet	13.0224	80.2195	15	12.4	10.0	12.7	9.1	9.4	10.2
5	Guindy	13.0102	80.2157	15	14.5	9.6	13.5	11.7	13.8	11.6
6	Aminjikarai	13.0699	80.2245	15	10.6	7.3	9.7	7.6	10.5	8.5
7	Tirumangalam	13.0835	80.1945	15	13.9	12.2	14.1	13.7	14.5	13.5
8	K.K.Nagar	13.0298	80.2130	16	14.4	12.9	15.0	12.7	14.5	12.8

Table 2. Pre-monsoon and Post-monsoon values of water levels (m) above mean sea level during tunnel construction

	Location				2012		2013		2014		2015	
S. No		Latitude	Longitude	Elev (m)	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon
1	Tandiarpet	13.1272	80.2900	12	7.7	7.9	7.2	7.5	5.9	4.8	5.7	4.6
2	Vepery	13.0853	80.2607	12	7.4	4.0	5.8	3.7	6.1	4.6	6.1	4.5
3	Chepauk	13.0633	80.2812	13	10.7	7.6	9.1	8.3	9.1	8.0	9.0	7.9
4	Saidapet	13.0224	80.2195	15	13.3	10.0	12.6	11.5	10.8	8.9	9.8	8.7
5	Guindy	13.0102	80.2157	15	12.1	11.8	11.8	7.5	13.9	10.9	14.3	10.4
6	Aminjikarai	13.0699	80.2245	15	10.7	7.1	8.0	6.3	9.8	8.2	9.8	8.1
7	Tirumanglam	13.0835	80.1945	15	14.0	13.1	12.6	10.9	15.0	14.3	13.8	12.8
8	K.K.Nagar	13.0298	80.2130	16	14.5	14.2	13.9	13.6	14.8	14.0	13.6	13.4

Table 3. Pre-monsoon and Post-monsoon values of water levels (m) above mean sea level after tunnel construction

S.No	Location	Latitude	Longitude	Elev(m)	2016		2017	
					Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon
1	Bible society	13.0825	80.2782	8	4.48	1.5	4.45	1.18
2	Aziz mulk 3rd st	13.0563	80.2534	9	2.71	-0.09	2.57	-0.45
3	GAA 9th street	13.0564	80.2516	11	4.31	0.27	4.19	0.05
4	Chokkalingam nagar	13.0467	80.2523	13	7.41	1.81	7.38	1.49
5	Siva Sankaran road	13.0451	80.2502	13	10.96	6.26	10.59	5.65
6	Lotus colony (1)	13.0301	80.2401	12	4.86	4.16	4.79	3.99
7	Lotus colony (2)	13.0296	80.2407	13	7.56	4.84	7.34	4.75
8	Saidapet Jeenis road	13.0210	80.2244	12	5.34	2.25	5.19	2.26
9	Saidapet	13.0224	80.2195	13	8.96	6.76	8.75	6.74
10	Kilpauk medical college	13.0784	80.2429	12	5.36	1.41	5	1.39
11	Mc Nichols st	13.0748	80.2425	9	3.01	-1.25	2.5	-1.31
12	kathiravan colony(1)	13.0897	80.2056	13	7.46	4.76	7.4	4.55
13	kathiravan colony(2)	13.0894	80.2056	13	8.86	5.58	8.81	5.46
14	16st main road,anna nagar(1)	13.0902	80.2064	15	9.09	7.35	8.63	7.02
15	16st main road,anna nagar(2)	13.0897	80.2063	15	9.96	7.53	9.94	7.14
16	school of handicapped	13.0932	80.1983	14	8.6	6.4	8.7	6.3
17	vanavil appartments(1)	13.0965	80.1977	14	6.11	3.84	6.08	3.74
18	vanavil appartments(2)	13.0959	80.1978	14	5.31	2.74	5.01	2.65
19	AP flates 6th street	13.0989	80.1941	15	8.76	7.5	8.65	7.05
20	united placement colony	13.0974	80.1933	15	10.14	8.6	10.09	8.58

IV. Analysis and Discussion

From the collected data in the three phases, the minimum to maximum values of premonsoon and post monsoon water levels are plotted for the three phases and it is shown in the Figure 2, Figure 3 and Figure 4. Before the construction phase, the post monsoon season the water level above mean sea level seems to be in the range of minimum 6.8m and to the maximum 15 m. Similarly during the pre monsoon period the water level ranges from 3.6 m to 13.7 m . During the construction phase, post monsoon water levels are varying from the minimum of 5.8m to the maximum of 15 m. The pre monsoon water levels are ranging from 3.7m to 14m.The range of values shows a slight difference of about 1 m decrease in the water level during the post monsoon season.

It may be due to the disturbance created below the ground surface by tunneling. After the tunneling, the post monsoon values of water level shows the minimum water level as 5m and the maximum water level as 9.96m.Similarly the pre monsoon values are showing the range as 2.7m to 7.6m.This shows a major decline in the water levels. During the post monsoon season nearly 40% decline of water level has occurred from the tunneling construction phase. Similarly in the pre monsoon decline of water level seems to be 59% in the maximum values range of during and after the tunnel construction.

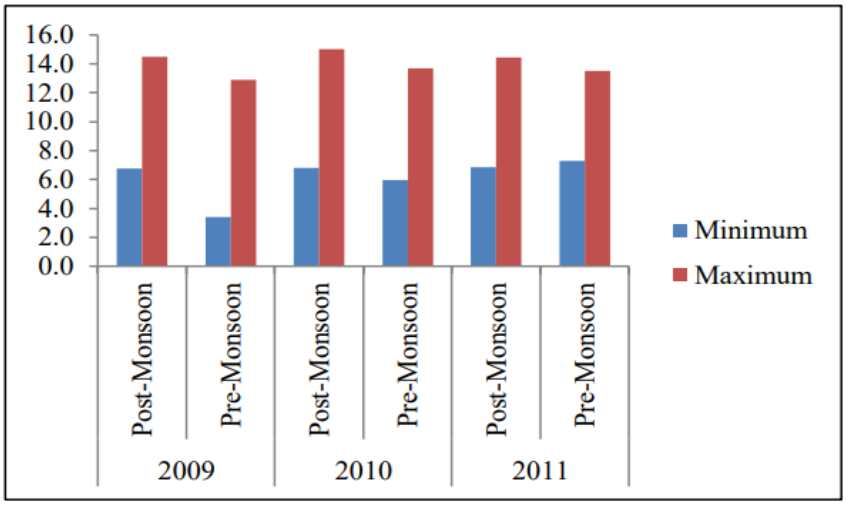

Figure 2. Minimum and Maximum values of pre-monsoon and post- monsoon water levels(m) above mean sea level before tunnel construction

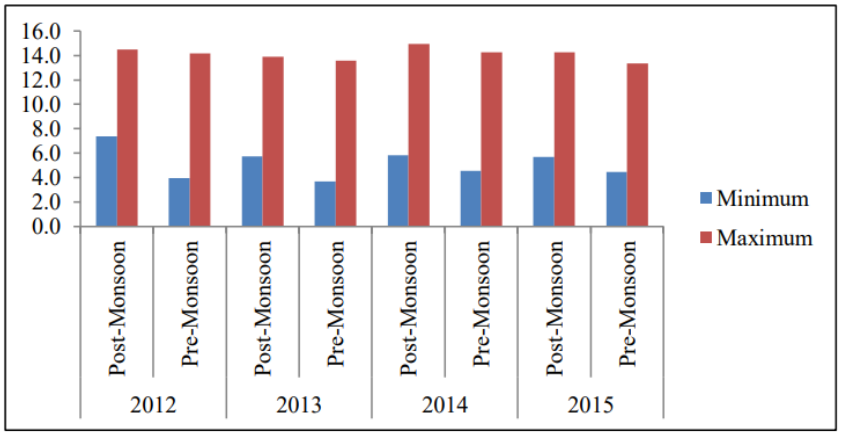

Figure 3. Minimum and Maximum values of pre-monsoon and post-monsoon water levels (m) above mean sea level during tunnel construction

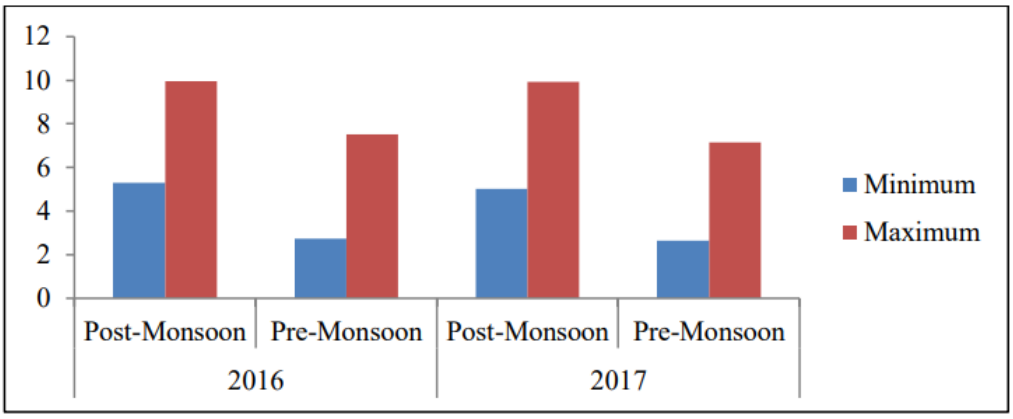

Figure 4. Minimum and Maximum values of pre-monsoon and post-monsoon water levels(m) above mean sea level after tunnel construction

V.Conclusıon

From the above discussion it is clearly shows that excess water has withdrawn for the tunnel construction and also due to the excavation the properties of the aquifer had got changed and may lost the recharge capacity. It also due to the sealant property of the chemicals used in the tunneling process. This analysis helps in restoring the properties of the aquifer by constructing recharge wells and storage pits etc. It also helps in optimizing the water storage around the study area and in future it plays a major role in sustainability of environment.

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An Analysis on Ship Routing and Scheduling Problems in Liner Shipping

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Abstract

The continuous growth in international container traffic volumes makes it ever more important for carriers to optimize their service network. In this thesis, we present a multi-start local search algorithm for solving the routing and scheduling problem in liner shipping. The objective is to find a service network of routes, given the demand between ports that maximizes profit. The algorithm consists of a randomized initialization phase that generates initial networks, and a local search phase that tries to improve the solution using local search operators. For each phase we present different implementations, such that several algorithm configurations are obtained, representing different multi-start local search heuristics. For the first phase, we propose the quantity sort insertion heuristic, and the profit-driven sort insertion heuristic. For the second phase, we propose three local search operators. The route-length operator removes ports from round trips that incur more costs than revenue, and tries to allocate unassigned cargoes by adding ports to round trips. The port-exchange operator relocates ports within a route or between routes in an attempt to improve solutions. The transhipment operator introduces the use of hubs and transhipment to save costs and allocate the remaining cargoes.

Keywords: Multi-start local search algorithm, Multi-start local search heuristics, quantity sort insertion heuristic, the profit-driven sort insertion heuristic, port-exchange operator and transhipment operatör.

Introduction

Background

Despite the global economic downturn of the last years, international seaborne trade continues to grow. According to the United Nations Conference on Trade and Development (UNCTAD 2009), the volume of international seaborne trade increased with 3.6 per cent to 8.17 billion tons in 2008. The world merchant fleet expanded by 6.7 per cent to 1.19 billion dead-weight tons. In maritime transportation we differentiate between three types of shipping, industrial

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shipping, tramp shipping, and liner shipping (Lawrence 1972). Industrial shipping is characterized by the cargo owner controlling the ship, and shipping takes place only for the company itself. Tramp ships have no fixed schedule and trade on the spot market, following the available cargo and making deals for shipments.

Liner shipping companies provide services according to a regular repetitive schedule, similar to a bus line. These three types are not mutually exclusive, since shipping companies may operate ships for different types of operations (Christiansen et al. 2004). In this work we focus on liner shipping and consider standardized containers as cargo. Container ships operate on scheduled routes, visiting several ports in a closed cycle, i.e., returning to the starting port. The sequence of ports visited in the cycle is referred to as the string of ports. Other words for cycle are loop, pendulum, and service. Routes in liner shipping are main-line routes, connecting the largest ports (i.e., hubs) Using big container ships. In contrast, feeder lines provide regional services on feeder routes, feeding and distributing containers to and from the hub using smallersized ships like barges.

A liner shipping carrier usually has a global service network, consisting of several main-line loops between multiple continents. The schedule of each service is fixed for longer time periods, and consists of regular port calls. That is, container ships depart at least once a week from each port, on a given day of the week. The number of departures from a port for a specific cycle is called the service frequency, which is seen as an important criterion for customer satisfaction and provides for competition among carriers. Liner shipping companies face decision problems at three different planning levels, the long term strategic planning level, the medium term tactical planning level, and the short term operational planning level (Agarwal & Ergun 2008). Strategic planning deals with determining the optimal fleet size and composition. Tactical planning covers the design of the service network, i.e. determining the set of routes that maximizes revenue. Operational planning considers choosing which cargo to transport, and assigning the cargo to the routes. These planning levels are highly related, making the decision problems very complex. The routes designed in the tactical planning level should be based on the demand in ports, and the fleet composition should be able to provide customers with a regular repetitive schedule on these routes. On the other hand, the fleet composition puts restrictions on which routes to service and the amount of cargo to be handled.

Research Goal

The problem considered in this work is the routing and scheduling problem in liner shipping. Routing refers to the sequence of ports that ships visit, whereas scheduling is routing with time windows in which the delivery must take place (Ronen 1983). Regarding the planning levels, we focus on the tactical planning and the operational planning level, also known as the simultaneous ship-scheduling and cargo-routing problem when following (Agarwal & Ergun 2008). Given the yearly demand between ports, our objective is to find a weekly schedule and a set of routes for a fleet of vessels that maximizes profit. Routing and scheduling are most often considered together because the regular visit of a port already implies a schedule. Designing a service network consists of creating routes and allocating demand over these routes. The number of candidate service networks grows exponentially with the number of ports considered. Ideally, calculating the objective function for all feasible service networks would reveal the optimal solution.

However, the problem is NP-hard, making it extremely time-consuming to find the optimal solution. To address this problem, one can impose constraints that limit the solution space. For example, one could generate all possible routes, and select only the most pro table ones to compose a service network. Another solution can be found in randomized initialization. This can reduce computation time dramatically, while the solution can approach optimality if the method is used properly. Randomized initialization is often repeated many times to create a diverse starting set, at which point the method is usually called multi-start. Local search methods can then be used to search neighbouring solutions, and find the best solution for each initialization. The multi-start characteristic must prevent ending up in a local optimum. Until now, this type of algorithm has only been applied in industrial and tramp shipping. The relevance of good solutions to the routing and scheduling problem in liner shipping is evident. Carriers are always optimizing their service network and schedules to maximize profit. Service network design has transformed to a customer-oriented differentiation exercise among carriers, and the companies are in the process of reviewing their network strategy (Notteboom 2004). Even today, many carriers still have planners that perform routing and scheduling manually based on their professional knowledge and experience (Lam 2009).

However, tools exist to support the routing and scheduling in sea shipping. One of the heuristic-based systems actually used by planners in the industry is Turbo Router, albeit for industrial

and tramp shipping operations. Turbo Router uses the multi-start local search heuristic described in (Fagerholt & 3 Lindstand 2007). In this work we will transform and apply the multi-start local search heuristic that is used in Turbo Router to liner shipping operations. The nature of the algorithm allows for variation among its two main phases, where phase 1 is an insertion heuristic and phase 2 is a local search heuristic. We will design different implementations for each phase.

The implementations of the insertion heuristic are referred to as sorts, and the implementations of the local search heuristic are referred to as operators. For the first phase we will implement the quantity sort insertion heuristic from (Bronmo et al. 2007), and a profitdriven sort insertion heuristic. For the second phase we propose three new local search operators, the route-length operator, the port-exchange operator, and the transhipment operator. By combining the implementations of each phase we obtain different algorithms that will be used in a benchmark simulation. The goal is to find the most effective algorithm, i.e., the combination of implementations that performs best. The quality of a benchmark depends for a large part on the data set and input parameters that are used. Since there is no de facto standard data set available in the field, a considerable part of this work will focus on creating such a data set. Besides creating a data set and performing a benchmark study, we provide an extensive analysis of the results, and discuss the resulting service networks based on their characteristics. In addition, we perform additional experiments that justify the experimental design of the benchmark study.

Objectives

In short, the objectives and contributions of this research are:

(A) To propose multi-start local search heuristics for the routing and scheduling problem in liner shipping.

(B) To add an analysis of the effectiveness of different implementations of these heuristics.

(C) To propose a data set that combines general applicability and reality.

(D) To investigate under what circumstances the use of transhipment hubs is effective. This research will also uncover possible future work directions in this field.

Research methodology

In order to answer the research questions, we use the following methodology. First, we introduce the reader to the world of liner shipping, and present an extensive literature review on the routing and scheduling problem, as well as related problems. More specifically, we perform an analysis of successful planning concepts from related work. Then, by programming, we form a synthesis of different multi-start local search concepts.

These heuristics serve as an input to a computer experimentation that benchmarks their performance with respect to effectiveness and efficiency. When referring to effectiveness we mean the profit that a service network yields, and when referring to efficiency we target the execution times of the algorithms. Naturally, we want to maximize profit, and minimize the execution times. In order to perform the experiment, we need a data set that will provide us with realistic cases. To come up with a decent data set we collect data from multiple secondary sources, mainly originating from previous work on the problem. We will analyse these sources, and discuss the contents of a good data set for the routing and scheduling problem in liner shipping. Using the available data, we construct a data set that serves a general purpose, i.e. the data set should fit our problem, but will be usable to other researchers as well. During the experiment, a large number of simulations will be run in order to draw reliable conclusions.

To obtain unbiased results, several configurations are simulated, where every configuration consists of a different combination of insertion and local search heuristics. After the experiment, we perform an analysis of the results, the variables, and their influence on the performance of the algorithms. In addition, the best network from the experiment is presented and subjected to further investigation. To support the results following from the main experiment, we perform various additional experiments.

In order to place the performance of our approach into perspective, we will benchmark the multi-start local search algorithm against algorithms from previous work. Furthermore, we investigate different approaches to model transhipment hubs. We also provide additional experiments with varying model variables and parameter settings, in order to get more insight into their influence on the final performance. The implementation of the algorithms, as well as the benchmark simulation and the additional experiments will be performed in Mat lab.

Classification of ship routing and scheduling problems in liner shipping

The first article presents a classification scheme for ship routing and scheduling problems in liner shipping and subsequently classifies existing literature on the subject according to the developed classification. The development of the classification scheme was based on the fact that there was no existing scheme exclusively concerned with liner shipping. The only prior classification scheme concerned with maritime transportation was done by Ronen (1983) but it encompasses all three operation modes in shipping.

Since the three operation modes have significantly different characteristics, the newly developed classification scheme exclusively for liner shipping is different from the one developed by Ronen (1983). The literature on routing and scheduling in liner shipping is largely concerned with specific applications wherefore the problem formulations and solution methods are very diverse. This makes the development of a classification scheme important, as it may serve as a first step towards developing a general model or a group of models that cover the main problems within ship routing and scheduling in liner shipping.

The main problem was to determine which fields should be incorporated in the classification scheme and to establish why they are important. In addition, articles pertaining to routing and scheduling in liner shipping had to be classified according to the developed classification scheme. The purpose of the article is to give an overview of the models developed so far, their assumptions, constraints and solution methods. As such, the article presents the state-of-the-art within the area. This will enable a more informed choice of which model to use in a specific case. In addition, the article can be used for establishing which assumptions and constraints should be included in a generic model.

The method used is a review of existing taxonomies and classification schemes within the area of routing and scheduling combined with a review of the articles that define liner shipping as well as the current literature on routing and scheduling within liner shipping. Lawrence (1972), Ronen (1983), Ronen (1993), and Christiansen et al. (2004) are the main articles used for defining liner shipping.A number of taxonomies and classification schemes exist within the area of routing and scheduling. Bodin and Golden (1981), Bodin et al. (1983) and Desrochers et al. (1990) have all developed classification schemes for vehicle routing and scheduling problems. Assad (1988) also considers the routing and scheduling of the crew which is required to follow the vehicle. Based on the previously noted classifications, Ronen (1983) developed a scheme for use in connection with ship routing and scheduling problems in maritime

transportation. Another application-specific scheme was developed later by Ronen (1988) with application to trucks.

The classification scheme has eighteen characteristics with anywhere from two to eight possible options. Twenty-four articles within ship routing and scheduling in liner shipping are classified and all but one option are used. The number of articles was rather small; however, this may be ascribed to the fact that articles concerning fleet management problems were only classified if they also consider routing or scheduling.

By characterizing and considering the problems described in the articles, it is possible to divide the articles into groups according to the three problem types: Scheduling, routing and fleet management. Table 1 shows the number of classified articles that fall into each of the three problem types and the four possible combinations of the three problem types. There is a clear focus on problems involving fleet management aspects while scheduling without fleet management is rarely considered in the literature.

Table 1. Classification of liner shipping articles according to problem types

	FLEET MANAGEMENT NO	FLEET MANAGEMENT YES
ROUTING	6	8
SCHEDULING	2	8

Routing and Scheduling Problems

Scheduling often involves a high number of deployment decisions which are decisions on which of the available ships to use, at what speed the ships should sail and which ship to use on a specific route. In liner shipping, deployment of the existing fleet is a part of fleet management which in connection with routing and scheduling in liner shipping is concerned with laying up ships, chartering ships in or out of the fleet as well as the deployment of the ships.

Table 2. Schedule for Maersk Seville as found on Maerskline.com

PORT NAME	ARRIVAL DATE	DEPARTURE DATE
SINGAPORE	25-11-2010 02:00	25-11-2010 22:00
BUSAN	01-12-2010 18:00	02-12-2010 10:00
XINGANG	04-12-2010 03:30	04-12-2010 23:30
DALIAN	05-12-2010 15:00	06-12-2010 04:00
QINGDAO	07-12-2010 06:00	07-12-2010 16:00
SHANGHAI	11-12-2010 20:00	12-12-2010 16:00
SUEZ CANAL	27-12-2010 01:00	27-12-2010 17:00
HAMBURG	06-01-2011 07:00	07-01-2011 03:00
ROTTERDAM	08-01-2011 11:00	09-01-2011 17:00
ANTWERP	12-01-2010 06:00	12-01-2011 22:00
SUEZ CANAL	20-01-2011 19:00	21-01-2011 17:00
SINGAPORE	03-02-2011 03:00	04-02-2011 15:00

Ships deployed in liner shipping usually operate on closed routes consisting of a sequence of ports where each port may appear more than once in the sequence. Once a ship is assigned to a route, it will often perform multiple voyages where a voyage is one traversal of the route. Due to the closed routes and the fact that ships often load and discharge in each port of call, the ships are rarely if ever empty and it is therefore difficult to define the origin and destination of a voyage.

Furthermore, liner shipping is characterized by heavy containerization and the possibility of transhipping containers between routes. Based on these characteristics, and on the fact that, according to Alpha liner (2010), the 100 largest liner shipping companies account for 95% of the TEU capacity and have an average of 48 ships and a minimum of 4 ships, it is unlikely that a liner shipping routing or scheduling problem would contain only one ship. Between 1990 and 2007, the volume of containers carried in liner shipping had an average annual growth rate of 9.8%. As a result, liner shipping expanded from transporting 5.1% in 1980 to 25.4% in 2008 of the world's dry cargo transported by sea (UNCTAD, 2008). The majority of cargo transported by liner ships is manufactured goods and high-value bulk commodities which have a higher value than the commodities transported in industrial and tramp shipping.

Despite the growth in liner shipping and the increasing importance of the industry, research on routing and scheduling has been scarce until 2004, as reported by Christiansen et al. (2004). However, since then the volume of research in the area has been increasing steadily. There are a number of classification schemes for routing and scheduling problems in transportation, but

most are concerned with vehicle routing. Ronen (1983) is the only classification scheme that deals with maritime transportation.

This scheme was created to cover all three operational modes of maritime transportation. The first characteristic of the classification scheme relates to the mode of operation but otherwise the scheme assumes that the same operational characteristics are relevant for routing and scheduling problems within the three modes of maritime transportation. Besides the classification scheme, Ronen (1983) also provides a review of ship routing and scheduling and closely related models in the literature. Similar reviews were published in Ronen (1993) and Christiansen et al. (2004), each covering the literature published in the decade between the reviews.

Since the publication of Ronen (1983), the liner shipping industry has developed considerably in terms of operational conditions, and liner shipping now differs significantly from the other two modes of maritime transportation with regard to routing and scheduling problems (Christiansen et al., 2004). Thus, the classification scheme developed by Ronen (1983) no longer reflects the operational conditions of the liner shipping industry. Along with the recent developments in the liner shipping industry, there has been an increase in the number of articles published on the subject of routing and scheduling related problems in liner shipping. This influx of articles has yet to be reviewed as the majority have been published after Christiansen et al. (2004). The objective of this paper is twofold. First, we want to develop a classification scheme reflecting the operational conditions of ships in liner shipping today and aspects which will become important in the future.

Table 4. Schedule for Grete Maersk sailing between Europe and the US West coast as found on Maerskline.com

PORT NAME	ARRIVAL	DEPARTURE
ALGECIRAS	05-02-2012 14:00	06-02-2012 20:00
SUEZ CANAL	11-02-2012 19:00	12-02-2012 17:00
TANJUNG PELEPAS	24-02-2012 24:00	26-02-2012 02:00
VUNG TAU	28-02-2012 01:00	28-02-2012 17:00
NANSHA NEW PORT	02-03-2012 12:00	03-03-2012 03:00
YANTIAN	03-03-2012 13:00	04-03-2012 12:00
HONG KONG	04-03-2012 18:00	05-03-2012 06:00
LOS ANGELES	18-03-2012 18:00	22-03-2012 03:00

When disruptions happen in a liner shipping network, their effect on the network needs to be contained both in time and space. The containment in time leads to a decision on the end time of the planning period by which time the ships and cargos must be back on schedule. The containment in space leads to a decision on which ships and ports are to be used in getting the network back on schedule.

All ports and ships that are directly involved in the disruptions are included but other ships and ports can also be include depending on their proximity to the disruptions and their perceived ability to alleviate the effects of the disruptions. The challenge is to find new ship schedules and cargo routings that minimize the operational cost given the capacity constraints and port productivity constraints.

The operational cost consists of the cost of fuel for sailing, all port related costs, the cost of transhipments, and the delay cost. The latter cost is the cost of delivering cargo after their planned time of delivery. The cost can be an actual cost stipulated in the contract between the shipper and the liner shipping company or it can be an estimated cost covering intangibles such as lost future sales. Disruptions in liner shipping have many causes.

As mentioned in estimates that port congestion and lower than expected port productivity account for the majority of schedule unreliability on the East Asia–Europe routes. Other common sources of disruption are poor weather which can both delay ships on route and close ports, mechanical problems on board ships, unexpected waiting time in connection with pilot, towage, bunkering, and tidal windows in ports and access channels. Other less common sources of disruption are strikes, civil unrest, search and rescue missions, ship arrests, and waiting for cargo. More severe disruptions exist and they will likely result in the ship being out of the network for the foreseeable future.

Such disruptions include fire incidents, ship collisions, ship grounding, and piracy. Due to the expected length of such disruption these types of incidents are not considered in this article. When a liner shipping company decides to react to disruptions by rescheduling their ships and cargo, the following information concerning the disruptions must be available. The starting time and ending time of each disruption must be known.

A disruption may already have started or it can be starting in the near future. The ending time of the disruptions must also be within the foreseeable future. In addition, the ships and ports involved in each disruption must be known.

Liner shipping companies can use a number of actions to try to recover from disruptions. Notteboom (2006) cites four common actions taken to recover schedules: rearranging the port calls, increasing the speed, omitting port calls, and 'cut and run' which means that the ship departs before all load moves and in some cases even all discharge moves have been performed. In addition, the author mentions the possibility of using ships that are not yet in service for recovering the schedules. For major disruptions this notion can be extended and shipping lines will then charter a ship merely for the purpose of recovering from a disruption. Finally, the author mentions the possibility of increasing port productivity as a way to recover from disruptions.

However, this action can only be used to recover small amounts of time and only in a limited number of ports around the world. Another method for schedule recovery is discharging cargo in another port than the final port and then routing the cargo via another mode of transportation to the final port. Trains and trucks are used for this purpose quite often in Europe due to the relatively small distances. However, the method was also used during the 2002 US West Coast lockout of longshoremen where cargo was discharged in Mexico for intermodal transport to the US.

Repair phase

In the second phase, the repair phase, the focus is on making the solution feasible with respect to the cargos that cannot be accommodated after the construction phase. In order for the solution to remain feasible with respect to the ships, none of the existing port calls are moved or deleted. Instead the repair phase uses four procedures in an attempt to increase the length of the existing port calls and the possibility of adding new port calls between existing ones. The port calls are extended as this provides additional time for loading (discharging) cargo.

1) The procedure advances the start of the port call by diminishing the waiting time before the port call.

2) The procedure delays the departure of the port call by diminishing the waiting time before the next port call.

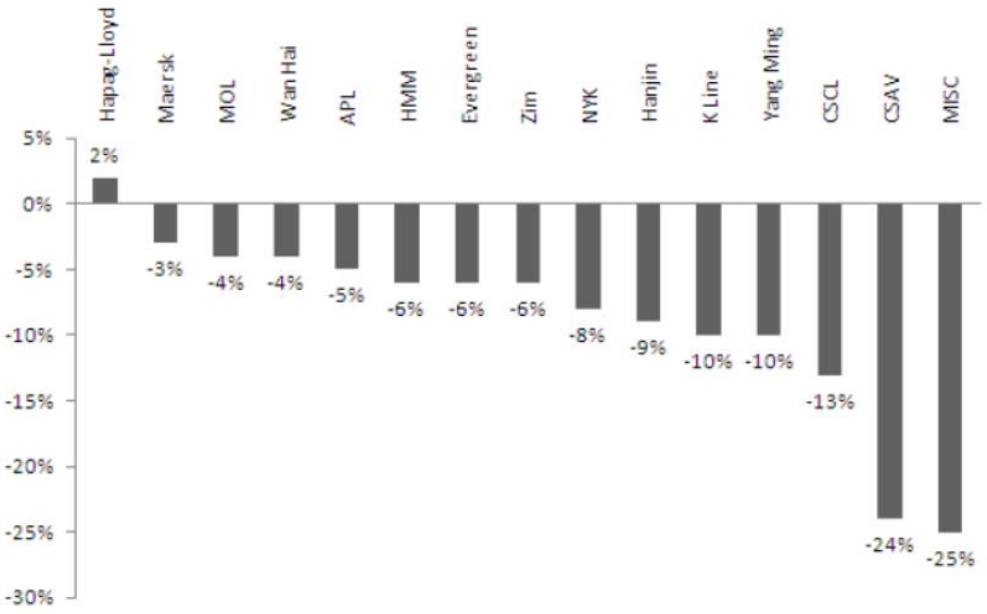
3) The procedure delays the departure of the port call by increasing the outbound speed.

4) The procedure advances the start of the port call by increasing the inbound speed.

These four procedures are used in different order depending on the problem at hand. However, in all cases the procedures related to waiting times are used first as these are not associated with any cost, whereas increasing the speed adds to the cost of sailing.

The existing port calls can be extended with as little as one time period. Likewise, new port calls can be created for cargo volumes requiring as little as one time period for the port call. The repair phase starts by randomly sorting both cargos and ships in order to treat the cargos and the ships in a different order each time the repair phase is performed. The cargos not yet accommodated are either on board a ship at the beginning of the planning period or they become available during the planning period.

Planning levels and terminology of liner shipping



“Operating margins for liner shipping companies surveyed by Alpha liner”

Planning problems in liner shipping can be divided into three planning levels: strategic, tactical, and operational.

Despite the heavy integration, especially between liner shipping companies and terminal operators, my focus will be on planning problems relating to the routing and scheduling of ships. Thus, I will not include problems such as terminal design, berth scheduling, or crew assignment.

Terminology

Throughout this introduction to the thesis and in the following articles the terminology below is used. Note that some words have a different meaning than their general usage when used in connection with liner shipping.

• The shipper is the owner of the transported cargo and contracts with a liner shipping company for the transportation.

• A cargo is a set of containers shipped from a single origin to a single destination. The volume of a cargo is given in TEU.

• TEU stands for Twenty-foot Equivalent Unit which is the most common size for a container. The measurement is often used to indicate volume of cargo and capacity of ships.

• Routing is the sequencing of port calls to be made by the available ships and the result is one or more routes. When a company involved in liner shipping creates routes, the company will often associate a ship type with each route in order to ensure adequate cargo capacity and compatibility between the ships and the ports that they visit.

• Scheduling is concerned with sequencing port calls and fixing the time of each port call for all ships involved.

• Deployment refers to the decisions on which of the available ships to use, which ships to use on a specific route and at what speed the ships should sail.

• Fleet management is concerned with laying up ships, chartering ships in or out of the fleet as

well as the deployment of the ships.

• A service is the voyages provided by the collection of ships sailing on a specific route.

• A voyage is one traversal of a route starting at a port specified by the ship operator. It is usually one of the primary loading ports.

• A move is the act of loading or discharging one container from a ship.

• Slow steaming is a term used when the average speed of a voyage is less than the commercial speed. The term comes in three degrees: slow steaming, extra slow steaming, and Super slow steaming.

Strategic Planning

Strategic planning is concerned with decisions that are medium to long term and sets the stage for the tactical and operational planning. In liner shipping strategic decisions span 1– 5 years with some decisions such as new building schemes and green field terminal projects extending 5–10 years into the future.

Due to the length of the time horizon and the volatility of the liner shipping industry, knowledge about the future is limited and associated with a high degree of uncertainty. Therefore, strategic decisions are based on aggregated information. Four of the most important strategic decisions for a liner shipping company are which trade lanes to participate in, the target market share, the long term fleet mix and size, and port choices. Initially, a company has to decide in which trade lanes to participate. Currently, only a handful of shipping lines operate globally and the majority of shipping lines has a regional base.

Entry into new trade lanes can be very expensive since it takes time to obtain the volume needed to achieve the economies of scale enjoyed by the present operators. For each chosen trade lane the company has to decide how big a market share it wishes to obtain. Since shipping lines compete for cargo, such a decision influences the service level, e.g. the frequency that the shipping line must provide.

The trade lanes and market share, along with the shipping line's expectations to market growth influence the fleet size and mix problem. Together these aspects give aggregated volumes which

can be used to estimate the required ship capacity while the choice of trade lanes decides the types of ships required. If the Far East–Europe trade lane is chosen, the shipping line will require very large ships to compete on economies of scale, and if the choice is the South America–Europe trade lane, ships with plenty of reefer plugs to transport refrigerated food are required. In addition, the shipping line has to decide the desired ratio between company owned and chartered ships. With regard to port choices, the main ports on each trade lane must be decided and so must the main transshipment ports that will connect the network. These decisions must be made in conjunction with the decisions on the fleet size and mix as they influence one another. Additional strategic decisions for the shipping lines can be found in Christiansen et al. (2004), Christiansen et al. (2007) and Andersen (2010).

Planning

Tactical planning focuses on decisions that are medium term which in liner shipping generally span anywhere from 2 months up to 1 year. The tactical decisions are based on the decisions made at the strategic level and will impact the operational planning decisions. Due to the shorter time horizon, the available information is more reliable, thus making it possible to make decisions based on the information directly rather than on the aggregation of information.

In liner shipping, this means that rather than having volume information per trade lane, the volume information is on a port-to-port basis. According to Christiansen et al. (2007), the main decision at the tactical planning level for liner shipping companies is fleet deployment. According to Andersen (2010) the main decisions at the tactical planning level also include the route design and the scheduling.

The three decisions are interrelated and dependent on the strategic decisions made. The route design or routing problem is the construction of a sequence of port calls that constitutes a route. For each trade lane a number of routes will often be constructed and some routes will cover more than one trade lane.

When a liner shipping company creates routes, the company will often associate a ship type with each route in order to ensure adequate cargo capacity and compatibility between the ships and the ports that they visit.

The allocation of ship types to routes constitutes part of the deployment decisions. Scheduling, as opposed to routing, also includes the actual timing of the port calls and thus includes

additional deployment decisions for all ships involved. The creation of a schedule includes the decision on which ship to deploy on the schedule and at what speed. All the schedules pertaining to one service are identical except for a time lag corresponding to the service frequency. This means that for each sea leg all the ships assigned to the schedules must maintain the same speed. The complete set of schedules for a liner shipping company constitutes the company's deployment decisions. The schedules resulting from solving the scheduling problem are normally published for the coming 6 months. However, the published schedule may be changed later as a consequence of other tactical planning problems. Such tactical problems include planning for dry docking of ships in connection with the periodic surveys required for the ships to remain in class and the decision on whether to lay up ships or slow steam in case of excess ship capacity.

Operational Planning

Operational planning is concerned with the short term decisions which span anywhere from a few hours to a few months. The operational decisions are dependent upon the decisions taken at the strategic and tactical planning levels. Due to the short time horizon of this type of problems, information at this planning level is often based on a specific port, ship or cargo. When a set of schedules from the tactical planning level has to be implemented, each ship in the fleet has to transition from its old schedule to its new schedule.

When a chartered ship has to be returned to (received from) the owner, it has to be phased out of service. In both cases the transition that must be planned is an operational problem. Another type of transition problem, named disruption management, arises when the liner shipping company faces or will face a disruption. Disruption management consists of getting the ships and cargos back on the published schedule within a given recovery period with as little cost as possible.

Another operational problem is the problem of choosing a sailing route between two ports known as route planning or environmental routing (Christiansen et al., 2007). The navigator has to take water depths, currents, tides, waves, winds and company regulations into account. However, if the two ports are separated by a large body of water such as the Pacific or the Atlantic Ocean, the navigator is aided by meteorological services to adequately take into account prevalent weather and currents known as weather routing.

As a result of the trade imbalance large quantities of empty containers build up in ports with net imports. The empty container relocation problem consists of routing the empty containers on the existing network to ports with net exports. Additional operational planning problems appearing in liner shipping can be found in Christiansen et al. (2004), Christiansen et al. (2007) and Andersen (2010).

Performance of Heuristic

The performance of the heuristic on the generated test instances is summarized. As expected, the heuristic's computing time increases as the size of the test instances increases and as the number of disruptions increases, with several test instances pushing the heuristic to terminate based on the 1,800 seconds upper time limit. However, it is worth noting that despite the occasional long run time, the best objective value for all test instances was found within 152 seconds. The cost of disruption is reported in 1,000 USD and it is the difference between the operational cost with and without the disruption. The operational cost consists of the sailing cost, the transhipment cost, the port and berth costs as well as the delay cost. When the cost of disruption is negative, it is most often due to a decrease in speed and omitted or shortened port calls. Since all affected and included ships and ports are included in the smallest test instance created for a disruption, and given that all cargo can be transported when there are no disruptions, it should be impossible for the volume of cargo not transported to increase when the possible ships and ports are added to the test instances.

Therefore, the amount of cargo not transported in test instance 4 represents an anomaly. Test instance 4 can be separated into two parts; test instance 3 and the possible ships and ports and the cargo associated with the aforementioned. Given disruption A, the possible ships and ports and the associated cargo have been tested by the heuristic and the ships are able to transport all cargo without any delay cost. Hence test instance 4 should have the same volume of not transported cargo as test instance 3 at the most. We are unable to establish the cause of this anomaly. Given a number of time periods, if the volume of cargo not transported remains the same, then the cost of disruption will remain the same or decrease as the possible ships and ports are added. In addition, increasing the number of time periods will result in the same or a lower volume of cargo not transported.

The results clearly show that it is more effective to extend the planning period than to include the possible ships and ports in an attempt to decrease the volume of cargo not transported. This may partially be due to the fact that the heuristic only allows inducement calls to the origin or destination port of the cargo, thereby excluding the possibility of inducement calls for transhipment purposes or to both the origin and the destination ports.

Conclusion

This project will help us to know the various develop and classification scheme for scheduling and routing problems in liner shipping, taking into account current operational conditions and aspects which will become important in the future. One of the main changes in the operational conditions is the increasing connectivity of the networks operated in the liner shipping industry which has prompted the addition of characteristic demand splitting and the addition in characteristic of the cost type transhipment. Furthermore, the industry is moving towards a setup more in line with the description of liner shipping. This has led to the inclusion of several characteristic to support a similar development in the literature. Number of routes which reflects the tendency towards ships remaining on the same route throughout the planning horizon.

As a consequence of this the ships may no longer be empty at any port and for that reason characteristic ships required to be empty has been included. With the ships remaining on one route and retaining cargo on board at all times, it is relevant to include the choice None in characteristic number of starting points as no starting point is required for such an operation. Based on an increasing awareness of especially the carbon emissions in the liner shipping industry, the choice Minimizing environmental impact has been included as a possible objective. The choice has yet to be used in the literature; however, as the carbon footprint has become a selling point for the liner shipping companies, it is likely to appear in future literature.

As we understand in the project there has been an interesting issue to note that the two important characteristics in liner trade: Cargo transhipment and Cruising speed have only been an issue to the liner trade. It is evident from the reviews that the majority of the work within routing and scheduling in liner shipping contains an element of fleet management. It is worth noting that the articles are evenly split between routing with fleet management and scheduling with fleet management. On the other hand, there are only two articles relating to scheduling without fleet management, which is in line with the comment in stating that scheduling often involves a high number of deployment decisions and thereby includes fleet management.

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Novel Hybrid-Relay Cooperative Communications Technique for Agriculture

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Abstract

Objective – To investigate and analyses the novel Hybrid-Relay Cooperative communications technique and algorithms which provides the possibility of obtaining improved system performance, with minimal cost, complexities, and overall energy consumption in wireless fading channels while retaining spectral efficiency to aid decision making processes for a more efficient and effective water-agriculture-food nexus.
Methods– Henceforth, the comparative performance and energy efficiency analysis of the fundamental cooperative MIMO techniques namely: Detect & Forward (***DF***), Amplify &

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Forward (***AF***) and the Coded cooperation were analysed with respect to the Hybrid Cooperative Communications technique. The methodical and data-driven analyses were carried out using MATLAB and Wireless Communications Systems Parameters.

Results – In harmony with the 'Green Communications' wireless communication theme; the excellent trade – off between performance (data rate) and energy efficiency is confirmed, which of course creates very good potential for use for an improved agricultural monitoring and management system.

Conclusion – The Hybrid-Relay Cooperative communications system serves as a basis for the comparative analysis of the aforementioned cooperative MIMO techniques and provides fundamental, but meaningful deductions and potentials with regards to efficient cooperative communications for innovative, efficient and effective water management for improved agricultural practices and a sustainable environment.

Keywords: Water management, Agriculture, Food Production, Data, Analysis, Hybrid-Relay Cooperative communications system, Decode & Forward, Amplify & Forward, Coded Cooperative Communications, Innovative.

Tool: MATLAB

1. Introduction

All over the world, the issue of food security has been in the fore front of the campaign for sustainable development. Experience and news received from all over the world reveals that food security is dependent on effective agricultural practices. This also implies that areas with food shortages in the world would be required to step up agricultural production in the face of ravaging desertification caused by excessive draught and in the daunting face of global insecurity.

The challenge of food security necessarily suggests that global water management strategies need to be looked into in the light of improving agricultural development in sustainable manner. This is important to ensure year-round food production in areas with excessive dry season which includes Sub-Sahara African nations. Cameira & Pereira (2019) identified land and water as primary determinants of agricultural output calling for an innovative approach to land and water governance. Similar challenges have been identified by Inocencio, Sally &Merrey (2003) while providing an overview into the use of innovative approaches to agricultural water use for improving food security in Sub-Saharan Africa (Ruth Meinzen-Dick, 2006). The World Bank, Food and Agricultural Organisation have at different times made similar calls for improvements in water management techniques, policies, strategies, systems, technologies globally to aid effective agricultural practices and ensure food security in the midst of challenges such as the reality of climate change.

Hence, the Innovative Analysis and Management of Water Resources for Effective Agricultural Practices has become a global concept. The concept seeks to foster effectiveness of global water resources management practices to enhance food production. It also seeks to design and promote a coordinated strategy for the development and management of water, land and related resources, to maximise agricultural yield.

Therefore, the increasing challenge of modern agriculture meeting up with the production of food for the continued increase in global population, in the context of the ever-growing competition for water and land, climate change, drought, anthropic water scarcity and less participatory water governance; requires urgent and a thorough approach for the good of humanity. For a data-driven world of ours, innovative measures to analyse and recommend effective and efficient water management techniques and approaches becomes relevant and would help overcome challenges associated with field study; by providing cost effective, efficient, intelligent and safer measures to ensure better decision making for more effective water management policies to increase agricultural output efficiency and environmental sustainability.

Therefore, innovative issues and measures must be applied in agricultural water management and practices for both field and system, to mitigate water scarcity, increase environmental friendliness and the welfare of society, and thereby increase food production.

The aim of this research work is to investigate and analyse factors and techniques that influences and aids water resources management, as used in the agricultural sector; and how water management techniques, systems, technologies, processes, policy decision making can be optimized for a more efficient water, agriculture and food nexus; with the use of data analysis, algorithms, machine learning methodologies and simulation tools.

2. Literature Review

Wireless Sensor Networks

Wireless sensor networks (WSN) are typically composed of nodes, which are distributed thickly and are able to sensor, pick up and transmit signals and information (Pottie & Kaiser, 2000; Akyildiz & Su, Sankarasubramaniam & Cyirci, 2002). The enablement of information to be captured is the core function of WSN's, using a set of sensors able to communicate with each other and process data inside the network itself (processing in-network) in order to do a specific set of tasks which cannot be done by humans due to their inherent limitations and physical survival conditions (Gracon H.E. L de Lima, Silva, Pedro, 2014). Additionally, the WSN can also be applied where there is ongoing need for environment monitoring(for example agriculture) and control and in tasks that would demand too much time and resources if manually done (Mignaco, 2005; Karl & Willig, 2005). This way, many applications like agriculture, electronic commerce, animal tracking and industrial activities, need their data to be available at real time. This real time concept is characteristic of applications which transactions must satisfy their deadline, so as to allow that data may be handled without losing its temporal validity. This enables the system to react in a efficient way, due to the obtained data correctness and consistency (Ribeiro Neto, 2006).

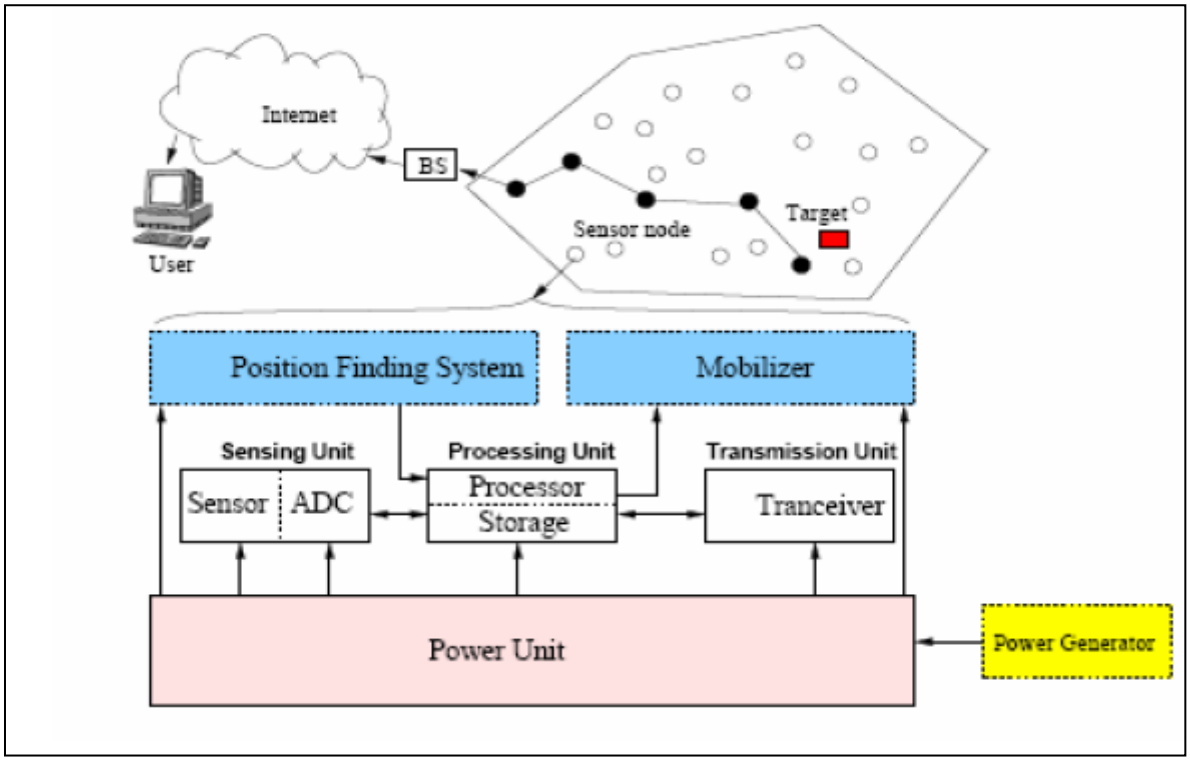

Figure 1.WSN Sensor Node General Structure (Dube, 2013).

Wireless Cooperative Communications

The method of cooperative communications involves the creation of spatial diversity through an array of single antenna users combining to produce a 'virtual MIMO' system. The principle basically involves a user/node and its 'partner' node/mobile sending independent copies of the user's information to the destination (base station) at a given time (Aazhang, Erkip & Sendonaris, 2003) to create a diversity called 'cooperative diversity', with the aims of improved overall performance and reduction in overall energy consumption; this therefore means that the baseline transmit power of the users/nodes will reduce as each user/node would need to transmit with a lesser power to achieve a target performance criterion. Therefore, users/nodes share their antennas and other resources to create a 'virtualMIMO' or spatial diversity system through distributed transmission and signal processing (Laneman, Tse, & Wornell, 2002) thereby each users/nodes acts both as a source and a relay of information (Hadayat, Hunter, & Nosratinia, 2004) unlike earliest works which was modelled according to the basic 'relay channel', where each user or node just forwarded or re-transmitted the signal it received , but not having its own signal to send; thereby assuming a 'memory-less' relay channel of which cooperation may not be possible when relay channel is poor (Cover & Gamal, 1979).

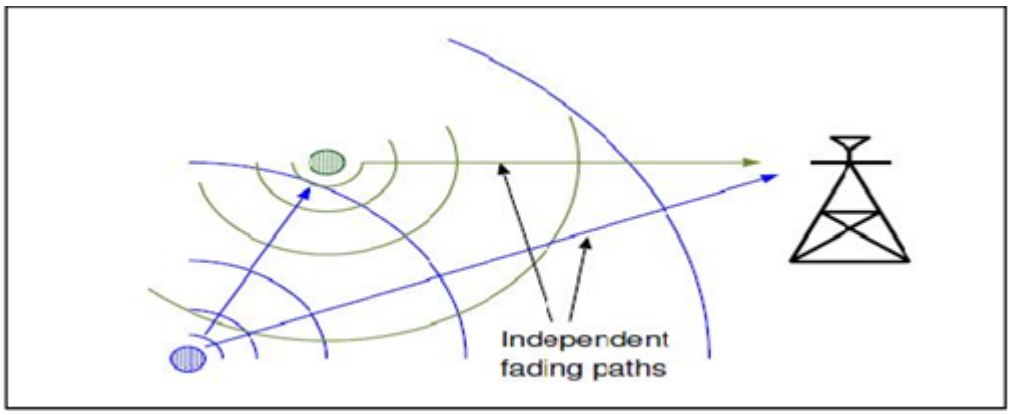

Figure 2. Cooperative Communication (Hadayat, Hunter, & Nosratinia, 2004)

Work thus far generally considers that the users/nodes transmit equal power, but it could be possible to improve performance by varying user/node power based on the nature of the inter-user/node channel; therefore, this makes power control schemes an important factor in developing effective cooperative communications (Hadayat, Hunter, & Nosratinia, 2004). On Energy efficiency, it has been shown that both users/nodes in a two- user system obtain improved energy efficiency, saving a significant amount of energy through cooperation, though 'weaker' (lesser power) users/nodes benefit more than the 'stronger' (more power) users/nodes during cooperation (Hadayat, Hunter, & Nosratinia, 2004; Aazhang & Nokelby, 2010; Hunter, 2004). Also, much work has been done at the physical layer, at whichcooperative methodologies are quite different from other higher protocol layers (Hadayat, Hunter & Nosratinia, 2004; Goeckel, Laneman & Scaglione, 2006; Ning, Shaogian & Zhongpei, 2009).

Furthermore, for reduced complexities and ease of analysis, most works have assumed mutually independent inter-user and uplink channels (Hadayat, Hunter & Nosratinia, 2004; Hunter & Nosratinia, 2004) a perfect channel state information (CSI) at all receivers (users/nodes and base station) (Aazhang & M. Nokelby, 2010; C. C. J. Kuo, M. Morelli, M. O. Pun, 2007; E. Erkip and A. Stefanov, 2004; Kim, Song, Yeo & Yoon, 2009; Blake, Nasri, & Schober, 2011; Aissa, Ikki, 2012) though this may not always be the case practically, as the wireless channel could vary unpredictably; this of course has been considered bysome works, where a feedback mechanism is used in the uplink transmission to address an imperfect CSI situation (Nishimura, Ohgane & Saito, 2009). Additionally, works also analysed the MIMO techniques for cooperative communications based on a two user/node system (Aazhang, Erkip & Sendonaris, 2003; Hunter, 2004; Blake, Nasri & Schober, 2011; Aissa, Ikki, 2012) that is to say each user just having one partner, this was also aimed at simplicity to avoid more complex algorithms for accurate partner assignment which is important in a much more practical multi –partner system; and also a Rayleigh flat fading wireless channel type was assumed (Aazhang, Erkip & Sendonaris, 2003; Patzold & Wu, 2008, Aissa, Ikki, 2012); which is typical for a'non – line of sight' (NLOS) system as in cellular wireless networks.

3. Methodology

3.1. Research Process Flow

The research activity carried out in addition to data acquisition and associated process, is summarized by the flowchart in Figure 3.1.

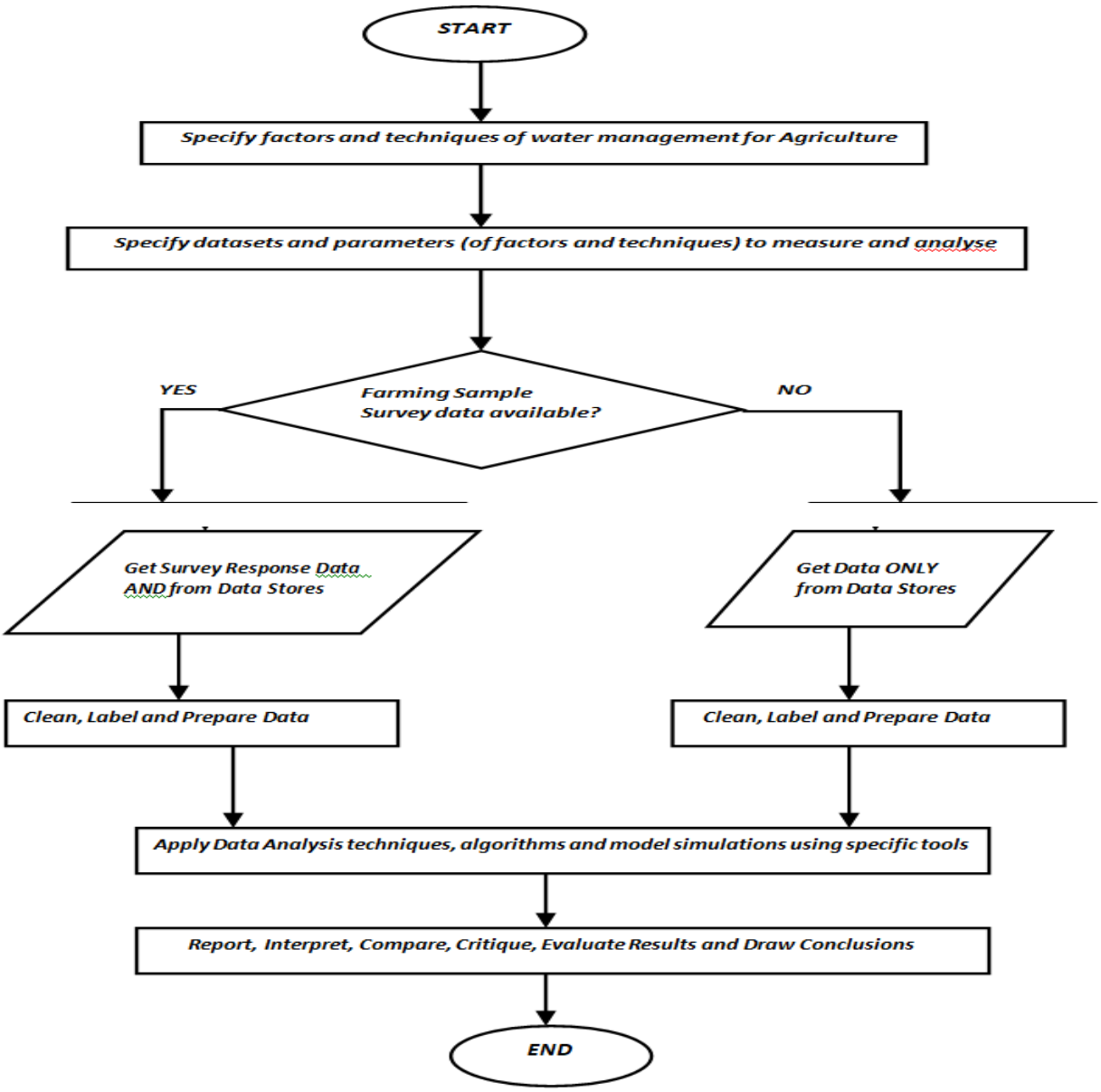

Figure 3. Summarized Research Process Flowchart

3.2 Factors influencing Water management for agriculture

Evidences have shown that for effective modern agricultural practices, adequate analyses should take into account influencing factors categorized as physical, agricultural and socioeconomic factors that act as drivers in the management of water resources as used in agriculture [28]. These factors are highlighted in the literature and must be properly investigated and analysed to ensure an efficient management of water resources for effective agriculture,

since water is a limited resource and modern agriculture has to face the increasing scarcity of water for irrigation, as a result of the reduced availability and the increasing competition of civil and industrial sectors (Montesano F.F. et al., 2015).

Physical Factors These include climate conditions, geological situations, soil types, hydrological conditions, and all other physical geographic conditions unique to an environment (for example aquifer conditions and underground water levels) that influences how water is used and management for effective agriculture.

Agricultural Factors As also explained in the literature, these includes irrigations systems and methods, crop section techniques, groundwater levels, use of effective technologies(for example wireless systems) and automotive systems and water body availability.

Socioeconomic Factors These are factors that influence water management/security for agriculture from a social, economic and political aspect, which is also very critical to develop effective and efficient water management strategies. Such drivers include water policies and laws, population and farmer population distributions, farmer profit, agricultural revenue, market prices (including cost of production using various systems).

Conditional Factors These are factors that are not directly measured but act as catalysts to water management results and processes for effective farming; and so must also be understood for more robust effective strategies. Such factors could be farming expertise and processes, fertilizers/chemicals, diversity/inclusion, management strategies and political will.

3.3 Techniques for Effective Water Management in Agriculture

Though while also recognizing that the utilization of technologies and techniques to aid water management and water security for agriculture is only part of the solution; it's very much pertinent to understand these technologies/techniques and the methodical analysis of their impact and how they can be optimized are important for the development of efficient water management activities for effective and productive agricultural practices. From ***irrigation technologies***, to ***water saving technologies***, ***crop specific water saving techniques/technologies***, ***ICT based and Wireless technologies***; these are the more common types of important water management technologies that contributes to effective agriculture and aids associated analysis, needed to continually improve or develop even newer technologies that apply new processes and techniques for an even more efficient water management methods for effective agriculture in the context of the ever-growing competition for water, climate change, drought and other forms of demographic, societal and climatic challenges.

For this data-centric research work, emphasis is on using some data analysis, Machine Learning and Wireless technology algorithms and techniques to analyse water management/security processes for effective agriculture and to meet the challenge of how to incorporate innovative technologies and management approaches in decision making and long term water management

policy making to increase and optimize agricultural output and processes with lesser resources and maintain environmental sustainability (Kulkarni, 2011).

3.3.1 Hybrid Relay-Cooperative Wireless Sensor Network System

For the hybrid relay - Cooperative system as shown in Figure 3.4, it is a combination of a multi – hop relay system and a two sensor nodes(i.e. source N and cooperating node N_C) cooperative wireless system.

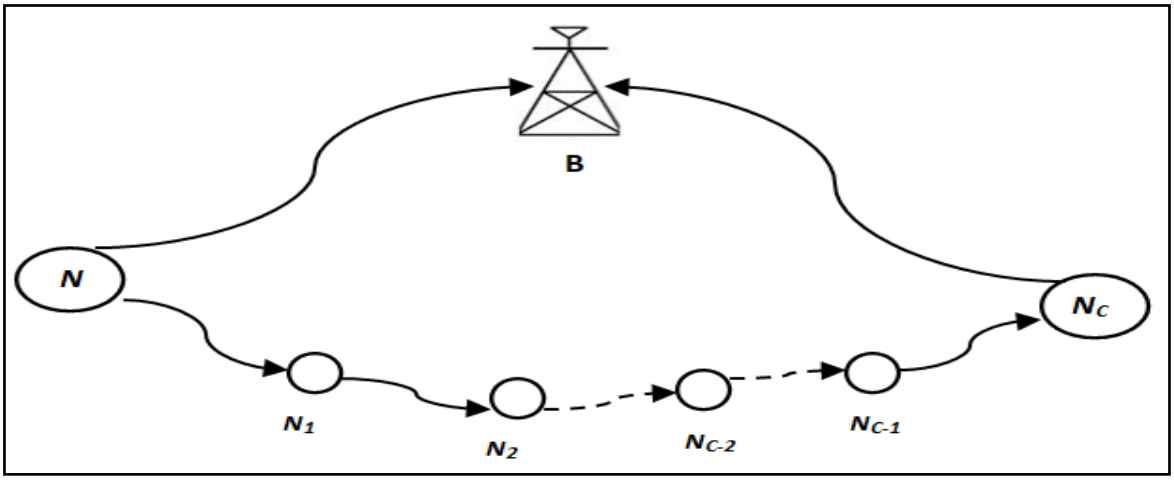

Figure 4. Hybrid Relay-Cooperative Wireless System

In this case as shown in Figure 4, there are relays: N_1, N_2,..., N_{C-1} between the source transmitting sensor N and the 'last relay' which is the cooperative node N_C. This system is suitable for a case where the sensor nodes can access geographical data, and so the cooperating sensor node is selected based on its location, needed to provide effective cooperation to the source sensor node. The sensor nodes between the source node and the cooperating node act as relays (limited intelligence and communication resources) of the signal by forwarding hop by hop the signal from the source to the cooperating sensor node, which then sends the signal to the Base Station (Sink Node) ***B***, where it is combined with the direct signal from the source to the destination, and then the resultant signal is effectively detected by ***B***, thereby benefiting from cooperative communication. The base station then transmits the signal via internet or cellular network to the farmer's mobile devices and intelligent information is received and acted on.

The main ***advantages*** of this system are that it reduces the need for extra hardware and communication resources all around the farm or field, due to the use of less complex relays

used to hop signals and a limited number of processing nodes (source and cooperative). This thereby makes the system more cost effective, energy efficient and environment friendly.

The cooperative communications MIMO(Multiple Input-Multiple Output) technique of ***Amplify and Forward (AF)***, which involves each relay and/or cooperative node amplifying the received signal and then forwarding it to the Base Station; while the ***Decode and Forward (DF)*** algorithm involves the relay and/or cooperating nodes in turn tend to detect each node's transmitted data (bits/symbols) and then re-transmitting it to the base station (destination) thereby providing spatial diversity to combat the effect of fading on each individual node's signal.

For the ***Coded Cooperative*** algorithm, which involves more complexity and better performance, it is described in more details as follows:

In the first period: The source node N which is also the node closest to the intended or target area of measurement, sends its data vector X to the first relay node N_1 and the base station B, with the received signals given as $Y_{N,N1}$, $Y_{N,B}$ respectively; and $H_{N,N1}$ and $H_{N,B}$ being the channel co-efficient matrices with their associated Gaussian noise ($n_{N,N1}$ and $n_{N,B}$) ; as given in equations *(3.9)*and *(3.10)* respectively :

$$Y_{N,N1} = X.H_{N,N1}.\sqrt{P_N} + n_{N,N1}$$
(3.10)
$$Y_{N,B} = X.H_{N,B}.\sqrt{P_N} + n_{N,B}$$
(3.11)

Also, where P_N is the Average signal power of the source node ,which is normalized to 1.

At the second period: Since the relay network is actually a multi-hop system, the first relay node detects the received signal $Y_{N,N1}$ from the source and forwards it to the next relay node N_2 as ($Y_{N1,N2}$) *:*

$$Y_{N1,N2} = Y_{N,N1}.H_{N1,N2} + n_{N1,N2}$$
(3.12)

So from one period to another, the relay nodes keep hoping the signal received from a previous relay node to the next relay node, until the data arrives at the last relay node (i.e. the cooperating node N_C) as:

$$Y_{NC-1,NC} = Y_{NC-2,NC-1}.H_{NC-1,NC} + n_{NC-1,NC}$$
(3.13)

Then at the final period, the cooperating node N_C detects and forwards the signal $Y_{NC-1,NC}$ to the Base Station B, as shown in equation *(3.19)*:

$$Y_{NC,B} = Y_{NC-1,NC} . H_{NC,B} + n_{NC,B}$$
(3.14)

Then the signal $Y_{NC,B}$ from the cooperating node N_C is then optimally combined with that from the source node $Y_{N,B}$, and then effectively detected.

At each relay node, and also at the cooperating terminal/node N_C, the appropriate cooperative communication technique(e.g. Coded)/protocol is applied to combat the effects of fading, shadowing, thus processing the signal to ensure that the signal can be detected efficiently.

For the **Coded hybrid relay-cooperative system**, at the first period as similarly described; the source/ transmitting node punctures its coded signal N_T(codeword) and sends its first part $NT1$ to the first relay node N_1, and the base station B. At the second period, the punctured codeword is de-punctured and decoded by the first relay N_1, and then re-encoded, punctured and sent again to the next relay node, N_2. So the source node's codeword $NT1$ is de-punctured, decoded and then re-encoded, by each relay node and then punctured and hopped from one relay node to another until the last relay node (the cooperating node N_C); which is assumed to have successfully decoded the $NT1_{NC-1,NC}$ parity bits from the previous relay node N_{C-1} using the Viterbi decoder. Then N_C sends the punctured (second) part $NT2_{NC,B}$ of the source node's codeword to the base station, where the codeword of the source node is de-punctured and then effectively combined.

For a **Coded hybrid relay-cooperative system** with more than one cooperative node (multi-cooperation); MRC is employed first by the base station, to combine all the several versions of the transmitted codeword $NT2$ from the cooperating nodes, to form one optimal second parity codeword of the source node's signal. Then the base station then carries out the de-puncturing and efficient detection using the hard decision viterbi decoder, in this case also, it must be pointed out that decoding was assumed to be successful at every cooperating user and the base station, thereby the CRC would need not to be implemented.

Table 1. Cooperative Wireless System Parameters

Modulation Scheme	QPSK	**FFT Size for OFDM**	64
Multiple Access Scheme	OFDMA	**Cyclic Prefix Size**	12
Fading Channel Model & Number of Taps	Rayleigh Frequency selective fading & 13Taps	**Data Frame Size**	128
Simulation Technique	Monte Carlo	**Target Bit Error Rate (BER)**	10^{-3}

Wireless System Figures of Merit

- ***Bit Error Rate (BER) -*** The *BER* was used as a measure of the performance of the systems analysed, therefore it is the figure of merit used to achieve one of the targets the Hybrid Cooperative Communication system. The *BER* indicates the probability of bit error P_b, or how many bits are in error for a given transmission, range of available energy, and channel conditions; therebyproviding a measure of the quality of data transfer.

Therefore;

$BER = Ne/Nb$

(3.15)

Where: Ne is the number of bit errors, and Nb is the number of bits transmitted

- ***Signal to Noise Power Ratio (SNR) -*** In harmony with the second key 'target' of this project work, which is **Energy Efficiency** described in Chapter1 of this thesis; the *SNR* isused as a measure of the energy (processing and transmission) consumed to achieve good quality communication at a target *BER*.

$SNR\ (dB) = E_b/N_0$

(3.16)

Where: E_b is the energy per transmitted bit, and N_0 is the noise spectral density, denotingthe noise power.

So in the simulations, the ratio of energy consumed in the transmission of a bit to the noise, provides the particular *SNR* or rather energy consumed. Therefore, the ***BER vs E_b/N_0*** curve is a standard in this work for analysing theperformance and overall energy consumption of each system model simulated.

Also, another figure of merit relating to energy efficiency is the **Energy Saved**, which is a measureof the overall amount of energy saved (*SNR*) to meet a target *BER* as more processing is done in thesystem:

$$Overall\ Energy\ Saved\ (dB) = E_P\ (dB) - E_P(dB) \qquad \textbf{(3.17)}$$

Where: E_P is the energy spent in processing, and E_{PER} is the reduced energy spent to achieve the new improved performance.

4. Results and Discussion

4.1 Performance (*BER*) Comparison of Cooperative MIMO techniques for the Hybrid Cooperative System

4.2

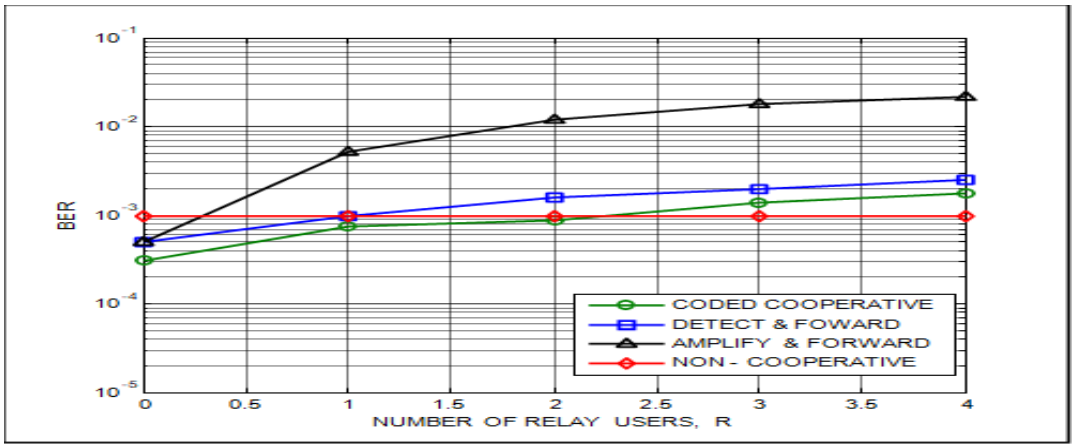

Figure 5. Performance (*BER*) Comparison of Cooperative MIMO techniques for the Hybrid Relay / Cooperative System having *R* Relay nodes, between the source node and cooperating node.

4.3 Energy Consumption Comparison of Cooperative MIMO techniques for the Hybrid Cooperative System

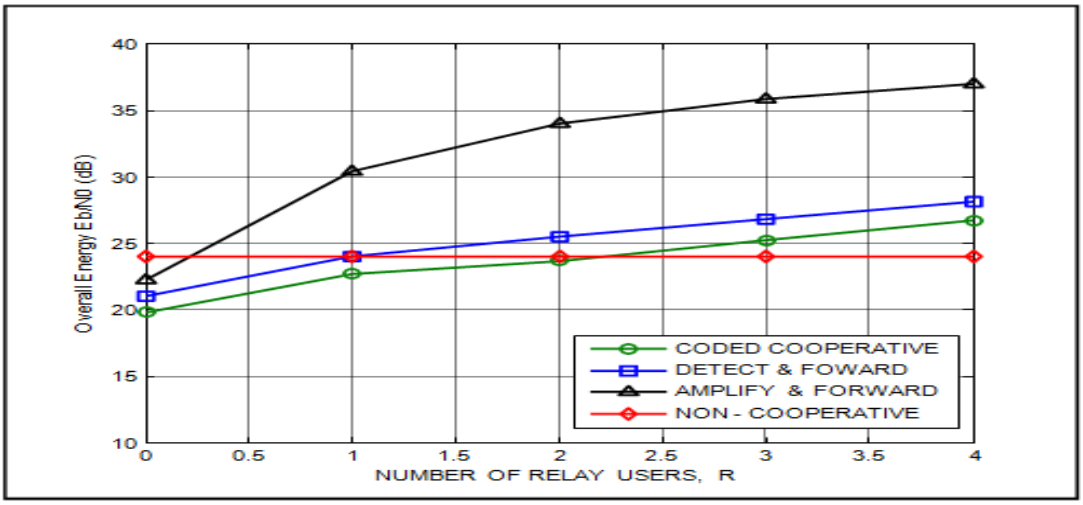

Figure 6. Overall Energy Consumption Comparison of Cooperative MIMO techniques for the Hybrid Relay / Cooperative System having *R* Relay nodes between the source(N) and cooperating node(Nc),where the inter – node and uplink channels have the same mean SNR (E_b/N_0).

As earlier described in the methodology, this Hybrid Cooperative Communication System is designed and analysed to investigate the performance and Energy Consumption of such a system and the output of each of the cooperative MIMO techniques in such a system. Here in Figures 5 and 6, more cooperative communications techniques (***Amplify and Forward (AF***), ***Decode and Forward (DF)*** and the ***Coded Cooperative System***) and are compared with respect to their Performance and Energy Consumption as against a non-cooperative wireless system. Where the relays nodes ($N_1 \ldots N_{c-1}$) and indicated as ***R***, the cooperative node(s) (***Nc***) as ***C***; and the Base/Control sink node or station as ***B.*** For this analysis, he nodes (i.e. Source, Relay and Cooperative) are also 'unpaired', and just one cooperating node (***Nc***) provides cooperation to the transmitting/source node (***N***); while the inter – node and uplinkchannels have the same mean SNR (E_b/N_0).

As shown in figure 5; the comparison in performance (*BER*) was made at a fixedSNR (E_b/N_0) of 24dB for the non – cooperative case that gives the target *BER* of 10^{-3}. As shown the cooperative systems show significant decline in performance as the number of relay nodes, increases ; this because the multi – hop protocol has the draw – back of loss of data integrity as the links gets longer (reduced end-end reliability), because the data received and then forwarded by a relay would be also contain more noise, thereby reducing performance. For the **Amplify& Forward** and **Detect & Forward** techniques; this is more evident because of their repetitive protocol, for the ***AF***, this is because each relay amplifies the signal received, thereby also amplifying more noise, while for the ***DF***; since each relay forwards the data it receives, so it forwards also erroneous bits, therefore reducing the performance of the system. The ***Coded*** cooperation on the other hand shows a better performance than the other two techniques because of the inherent error correcting ability of the channel code, but as the number of hops gets longer, performance degrades, as the number of erroneous bits can no longer be handled by the code. This again confirms that increased processing, and channel coding gives a boost to cooperation, as coded cooperation benefits from its error correcting ability of its code.

As shown in Figure 6; the comparison in overall (total) energy consumed by cooperation was made with the non – cooperative case at a fixed target *BER* of 10^{-3}. As shown the energy efficiency also reduces as the number of hops increases. This is due to the limitation of the multi – hop system, whereby data integrity reduces as the link gets longer, therefore, making the relay nodes need more energy to maintain link quality, henceforth leading to an overall increase in energyconsumption. As shown , the for the **Amplify & Forward** and **Detect & Forward**, show very low energy savings, due to the repetitive nature of their protocols as explained in the performance section above, so as loss of data integrity increases, they would need more energy to maintain a good performance. Furthermore, as shown in Figures 5 and 6; the ***AF*** and ***DF*** algorithms show acceptably good performances and energy savings when the number or relay users are at minimal values. Though small, but on a practically larger scale of many nodes, this incremental savings of energy and performance advantages can also be of very good use; as it has the advantage of lesser coding that accompany the ***coded*** system.

As indicated, the Coded Hybrid cooperative system will give a better performance in terrains where there tends to be signal distortions, which will enable a more intelligent monitoring and management of water resources for effective agricultural processes. As shown, the **coded cooperative** having the advantage of the error correcting ability of the code, is the most energy efficient of the three techniques, though also nor being very energy efficient as the number of relay hops increases, thus the diversity gain and also the coding gain is reduced, as typical of sensor nodes as also confirmed by other research work that simulated output results for the two wireless sensors differed as the number of nodes increased; when there were more nodes, the packet loss ratio increased, and the throughput decreased (Malik, et al., 2020). So also, this system's performance and energy efficiency reduces as the number of relayhops increases, though the cooperating node tries to improve the performance and energy efficiency.

For the integrated algorithm approach, this extra simplification provided by the ***AF*** and ***DF*** for minimal number of relays and also shorter hops, can be put to use by developing an integrated system that incorporates ***AF*** and ***DF*** schemes for specific hops and then the ***coded*** algorithm for specific longer hops, to ensure that a tradeoff between simplicity and cost is achieved by ensuring the whole network of nodes operates optimally and at minimal energy consumed with the use of different MIMO schemes/techniques at different hops and linkages. Therefore, it can be deduced that the hybrid relay / cooperative system can also be profitable, meeting performance targets and also being energy efficient and environmentally friendly; by ensuring a coded cooperation technique or a technique with channel coding is used, using short relay hops between source(s) and cooperating nodes(s), lesser hardware and power consumption. Channel variations are a major issue in practical wireless systems, and so this makes efficient power control schemes for cooperative communications a key factor of practical importance (Nishimura, Ohgane, and Saito, 2009; Cai, Pan, Yang, 2006). Also, the possession of geographical data (as needed in an agricultural setting) would serve well in this case, thereby using the short and even possibly longer relay hops to route the data from the source to the cooperating node via energy efficient routing algorithms, since the position of the best cooperating node as well, as other nodes would be known. As also in previous researches (Mafutaa, Zennarob, Bagulac, 2012) a typical WSN agricultural system as demonstrated can be the implementation of an Irrigation Management System based on WSN, which incorporates a remote monitoring mechanism via a GPRS modem to report soil temperature, soil moisture, WSN link performance and PV power levels. Sensor network and other (Hussain, Sahgal, Mishra, Sharma, 2012) agricultural techniques might also help them to store and utilize the rain water, increase their crop productivity, reduce the cost for cultivation and make use of real time values instead of depending just on prediction. Furthermore, previous research (Vora, Tiwari, Singh, 2015) also proposed a complete agricultural solution for the farmer based on Wireless Sensor Networks and GSM technology. The data acquired about environmental factors of the field is transmitted to the farmer enabling him to control the actuators in the field. As also described by previous research works, the sensor/node data uploaded to the internet using the data logging unit can be accessed from both personal computers (PCs) and mobile phones (Dube, 2013).

4.4 Analysis of the Hybrid Cooperative Wireless System and number of Cooperating Nodes

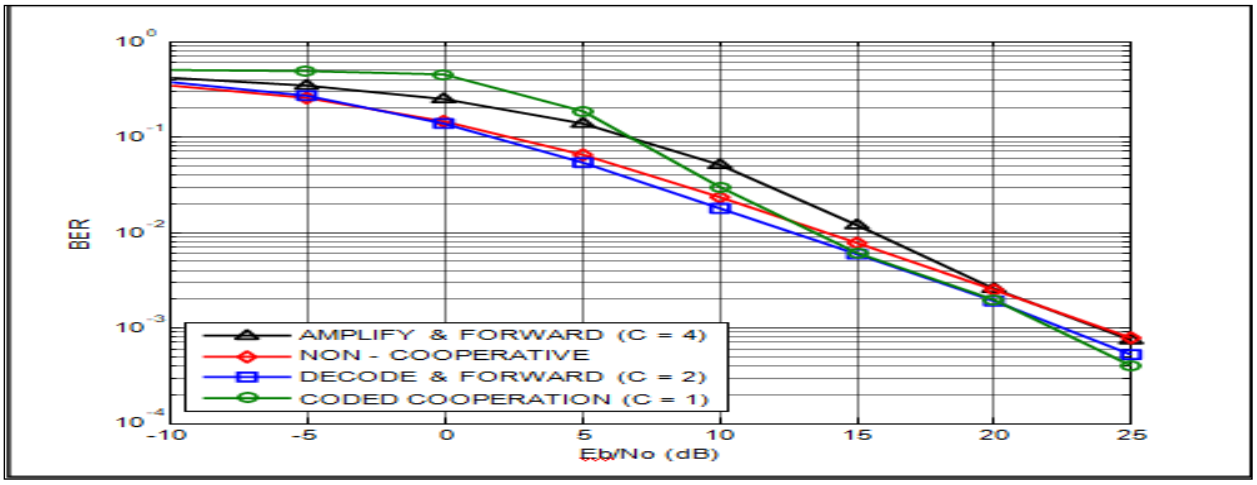

Figure 7: Cooperative MIMO techniques for the Hybrid Relay / Cooperative System and having one Relay, ***($N_1 \ldots N_{c-1} = R = 1$)*** and number of Cooperating nodes ***($Nc = C$)***; where the inter – node and uplink channels have the same mean SNR (E_b / N_0).

The Hybrid Cooperative system is analysed as shown in Figure 7, with respect to number of cooperating users, with the intent to investigate how the system Performance and Energy Efficiency varies with respect to each of the cooperative MIMO techniques.

As shown in figure 7, the nodes are also 'unpaired'; and each cooperative MIMO technique is shown with the amount of cooperating nodes ***(Nc =C)***, each technique needs to achieve at least the performance of the non – cooperative case. Also shown by the *BER* values, the **performance** of this system improves as the number of cooperating nodes to the source, and the relay increases; this is so, because as diversity, better signal integrity increases; there would be fewer errors at the receiver(s). Furthermore, the minimum number of cooperating users ***(Nc =C)***, in relation to the amount of relay nodes differs with respect to the cooperative MIMO technique, due to each technique's protocol as earlierexplained.

Also, as shown in figure 7 at a target *BER* of 10^{-3}; **energy efficiency** improves for each cooperative technique as the number of cooperating nodes' increases; this as earlier pointed out is due to more processing by more nodes, reduced errors, and more diversity, thereby reducing the overall energy consumption of the system. Furthermore, as management of resources is also a key potential of this system; each technique is shown to require a minimum amount of cooperating users to be added to a minimum amount of relay nodes (one in this case), to provide at least a performance as good as the non – cooperative system, and saving a sizeable amount

of energy.

Therefore, from this basic analysis, based on the target BER; the cooperative techniques would require the following least amount of cooperating nodes to meet the set target Performance and Energy threshold:

- Coded cooperation - $Nc = C \geq R$
- Detect & Forward - $Nc = C \geq R + 1$
- Amplify & Forward - $Nc = C \geq R + 3$

Where, $R = 1$; is the minimum number of relay nodes $[(N_1 \ldots N_{c-1}) = R]$, and $(Nc = C)$ is the minimum number ofcooperating nodes.

Also, as shown is that as the number of cooperating users are increased or made larger than the number of relays, the performance and energy efficiency improves for each technique, though each technique would require a unique criterion for the minimum number of cooperating users needed. This hybrid system can also have the potential of providing effective management of resources, because any relay while acting as a multi – hop link between a source and a cooperating user, can simultaneously be a cooperating user to another source, thereby maximizing system resources. Additionally, as a typical WSN wireless network, based on the network connectivity, the power consumed in the network can also be computed or also estimated and then can be predicted. As shown by other research works (Kamarudin, Ahmad, Ndzi, Zakaria, Ong, Kamarudin, 2012) WSN nodes have three energy consumptions states: sleep, transmit and receive; but for this research work, the focus here is transmitting/transmission wireless power.

The hybrid relay / cooperative system mitigates loss of data integrity associated with a repetitive multi – hop system (which has also been shown to be less energy efficient as the number of relays became larger than the number of cooperating users for all cooperative MIMO techniques). Additionally, the coded cooperative technique of the Hybrid/Relay cooperative system was shown to be the best in terms of performance and energy efficiency,and for even further improvement of the coded cooperative technique, the use of more robust coding schemes like turbo codes, overlay block – fading codes could be implemented to improve performance (Hadayat, Hunter, & Nosratinia, 2004; Cover & Gamal, 1979; Erkip & Stefanov, 2004) over the RCPC codes as used in this research work.

Furthermore, from the comparative analysis results of the three Hybrid/Relay cooperative MIMO techniques; further increased performance and energy efficient cooperative communications could be achieved by using cooperative technique(s) that involve channel coding (maintaining quality signal strength and performance is regardless of the conditions of the wireless channel); pairing between users, appropriate relay assignment scheme(s), and possibly more cooperating users for greater cooperative diversity gain.

5. Limitations and Recommendations of Study

The cooperative hybrid/relay wireless system; the code rate of the RCPC codes can be made more flexible by dividing the frames into more sub frames, and thereby adjusting the sizes of the frames for much improves performance and energy efficiency, especially in a multi –user system (Hunter & Nosratinia, 2004). Furthermore, pairing and the issue of partner assignment was not implemented in this work; it is an issue in multi – user systems, and can be effectively implemented by using effective algorithms or schemes that give optimal or near optimal performance by efficient choice of partners in a multi – user environment making the base station able to treat all nodes fairly, based on the knowledge it has of all the channels between nodes.

Also, this work was done on the basis of equal transmit power of wireless sensor nodes; but it can be taken furtherby implementing an adaptive power control mechanism, that varies as nodes' transmit power basedon the instantaneous channel (inter – user and uplink) conditions; in this way much more energy efficiency and improved performance would be achieved. Additionally, as it's also known that the range of battery-operated wireless sensor devices is limited; so, multi-hop communication is also very useful in sending data to control or base station (Bendigeri & Mallapur, 2015).

Tests on the cooperative MIMO techniques can also be done on a variety of environments, which do possess unique channel characteristics; in this way much more developments in the cooperative MIMO techniques as well as improving each techniques' performance with reference to unique wireless environments shall be obtained.

This hybrid relay / cooperative system can be further investigated, with energyand performance efficient routing protocols developed, so as to 'unlock' the potentials of this system. This system promises efficient resource management, effective geographically based communications, improved performance and energy efficiency, and other potentials which may notbe fully known at this stage.

6. Conclusions

Agriculture is the primary source of income for three out of every four people on the planet who are living in poverty, and it is crucial for food security and economic development in developing countries. Therefore, innovative concerns and measures must be used in agricultural water management and practices for both field and system in order to decrease water scarcity, increase environmental friendliness and societal welfare, and thereby increase food production.

Datasets from trustworthy and recognized data stores, portals, and sources were used for this study's research work, analyses, demonstrations and investigations; as a result, it may be assumed that the datasets are reliable and credible.

Cooperative communications has been shown in this work to improve performance in terms of *BER* and also energy efficiency by saving a good amount of total energy (for similar channel conditions), thereby reducing the overall (total) energy consumption of the system, compared to a non – cooperative system. Therefore, the trade – offs in performance and transmit power is confirmed; because, having more wireless nodes cooperating would mean more processing at each node leading to better performance, though this would arguably mean more node power for processing; but each node would transmit with a reduced energy to maintain network quality, thereby reducing the net energy consumption of a cooperative system. Analysis of the Hybrid/Relay cooperative communications system, showed useful potentials and benefits in terms of performance and energy efficiency and thus is a key technology needed to further improve wireless communications, which will be very useful in the intelligent and technologically driven management of water resources for effective agriculture; by ensuring that useful information on weather, soil, environment, crop, demographics, water sources and water related and irrigation information and data can be accessed, transmitted in real time and used to analyse, monitor, manage and implement timely actions and policies that would further optimize the water agriculture and food nexus for the great good of society.

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Minimization of Waste in Printing Sector of Pharmaceutical Industry Using Lean Manufacturing Tools[1]

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Abstract

Lean manufacturing helps to reduce (eliminate) all t ypes of waste. Keeping the inventory high causes you to dump too much money. Also if you don't have the systematic approach will lead to an inventory ocean.

Throughout the world lean concept and lean applications has been used not only in the manufacturing sector but also in pharmaceutical industry. Few of the Pakistani industries also initiated lean Manufacturing Projects; N UROB lOTlCS 1NDUSTRY was also interested to cut its waste down.

NUROBlOTICS lN DUSTR Y also face the problems of waste management so we are using different techniques and tools to reach out the causes of the problems which was identified as wastages of materials. We use PDCA, VSM and SMED as our lean manufacturing tcinls to reduce waste as the results are given in chapter 4 and 5 the percentage of the waste is reduce from 7°/c to 3°/c as our improve in the project

Keywords: lean manufacturing, waste

Introduction

Nutrabiotics Nutritional life science Pakistan was incorporated as a private limited Company in 2012. From the very beginning . Nutrabiotics embarked on a relentless pursuit of excellence lead by its visionary CEO. Leading from the front, he developed a culture of commitments, fierce competitive and distinction in every area of the company operation.

The printing sector of the Nutrabiotics has been working to provide the printing materials to their direct customers NUTRABIOTICS Nutritional life.

[1] **Outline**
This project is about the analysis of waste material (paper) production in a printing sector of pharmaceutical industry (NUTRABIOTICS). The main aim of the project is to work on the smooth production of the printing sector and increased efficiency by eliminating the waste from the production system using (LEAN MANUFACTURING).

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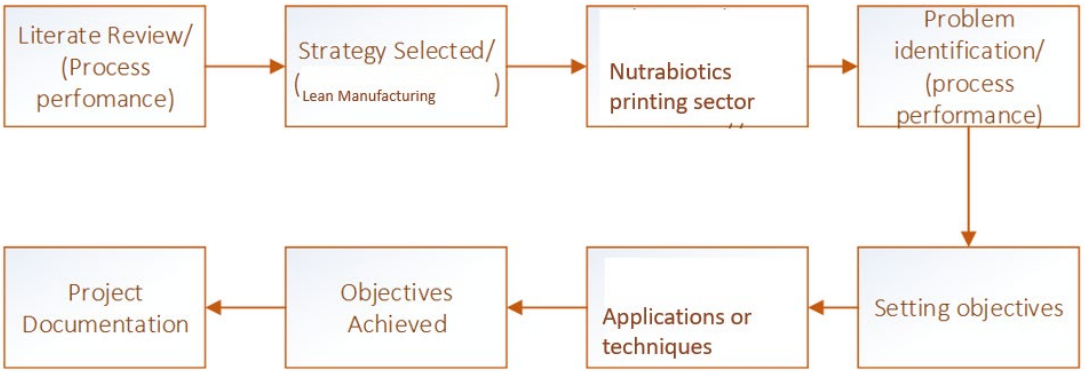
Methodology



What is Lean Manufacturing?

Lean, also denoted to as Lean Management, Lean Manufacturing (LM), Lean Enterprise, or Lean Production, is a set of principles, tools and techniques that many industrial organizations or companies opt to implement, in order to enhance the efficiency of production and overall customer value while at the same time eliminating waste (Mwacharo, 2013).

Lean is generally used in manufacturing and supply chain management but it is a philosophy that can be applied to an entire industry organization (Mwacharo, 2013).

LEAN MANUFACTURING TOOLS TO BE USED:

- PDCA (PLAN DO CHECK ACT)
- FIVE WHYs

What is PDCA ?

The Plan-do-check-act cycle is a four-step model for carrying out change. Just as a circle has no end, the PDCA cycle should be repeated again and again for continuous improvement . The PDCA cycle is considered a project planning tool.

The four steps of PDCA cycle .

Fig. 1. PDCA Cycle Diagram

Why PLAN DO CHECK ACT procedure ?

It provides a simple and effective approach for solving problems and managing change. The model is useful for testing improvement measures on a small scale before updating procedures and working practices.

Moreover , our project was based on reducing different types of wastes from processing system of so that we can improve the waste by only doing just incremental changes into the wastes.

There were no other manufacturing tools which could specifically work on the wastes in the product or material.

Problem Statement

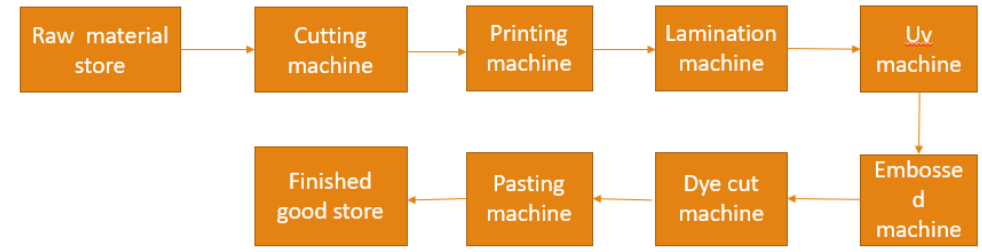
As the project is about minimization of paper waste in printing sector of our industry so it was noted that during the offset printing section about 6 - 7% of paper is wasted during the production of boxes and some the other problem identified will be discussed using the lean manufacturing tools

1. Using different lean manufacturing tools in order to reduce waste from the processing system from different aspects
2. To improve the efficiency of the production system

OBJECTIVES

1. Using different lean manufacturing tools in order to reduce waste from the processing system from different aspects
2. To improve the efficiency of the production system

PROCESS FLOW CHART



Data Collection

According to the PLAN act of PDCA its mandatory to mention the problem statement first . So, the problem statement is , what is the problem with the process flow of the industry? And it came out to be the WASTAGE of the paper which is about 6 to 7% approximately.

Now, the main challenge was reducing the wastages from the different processes from the processing system and for that the working begin with the DO ACT.

PLAN ACT

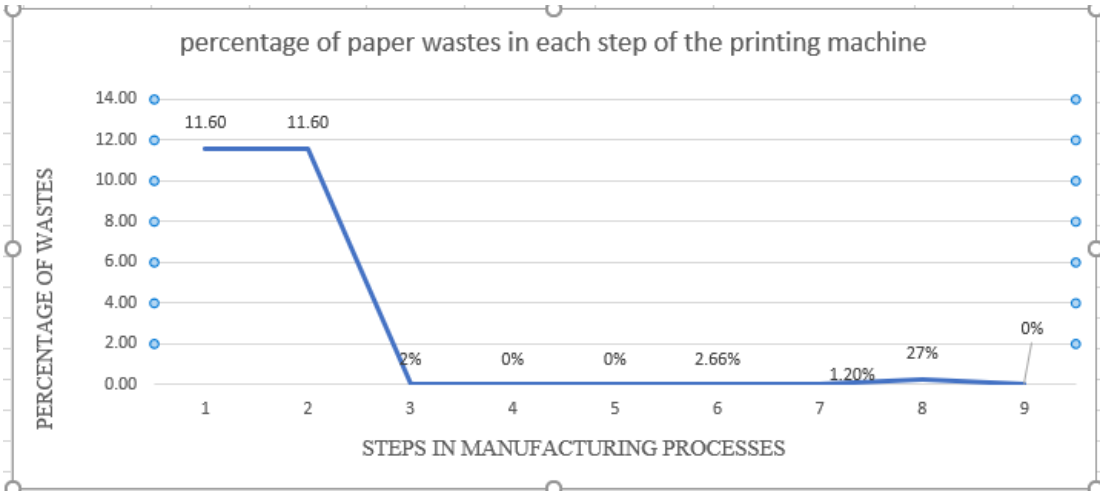
According to the PLAN act of the three main steps were mandatory to follow;

Table 1. Percentage of Waste in Weight and Paper Per Day in Every Step of the Printing Process

Problem statement	The waste is about 6 -7% in the printing sector in the material
Problem analysis	Going through every step of the printing sector and calculating waste in every step
Developing an experiment	Then developing an experiment by engineering knowledge by calculating batch number, lengths, weights, percentages and weights d

Table 2. The Steps Followed in the Plan Step for Data Collection

	Weight (g)	Percentage (%)
Paper cutting process	360000000	11.6
Color printing	27000	2
Lamination process	0	0
UV process	0	0
Embossed	36000	2.66
Die cutting embossed	13800	1.20
Breaking	18500	27
Pasting process	0	0



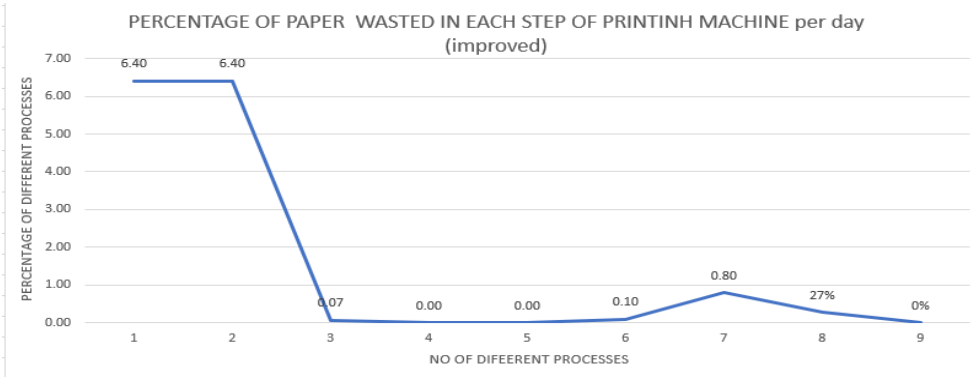
DO ACT

Table 3 steps in do act for data analysis

PROPOSED SOLUTION	Removing waste from every process by increasing batch number and keeping number of pages wasted the same. By changing dimensions and cutting methods.
APPLICATION	Comparatively less expensive to other lean manufacturing tools
CHANGES	The waste reduced to 3 to 4 %

Table 4. Improvement Percentage of Waste in Weight And Paper Per Day in Every Step of the Printing Process

	Weight (g)	Percentage (%)
Paper cutting process	360000000	6.40
Color printing	27000	0.07
Lamination process	0	0
UV process	0	0
Embossed	36000	0.10
Die cutting embossed	13800	0.80
Breaking	18500	27
Pasting process	0	0



CHECT ACT

Did the implementation of the change achieve the desired results?	**YES It achieved the desire results by bringing down the waste from 6% to 4%**
What was learned from the implementation?	That the result is applicable and changes are practical
Is there enough data to show that the change was effective?	Yes there is enough data to show the changes by making improvements in every step of the printing process
Do you need to run another experiment?	Yes after running the first cycle of PDCA another cycle can be run to make further improvements
How does the small scale experiment measure up to the larger picture?	Wastage problems are common in every industry and using lean manufacturing tool changes can be made easily and in economically feasible way
Is the proposed solution still viable and practical?	Yes it is practical

ACT STEP

For act step we adopted the 5 WHYS methods . The reason for adopting this method was to find the root causes of the waste and It ended up telling us the following things.

WHY 1 There is 6 -7 % of waste of paper ?

Because the labors are not skilled

WHY 2 Why the labors are not skilled ?

Because they are not being properly trained by the management

WHY 3 The management has not trained them properly ?

Because the management is not educated

WHY 4 The management is not educated ?

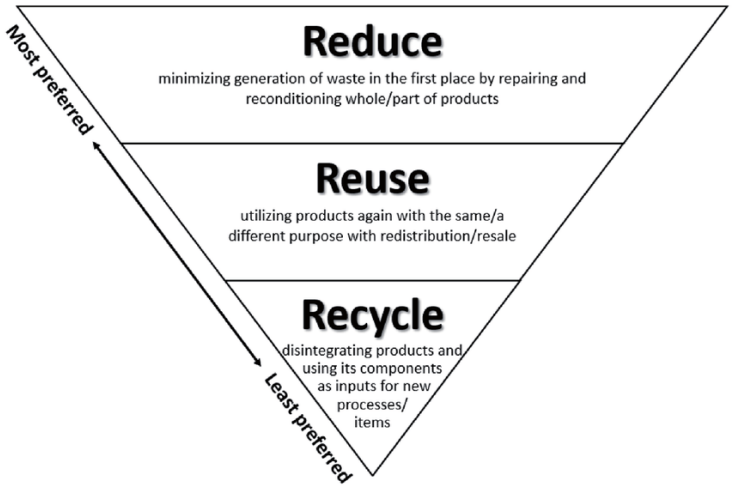
Because the company has not hired proper staff and management.

WHY 5 The company has not hired proper management and staff?

Because they don't think it as a important factor of development

SUSTAINABILITY

- From 2010 to 2060, the global consumption of pulp and paper is expected to double. The same will the amount of paper waste. An increased paper production will also add further to the pressure on the world's forests that are already in a critical state - and constantly getting worse.
- From 2001 to 2019, a total of 386 million hectares of forest were lost globally (in all forest types combined). This loss represents an almost 10 % decrease in tree cover since 2000.
- The main aim of reducing paper waste is to promote the concept of clean and green environment.
- Paper wastes and paper products results in cutting of trees which can effect the environment badly.
- To work on sustainable eco system its necessary to work on eco printing .Its also necessary to work on the 3R method to recycle the paper.



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The use of Satellite Data in the Detection of Radioactive Fallout on the Territory of Azerbaijan

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Abstract

In the event of possible accidents at nuclear power plants, there is a huge release of radioactive substances into the environment in the form of indivisible particles. As a result of falling out in the form of radioactive fallout during the transboundary mass transfer of these substances over vast distances on the territory of neighboring states. The formation of precipitation over a given area is primarily determined by the moisture content, relative humidity of the air, the conditions of its ascent and evaporation in air masses of various origins, which, under certain circulation conditions, become potentially precipitation-forming. For operational monitoring of environmental pollution studies, it is necessary to use modern methods and means of remote sensing of the earth. This is an integral part of the detection of radioactive waste using low-orbit satellites using synthetic aperture as the basis for research.

Keywords: Radionuclides, radioactivity, radioactive fallout, turbulence, cloudiness, IAEA, low orbit satellites

Introduction

Radioactive fallout (r.o.) - radioactive substances falling from the atmosphere to the earth's surface together with rain or snow precipitation or in dry form (dry fallout). R.o. gain always observed after tests of nuclear weapons, especially after tests in the atmosphere and on the surface of the Earth, as well as during nuclear accidents at military and power reactors (Ecological encyclopedic dictionary, 2002).

When cloud elements become so heavy that resistance and upward movement of air can no longer hold them in suspension, they fall out of the cloud as precipitation. Drops can become larger

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as a result of their mutual merging. If the drops are charged with opposite electric charges, then this favors merging. The difference in droplet sizes is also of great importance. With different sizes, they fall at different speeds and therefore more easily collide with each other. Collisions of drops are also facilitated by turbulence (Khromov & Petrosyants, 2001).

Turbulence is a phenomenon observed in many flows of liquids and gases, which consists in the fact that numerous vortices of various sizes are formed in these flows, as a result of which their hydrodynamic and thermodynamic characteristics (velocity, temperature, pressure, density) experience chaotic fluctuations and therefore change from point to point. point and in time irregularly (https://www.booksite.ru/fulltext/1/001/008/112/898.htm).

This is facilitated by the magnitude of the total radiation, which is quite noticeably and steadily growing, starting from the lower to the high mountain zones. Thus, the nature of the vertical zonality for the summer and winter periods is quite significantly different from each other. This is explained by the climatic features of these seasons and, first of all, by the regime and vertical zoning of cloudiness and precipitation (Shikhlinsky, 1960).

The radioactivity of precipitation is due to the capture of radioactive aerosols and gases from the atmospheric air by particles of clouds and precipitation. In addition, the sediment water itself contains radioactive 3H atoms. A distinction is made between natural and artificial aerosols, which are caused by the washing out of the atmosphere, respectively, of natural and artificial aerosols and gases. The highest level of radioactivity falls on short-lived decay products of 222Rn: 218Po (RaA), 214Pb (RaB), 214Bi (RaC), 214Po (RaC') (https://www.booksite.ru/fulltext/1/001/008/094/881.htm)

According to the Safety Glossary of the International Atomic Energy Agency (IAEA), environmental monitoring means the measurement of external dose rates from sources in the environment or concentrations of radionuclides in environmental media (ie air, soil and water). The results of these measurements are used to assess the radiation hazard and the doses received or potentially received as a result of exposure (https://documents1.worldbank.org/curated/en/219301594880509884/pdf/Strengthening-Hydromet-and-Early-Warning-Services-in-Belarus-A-Road-Map.pdf)

The nature of the radiation impact on the population during an accident at a nuclear power plant depends on the composition of radioactive products released into the environment. In the general case, in the event of a nuclear reactor accident, practically all radionuclides generated in

the core before the accident can potentially enter the environment (Styro, Nedvetskaite, and Filistovich, 1992).

According to the law of the Republic of Azerbaijan on the protection of atmospheric air in case of trans boundary pollution of atmospheric air of the last one country as a result of the spread of harmful substances, the source of which is located on the territory of another state, as well as the implementation of measures to protect the population in emergency situations that pose a threat to human life and health as a result of atmospheric air pollution requires the use of methods and means of continuous monitoring (Zeynalov, 2020).

The Metsamor Nuclear Power Plant (NPP), built on the territory of Armenia, poses a particular threat to the radiation safety of the territory of Azerbaijan. The Armenian NPP is a nuclear power plant built during the Soviet era on the territory of the Armenian SSR near the city Metsamor. It consists of two power units with VVER-440 type reactors. The installed thermal capacity of one unit is 1375 MW, the electrical capacity is 407.5 MW. The average annual production of electricity, depending on the duration of repair campaigns, at nuclear power plants ranges from 2.3-2.5 billion kWh.

Initially, the European Union insisted on the conservation or modernization of nuclear power plants and was ready to allocate 200 million euros for this free of charge (negotiations between Euro atom and the Ministry of Energy of Armenia, 2007). However, the Union later admitted that the station "cannot be improved so that it fully complies with international safety requirements" and set a condition for its closure. The problem is only in finding alternative sources of energy and determining the timing of the closure of the station. The solution to the problem could be the construction of a new nuclear power plant, the cost of which, according to some estimates, will be 5 billion dollars (https://ru.wikipedia.org/wiki/Армянская_АЭС).

The possibility of using radar tools for monitoring energy facilities is based on the fact that the appearance of a man-made release in the lower layers of the atmosphere leads to a change in the physical parameters of the radio wave propagation medium, which creates a radar contrast and makes it possible to detect atmospheric inhomogeneity (https://cyberleninka.ru/article/n/distantsionnyy-radiolokatsionnyy-kontrol-radioaktivnyh-vybrosov-v-atmosferu/viewer).

The principle of operation of a pulsed incoherent radar is that the electromagnetic energy of the microwave range of radio waves is emitted in the form of short-term pulses (τ = 1-2 μs) of a large, over 100 kW, power. The pulses are emitted by a narrowly directed parabolic antenna,

which focuses electromagnetic radiation into a very narrow radio beam with a beam width, as a rule, not more than 0.5^0.

When the impulse meets a target on its way, part of its energy is scattered towards the receiver, which is located next to the transmitter and works together with it on one antenna. The received signal, or radio echo, is very weak compared to the transmitted pulse, because the wave is attenuated in proportion to the square of the distance traveled, and the target reflects only a small fraction of the incoming wave.

In electronic meteorology, a fundamental concept is generally accepted - radar reflectivity Z (the ability of a meteorological target to reflect a radio wave), which is measured in mm^6 / m^3:

$$Z = \sum_{i=1}^{n} d_i^6 \left|\frac{(m_i^2-1)}{(m_i^2+2)}\right|^2, \quad (1)$$

m is the refractive index of radio waves; d_i is the diameter of the 1-th particle; n is the concentration of cloud particles (Gorbatenko, Slutsky, Bychkova, 2007).

Weather radar (in the English literature, the term radar is used, from Radio Detection) is designed to detect cloud fields and zones of precipitation, thunderstorms and hail foci in the clouds.

The main radar energy characteristic of the scattering of electromagnetic waves (EMW) by targets concentrated in space is the effective scattering area (ESR). It should be taken into account that many characteristics are used to describe the field reflected from objects of a complex shape.

The EPR is a complex function of many variables: the viewing angles in the vertical and horizontal planes, the wavelength, or the direction of the field polarization. Using a single-position radar, it is possible to measure the following main statistical characteristics of the EPR of meteorological objects: correlation function and spectral density; distribution density and its moments: structural function and spectral density (in the presence of non-stationary of meteorological objects); spatiotemporal scattering function.

As parameters of the calculation formulas, the RCS values for small-sized bodies, radar reflectivity or the effective scattering area per unit volume of volume-distributed targets and the radar reflectivity Z functionally related to it, which characterizes the scattering properties of clouds, precipitation and is measured experimentally in meteorological radars, can be used. The parameter Z does not depend on the operating frequency of the radar and any other parameters of the radar, on the contrary, the volumetric and concentrated EPR depends on the frequency [12].

Outlier detection requires careful analysis, availability of a priori information about the meteorological situation in the NPP area, coherent processing of echo signals with a long accumulation time (up to several tens of seconds). RCS increments due to the radioactivity of the release can be established using a multi-frequency, multi-band signal and analysis of its correlation-spectral characteristics. The values of the theoretical estimate of the RCS of the release under different conditions can differ up to 100 dB.

One of authors developed a model for theoretical estimation of r.o. while explosion at NPP. The modelling includes radial equation for r.o. expansion from the explosion epicenter. In stationary case when it's suggested that r.o. fully fall onto the earth's surface one gets law.

$$\theta = \sqrt{C_1 - C_2\, lnr} \qquad (2)$$

So, it means that intensity of radioactive pollution of territory while explosion reduces by logarithmic law. Herein, θ - certain function of radioactive substance concentration which needed to be calculated, r is the distance from the epicenter. The function θ expresses the increment of radioactive concentration in atmosphere over the nominal value due to diffusion process.

The advantage of the considered algorithm in solving the problem of radar detection of NPP emissions lies in the possibility of prompt comparison of field measurements data with theoretical estimates, taking into account specific changing conditions (https://cyberleninka.ru/article/n/algoritmy-rascheta-radiolokatsionnyh-harakteristik-radioaktivnyh-vybrosov-v-atmosferu/viewer).

Conclusion

The paper reveals the main patterns in the formation of the formation of radioactive fallout as a result of possible accidents at nuclear power plants. Some of which are moisture content, components of the radiation balance, as well as climate-forming factors.

This, in turn, creates the main problem in developing a methodology for operational monitoring of the detection of radioactive types of pollution using modern methods and means of remote sensing of the earth from space.

What is an integral part in the detection of the latter using a synthetic aperture installed on low-orbit satellites, since they determine the main types and methods for detecting the latter in the environment.

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Recognition and Classification of Vegetable Types in Agricultural Areas Using the Mobilenet Model Structure

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Abstract

Deep learning method is a method that provides superior success in detecting and classifying objects in an image. In this method, an algorithm is generally used that distinguishes objects in complex images. Convolutional neural networks (CNN), especially used in deep learning, are an important research topic in computer-aided recognition and are used in many areas. In recent years, recognition and classification have been made in the agricultural area, as in many areas. Especially with the introduction of special robotic applications into the agricultural area, it is ensured that the workforce and loss in agricultural activities are reduced. Deep learning methods used in advanced robotic applications help to collect objects efficiently by distinguishing them from each other.

In this study, a vegetable recognition and classification system are proposed to support special robotic systems used in agriculture. In this application, the MobileNet model structure, which was previously accepted in the literature, was used. In this model, recognition and classification were made using a data set containing 4 different types of vegetables. According to the evaluation results, it was seen that the vegetable types in the data set were classified correctly with a high success rate.

Keywords: Deep Learning, Convolutional Neural Network, Mobilenet, Vegetable Recognition and Classification.

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1. INTRODUCTION

Computer vision-based methods, which have become popular with the developing technology, are used extensively in various fields (Hameed, Chai, & Rassau, 2018; Ukwuoma, Zhiguang, Bin Heyat, Ali, Almaspoor & Monday, 2022). Deep learning methods, one of the computer vision-based methods, have shown superior success in the field of object recognition and classification in recent years. Convolutional neural networks, especially used in deep learning methods, have an important place in the field of object recognition and classification. Object recognition and classification have also been used in agricultural areas in recent years and have made significant progress in many agricultural applications (Rocha, Hauagge, Wainer & Goldenstein, 2010; Özgür & Nar, 2019). Recognition and classification of vegetables in agricultural areas can help many traditional practices (Zawbaa, Hazman, Abbass & Hassanien, 2014). Zhang In recent years, many computer vision methods have been proposed for object recognition and classification in agricultural areas.

In a study by Zhang et al., a classification model that can recognize 18 different types of fruit was proposed and a classification success accuracy of 89.1% was achieved (Li, Li, Zhu & Yue, 2020). Zawbaa et al. proposed a machine learning technique that classifies three different types of fruit using the Random Forest algorithm and obtained successful results (Zawbaa, Hazman, Abbass & Hassanien, 2014). Zhang et al. proposed a method to classify 18 fruit species based on biogeography-based optimization and a feed-forward neural network. In the proposed method, they reached 89.11% classification success accuracy (Zhang, Phillips, Wang, Ji, Yang & Wu, 2016). Li et al. proposed a deep learning-based vegetable recognition and classification model and obtained a recognition accuracy of 96.5% (Li, Li, Zhu & Yue, 2020). In the study conducted by Duth and Jayasimha, they recognized the vegetables consisting of 24 different species with a rate of 95.50% using the deep learning method (Duth & Jayasimha, 2020). Yuesheng et al. used the optimized GoogLeNet model architecture to classify fruits and vegetables and

achieved 98.82% success accuracy (Yuesheng, Jian, Fuxiang, Yang, Xiang, Peng, Zhengtao & Shengqiao, 2021).

In this study, an application that recognizes and classifies 4 different vegetables (cauliflower, eggplant, pepper green, and tomato) in agricultural areas is proposed by choosing the MobileNet model structure, which has shown significant progress in deep learning methods. For training and testing of the proposed deep learning model structure, vegetable recognition using cauliflower, eggplant, pepper green, and tomato datasets included in "Fruits 360 dataset: A dataset of images containing fruits and vegetables" (Kaggle, 2022; Mureşan & Oltean, 2017) and classification was performed.

2. Material and Method

2.1. System configuration

In the study, a deep learning application was applied to support specially produced robotic systems for the recognition and classification of vegetables grown in agricultural areas. Python programming language was used to train, test, and analyze the preferred MobileNet model structure for the implementation of the application, and it was run in the Google Colaboratory (Colab, 2022) environment.

2.2. Acquisition of image data

A dataset consisting of 936 Cauliflower, 624 Eggplant, 592 Pepper Green, and 984 Tomato images was used to recognize and classify 4 different types of vegetables discussed in the study (Kaggle, 2022; Mureşan & Oltean, 2017). The images of the vegetable types discussed in the study are shown in Figure 1.

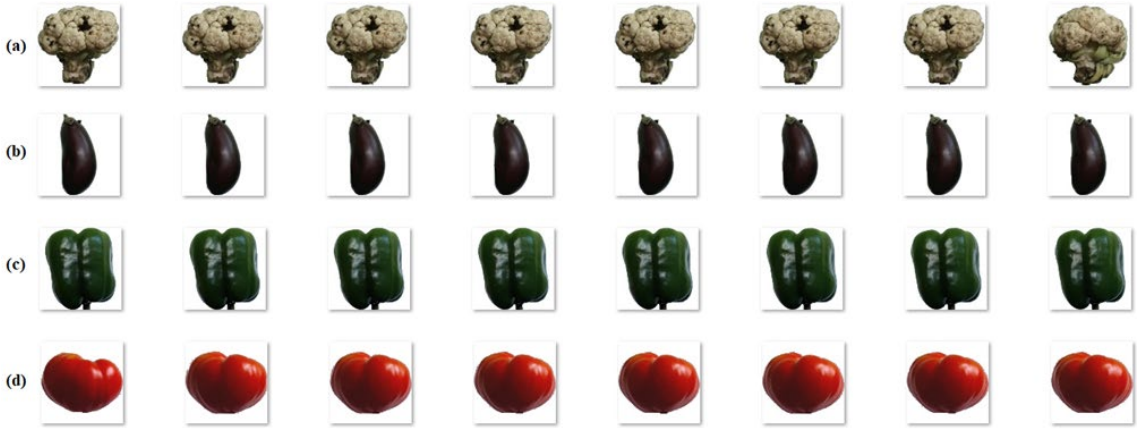

Figure 1. Dataset images of vegetable types (a) Cauliflower, (b) Eggplant, (c) Pepper Green (d) Tomato

2.3. Training and testing of the MobileNet model structure

In the study, the MobileNet (Howard, Zhu, Chen, Kalenichenko, Wang, Weyand, & Adam, 2017). model structure, which has shown outstanding success in the field of object recognition and classification in recent years, was used. For the training and testing of the model structure, a vegetable data set consisting of 4 different types was used. 2352 images in the data set are reserved for model training, and 784 images are reserved for model testing. Vegetable images reserved for training and test data were used for training the model structure. In Table 1, the number of images of 4 different types of vegetables used in the model structure is given in detail.

Table 1. Number of images of the vegetable dataset

Vegetable Dataset	**Training**	**Test**	**Total**
Cauliflower	702	234	936
Eggplant	468	156	624
Pepper Green	444	148	592
Tomato	738	246	984
Total	2352	784	**3136**

3. RESULTS

In the study, the MobileNet model structure was trained using the vegetable images reserved for training and test data. The success graphs obtained as a result of training the model structure are shown in Figure 2. In addition, the success results of the vegetable images obtained in the model structure are given in Table 2 in detail. When the success results were examined, it was seen that the MobileNet model structure classified 4 different vegetable types with a success accuracy of 97.19% and a loss rate of 0.2441.

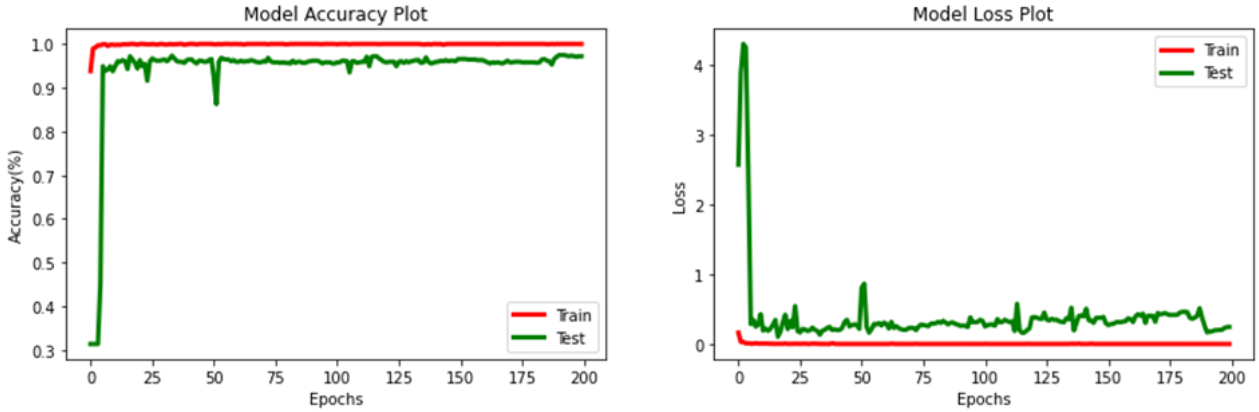

Figure 2. Graphs of change during training of the model structure (a) accuracy (b) loss

Table 2. Success results from the model structure.

	Precision	Recall	f1-score	Support
Cauliflower	0.98	1.00	0.99	234
Eggplant	1.00	0.86	0.92	156
Pepper Green	0.89	1.00	0.94	148
Tomato	1.00	1.00	1.00	246
Accuracy			0.97	784
macro avg	0.97	0.96	0.96	784
weighted avg	0.97	0.97	0.97	784

In addition, the classification success of the MobileNet model structure discussed in the study was analyzed with the confusion matrix shown in Figure 3.

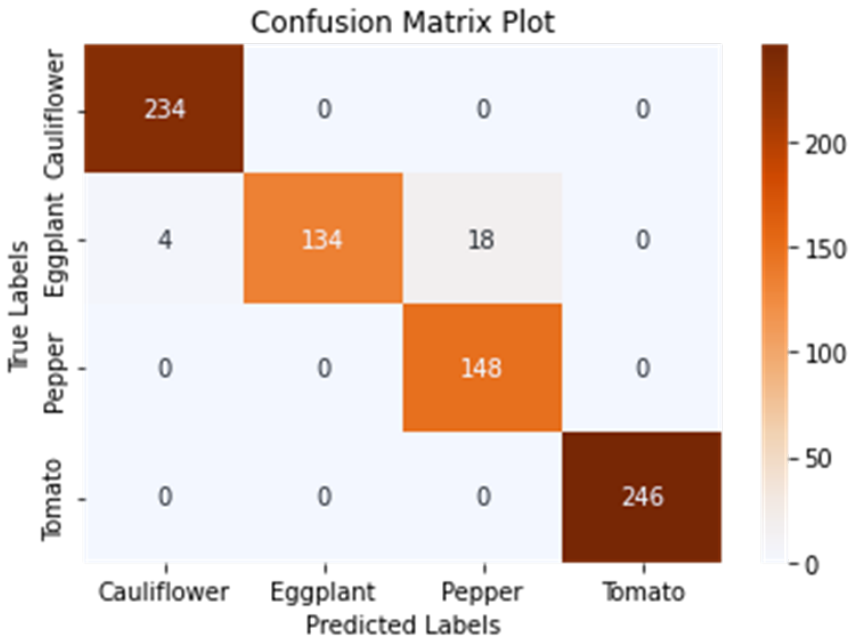

Figure 3. Confusion matrix plot

4. CONCLUSIONS

In this study, MobileNet, one of the deep learning model structures, was used to recognize and classify 4 different types of vegetables (cauliflower, eggplant, pepper green, and tomato). A total of 3136 vegetable image datasets were used for training and testing this model structure. According to the results obtained, a loss rate of 0.2441 was achieved with a classification success rate of 97.19%.

As a result, the use of the deep learning model structure discussed in the study has achieved high success in the recognition and classification of vegetable varieties in agricultural areas. The applicability of deep learning model structures in the recognition and classification of vegetable types to support advanced robotic systems in agricultural areas increases the importance of the study.

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Electricity Energy Demand Forecasting for Duzce

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Abstract

Energy is the capacity or ability of a system to do work. Energy is an important source of life in today's world civilization. It seems almost impossible to sustain this civilization without energy. Energy has been one of the indispensable needs of our lives from the past to the present. Today, one of the methods to decide the development level of showing a country is can be called the amount of energy used by that country. For this reason, we can state that countries should use more energy in order to develop and developed countries to continue to develop.

Electrical energy can be transported from the region where it is produced to other regions, but cannot be stored, by means of transmission and distribution networks. Because of this, estimating the electrical energy demand is important in terms of operational and financial planning. It is seen that the need for electrical energy is increasing rapidly day by day. In order to meet this increasing need, both state and private sector investments are constantly increasing. Electric energy investments are both financially costly and take years to realize and use. All these situations increase the importance of electrical energy DEMAND estimation day by day. In this paper, using EPDK estimates for both models, the estimated results for Turkey and Düzce electricity demand; Time Series were processed using ARIMA, Tbats.

Keywords: Energy, Forecasting, ARIMA, Time Series, Tbats

1. INTRODUCTION

When it comes to energy, the first thing that comes to mind is electrical energy. It can be said that the reason for this is the frequent usage area and commonness of use. Considering the majority and places of use of electrical energy, its absence is now unthinkable. The demand for electrical energy is increasing exponentially. It is observed that the amount of electricity consumption in Turkey increases rapidly depending on the economic, population and social life. In addition, it is important to ensure the supply-demand balance, since electrical energy must be used at the time it is produced.

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Producing electrical energy more than the demand causes damage, and when it is produced less, the demand cannot be satisfied. For this reason, the accuracy of the demand estimation of electrical energy is important. Many methods are used for electrical energy demand forecasting. The most preferred method among these methods is time series analysis.(1)

The electrical energy demand fluctuates according to the region, the season and momentarily. Since the electricity demand is highly variable and the electrical energy cannot be stored, the electricity transmission must be done continuously and without interruption, and the demand must be met instantly.(2)

By using the monthly electricity energy consumption data of EPDK of Düzce for the years 2017- 2021, monthly consumption amounts and annual total consumption amounts for the year 2022; Time Series (ARIMA) were estimated with Tbats methods and the performances of forecast models were evaluated by comparing with actual values.

2. LITERATURE REVIEW

As a result of literature research; numerous studies have been carried out for the estimation of electrical energy consumption and many different methods have been used. Some of the studies carried out are listed below.

Hengirmen and Kabak (1999) carried out five-year load estimation for the province of Gaziantep using the least squares method.

Ceylan and Öztürk (2004) made Turkey's energy demand estimation for economic indicators with the genetic algorithm approach. The energy demand forecast for the future is calculated on different situations. They estimated that the energy demand in 2020-2025 will be high.

Oğurlu (2011) in his thesis study; The data to be trained were used from the GDP data of Turkey between 1999-2009, the census data, the amount of energy consumed per day and the total energy consumption values of the time period when the annual electrical energy consumption recorded on EPDK was the highest. With the mathematical modelling, the amount of energy consumed in the peak day between the years 2010-2025 was estimated. This estimation result has been compared with other academic studies done before.

Balcı et al. (2012) made a short-term load estimation using regression analysis and least squares method. In this study, hourly energy consumption data of Turkey between 2003-2010 years is used. Made daily load estimation and compared these values with the actual values.

In this study; By using the monthly GDP and electrical energy consumption data of Düzce between the years 2017-2021, the electrical energy consumption between 2022 and 2017-2021 has been tried to be estimated. Python software was used for estimation. In the third part of the study, information about the methodology, electrical energy demand estimation and the methods used in this study are given. In the fourth chapter, the results obtained from the methods used in the thesis study are included. In the fifth chapter, the results were evaluated and suggestions were made.

3. METHODOLOGY

3.1 Estimation Methods

The first studies on the estimation of demand and electrical energy consumption for electrical energy started in the 1960s in our country. Many methods have been developed for energy demand forecasting over time.

Methods such as Regression, Time Series Analysis, Arma, Artificial Intelligence (AI), and Fuzzy Logic (BM) can be given as examples of these methods. In addition, the "Tbats" method, which we have heard frequently in recent times, has also started to be preferred.

3.1.1 ARIMA Method

ARIMA(p,d,q) Models ARMA(p,q) or ARMA(p,q) which is the special case of ARMA(p,q) or ARMA(p,q) when the time series is stationary and the mean, variance and covariance of the process remain the same depending on time. One of the MA(q) models specified as suitable can be used. However, in reality, there is a time-dependent change in the mean and variance of the time series. This situation is called the non-stationary state. (3) When such time series are made stationary, ARMA(p,q) models can be used for prediction. The stationarization of the time series is performed by the difference method.

3.1.2 Tbats Method

Models such as ARIMA, ETS, and State Space Models have been noted in literature reviews for modelling and forecasting, which often cannot easily handle data with complex seasonal patterns, such as multi-seasonality, high seasonal frequency, or non-integer seasonality. Tbats

is a seasonal model. Since electrical energy is also related to seasonality, Tbats model is included in this study. Livera et al. in 2011, BATS model was released for high frequency model, Box-Cox transform, ARMA residuals, abbreviation for trend and seasonal components. ω is the Box-Cox parameter, ϕ is the damping parameter, p and q are ARMA orders. Finally, m1, m2, . . . , mV denotes seasonal periods.(4)

3.2 Data Acquisition and Processing

In electrical energy estimation, data is of great importance as in other estimations. Thanks to the amount and accuracy of the data, estimation can be made that will yield efficient results. In this study, monthly electricity consumption data of Düzce for the years 2017-2021 were obtained from EMRA (Energy Market Regulatory Authority) Electricity Sector Reports. It is shown as a table in Table 1. Arima and TBATS methods were used on the data used. (5)

Table 1. Electrical energy consumption: Düzce

Date	MWh (Electricity Consumption)
2017-01-01	88149,12
2017-02-01	80465,56
.	.
.	.
2018-01-01	85709,5
2018-08-01	80676,36
2021-12-01	101534,38
2017-01-01	88149,12

4. APPLICATION AND RESULTS

By using ARIMA and TBATS methods on the Python programming language, and the general electricity consumption data of Düzce between the years 2017-2021, electricity consumption was estimated according to the months of 2022. For the ARIMA and TBATS methods, the MAPE measurement method was used and the success of the model was tested.

We see time-dependent changes and seasonality in Düzce Electricity consumption data. Apart from the significant electricity consumption in 2018, consumption was generally within a certain range (Figure 1, Figure 2, Figure 3 and Figure 4).

For the test run of the model, the data is divided into 80% Train 20% test. Figure 1 show for ARIMA and Figure 2 for TBATS, Figure 3 shows ARIMA and the forecast for 2022, and Figure 4 shows the forecast graph for TBATS for 2022. Studies on the data set were made as 80% training and 20% testing. As a result of the study, the MAPE results for ARIMA and TBATS are shown in table 2 below.

In the study conducted in the ARIMA method, we use the 5-year monthly electricity consumption data of Düzce as the last year of education and the last year of education as an estimate, and we see the results in figure 1. We found the MAPE result to be 4.47% in the ARIMA model.

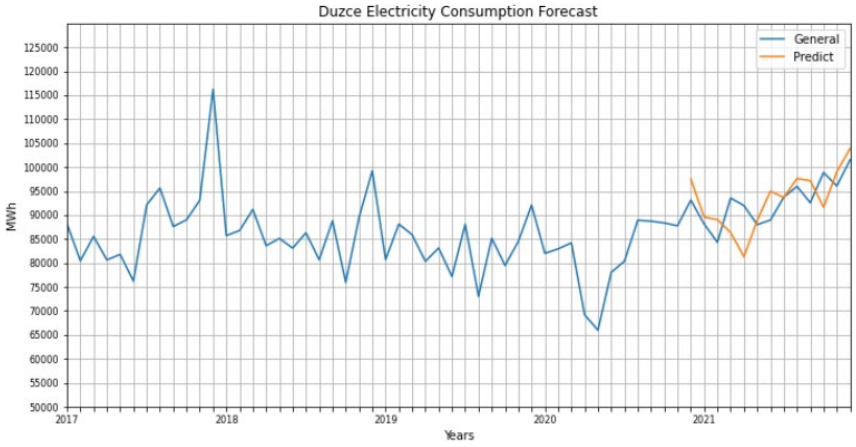

Figure 1. ARIMA Test Graph (%80 Train, %20 Test)

In the study conducted in the TBATS method, the training and test data were selected the same as ARIMA, and the 4-year data was used for training and testing in the last year. We observe in figure 2 that the MAPE result on TBATS gives worse results than the ARIMA method. The MAPE result in TBATS was found to be 10.65%.

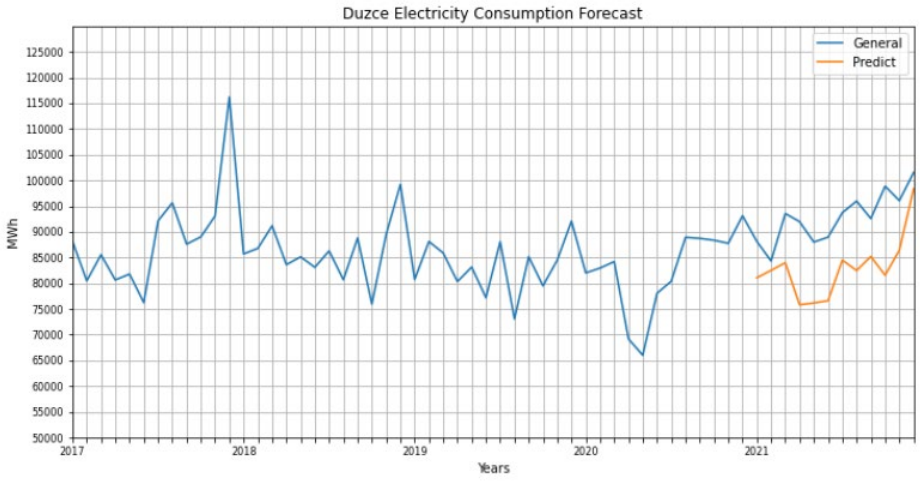

Figure 2. TBATS Test Graph (%80 Trains, %20 Tests)

When we start to predict the future after model training, we see by looking at figure 3 that according to ARIMA results, Düzce electricity consumption has increased compared to previous years.

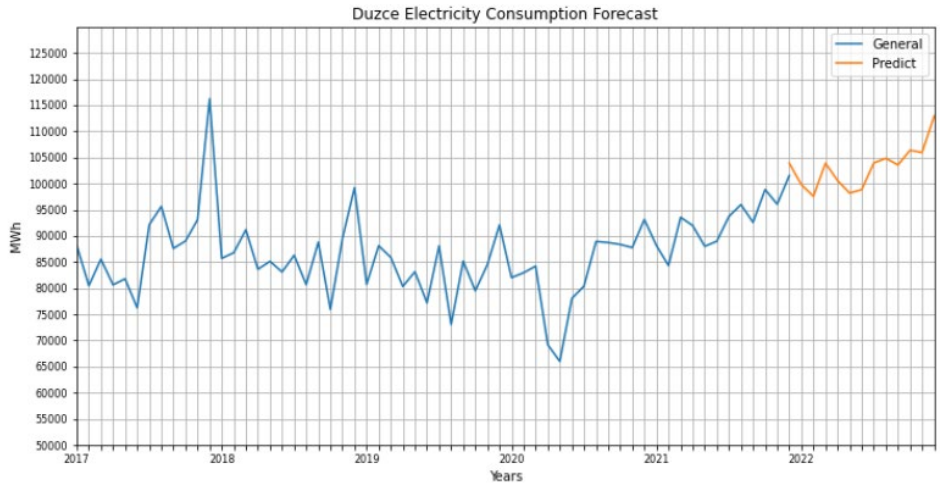

Figure 3. ARIMA Predict Graph

According to TBATS results, Düzce electricity consumption is similar to previous years and it is seen in figure 4 that there may be less consumption compared to 2021.

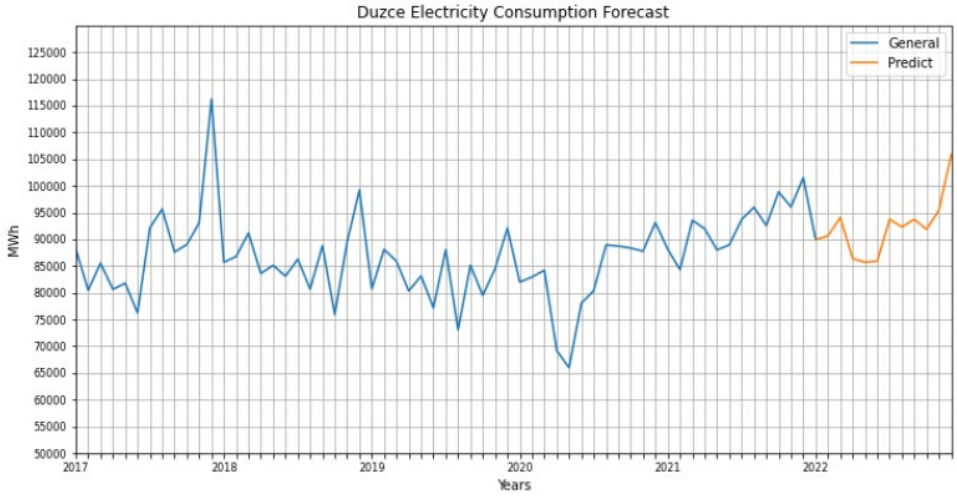

Figure 4. TBATS Predict Graph

We see in Table-2 that the ARIMA method gives the lowest error rate in the methods used.

Table 2. MAPE Results by Methods

Method	MAPE
ARIMA	%4.47
TBATS	%10.65

5. CONCLUSIONS

Electricity consumption estimation has been made for Düzce province. The data is taken from the Electricity Monthly Sector Reports published on the EMRA website. Data were collected from Düzce monthly electricity consumption data from 2017 to December 2021, including December. There are 60 pieces of data in total. Data is in MWh. The dataset is a clean dataset and does not contain null values.

We aimed to perform electrical energy demand estimation, considering that there is no preliminary forecast of electricity demand for Düzce, that obtaining electrical energy according to demand will save money and prevent unnecessary expenditures. For this purpose, we conducted a literature review. As a result of these researches; we observed that the Arima and Tbats method is frequently used. Therefore, we used the ARIMA and TBATS methods.

The data set was reserved for the first 4 years of education, and the 5th year was determined for testing. If we specify it as a ratio, it has been determined as 80% to 20%. This ratio was chosen because better results were obtained by working on different ratios. In line with this study; we saw that machine learning techniques give successful results. By testing such machine learning techniques, the methods that give the best result or a hybrid system can be derived.

As a result of our estimations for Düzce province, we see that there will be an increase in the demand for electrical energy. If energy is provided based on this increase, it is seen that unnecessary electrical energy expenditures will be prevented.

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Natural Gas Demand Forecasting for Duzce

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Abstract

Energy, ability to do work physically; energy source refers to the sources that produce energy using appropriate techniques. Energy resources are obtained using different methods and techniques. Energy sources can be divided into renewable and non-renewable or primary and secondary energy sources. Energy demand is the amount of energy demanded by individuals, institutions and organizations for the realization of daily consumption and economic activities. There are many factors affecting energy demand. Examples of these factors can be given as population growth, urbanization, economic growth and social development, technological development and productivity.

Natural gas can be defined as a colorless, odorless and lighter-than-air gas consisting of light molecular weight hydrocarbons such as methane, ethane, and propane. It is preferred because of its easy to use. As a result of factors such as industrialization, urbanization and rapid population growth in Turkey, the demand for natural gas has increased considerably due to the efficient aspects of natural gas. It is expected that natural gas will progress equally against demand, save energy and be demanded correctly from foreign countries. Therefore, we searched the importance of forecasting natural gas demand. The accuracy of demand forecasting will make natural gas imports, infrastructure investments and consumption planning in the country more efficient.

Keywords: Energy, Forecasting, ARIMA, Tbats

1. Introduction

The increase in the demand for energy has made the importance of energy more evident. In this case, countries are expected to be able to meet their energy demands. One of the most used of these energies is natural gas energy. Both its ease of use and environmental friendliness has

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opened the door to an increase in natural gas demand and use. In many countries, natural gas is preferred for these reasons.

The same consuming situation continues in Turkey. Increasing use of prevalence used in Turkey. Importance of natural gas in terms of economic use, the excess of produced natural gas causes unnecessary expenditures. This increase must be exceeded by the amount of material demanded and received. To achieve this, accurate and realistic estimation is required. Unnecessary expenditures can be avoided if the natural gas demand is forecasted correctly and provided foresight.

In this study; By using the EPDK monthly natural gas energy consumption data of Düzce for the years 2017-2021, monthly consumption amounts and annual total consumption amounts for the year 2022; Time Series (ARIMA) were estimated with Tbats methods and the performances of prediction models were evaluated by comparing with actual values.

2. Literature Review

Since the demand for natural gas energy is high and increasing gradually, it is important to estimate this demand. Therefore, in this section; Studies on the estimation of natural gas energy and the methods used are examined.

When Rathnayaka and Seneviratna (2014) carried out their study, they estimated the annual electrical energy consumption of Sri Lanka for the period 1998-2015. While estimating; gray estimation used GM (1,1) and ARMA (1,1) models. The accuracy of the models used in the estimations was compared using MAD, MSE and MAPE.

It has been concluded that the GM (1,1) model gives better results than the ARMA model. Topçu (2013), using the ARIMA Model, studies have been carried out to estimate Turkey's natural gas consumption for the coming years. In this study, monthly national natural gas consumption values between January 1987 and October 2011 were used as examination data. As a result of the study, the estimation of Turkey's natural gas energy demand for the years 2012-2020 has been carried out.

Aytez (2012); performed the estimation of electrical energy consumption in Turkey until 2018 by using multiple linear regression analysis, Artificial Neural Networks (ANN) and Least Squares Support Vector Machines methods.

As a result of the literature research; regression analysis, time series analysis, ARIMA and ANN are frequently used. It was found that TBATS was used because their results were not considered to be seasonal.

3. Methodology

3.1 Estimation Methods

3.1.1 ARIMA Method

ARIMA models are models that are applied to non-stationary series but converted to stationary using the difference-taking process. Models applied to non-stationary series but converted to stationary using the difference-taking process are called non-stationary linear stochastic models. The specified p and q are the degrees of the autoregressive (AR) model and the moving

$$Z\,t = \Phi\,Z\,t - + \Phi\,Z\,t - + + \Phi\,p\,Z\,t - p + + at - \Theta\,at - - \Theta\,at - - - \Theta\,q\,at - q \ldots \ldots 1\,1\,2\,2\,\delta\,1\,1\,2 \quad (I)$$

[2]

In equality; Zt, Zt-1,…, Zt-p Observation values differed by d degree, Φ1, Φ2,….. Coefficients for Φp Observation values differed by d degrees, constant value of δ, at, at-1,…,at-q shows the error terms and the coefficients associated with the error terms Θ1, Θ2,…, Θq.

average (MA) model, respectively, and d is the degree of difference. The ARIMA(p,d,q) model is as follows.

3.1.2 Tbats Method

Time series estimation means using a model to predict future values for values that have been observed in the past. Time series forecasting deals with specific time series data. This is because of seasonal data.

TBATS is a forecasting method for modeling time series data. The TBATS model is capable of dealing with complex seasonality (for example, non-integer seasonality, non-nested seasonality, and large-period seasonality) without seasonality constraints, making it possible to create detailed, long-term forecasts. (5)

3.2 Data Acquisition and Processing

The data to be obtained before the models are created in the realization of natural gas energy estimation is of great importance in the formation of the estimations. The accuracy and comprehensibility of the data will affect the models to be created and the estimation results.

The data used in this study, using the EPDK 60-month natural gas energy consumption data of the province of Düzce for the years 2017-2021, the monthly consumption amounts for the year 2022, the annual total consumption amounts; Time Series (ARIMA) were estimated with Tbats methods and the performances of forecast models were evaluated by comparing with actual values.

The data used are shown in Table 1.

Table1. Natural Gas Consumption Data

ID	Date	Natural Gas
1	01.01.2017	31,438
2	01.02.2017	24,676
.	.	.
.	.	.
59	1.11.2021	23,997
60	1.12.2021	30,151

4. Application and Results

By using the Python programming language, training was carried out on the 2017-2021 data of Düzce, and estimation was made for the year 2022. ARIMA (Figure 1 and Figure 2) and TBATS (Figure 3 and Figure 4) methods were used in this estimation.

When we look at the figures (Figure -1,2,3,4), we see that Düzce's natural gas demand increases seasonally, and when analyzed on an annual basis, it does not increase over the years. When the data is trained with the ARIMA model, we observe that our Test image (Figure-1) is almost the same except for a few deviations.

Here, the data we have for 2021 was taken as a test and the accuracy values were tested. MAPE was used as the error value in this test. As a result, the MAPE value was found to be 0.1056.

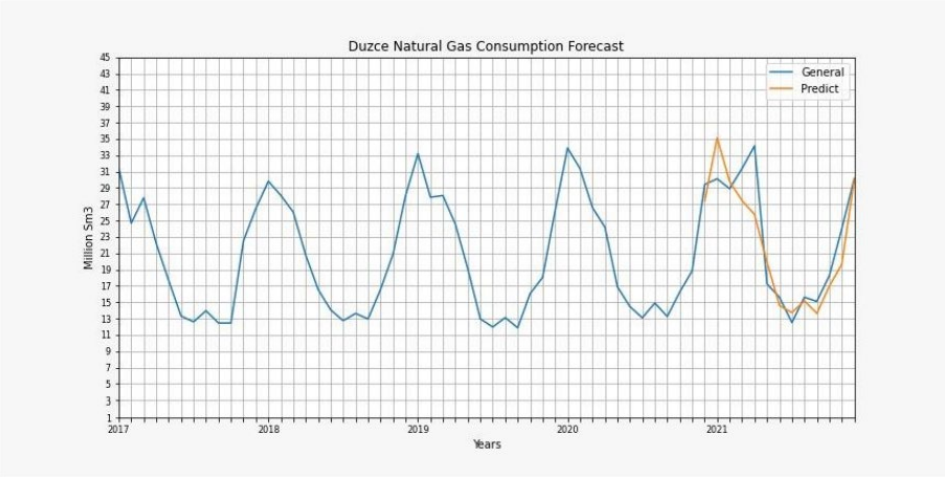

Figure 1. ARIMA (Test/Train)

Forecasting for the future in Arima Model (Figure-2) has been made for 2022. Although the use of natural gas varies seasonally, it can be said that it is almost at the same level annually.

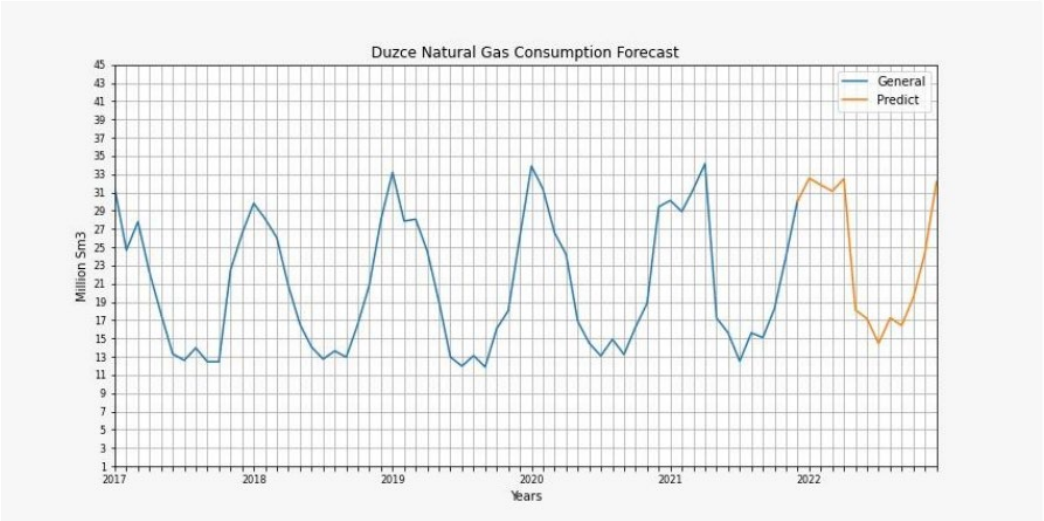

Figure 2. ARIMA(Predict)

When the data is trained with the Tbats model, we observe that our test image (Figure 3.) deviates in early 2021, but is almost the same afterward. Here, the data we have for 2021 was taken as a test and the accuracy values were tested. MAPE was used as the error value in this test. As a result, the MAPE value was found to be 0.0851.

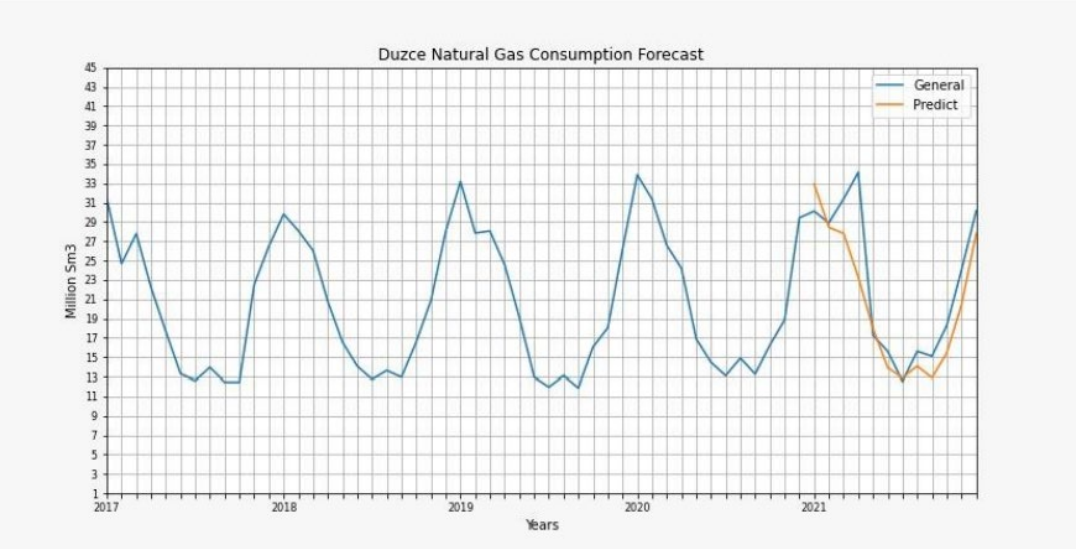

Figure 3. Tbats (Test/Train)

Forecasts for the future in the Tbats Model (Figure 4.) were made for the year 2022. Here we see a softer change compared to Tbats.

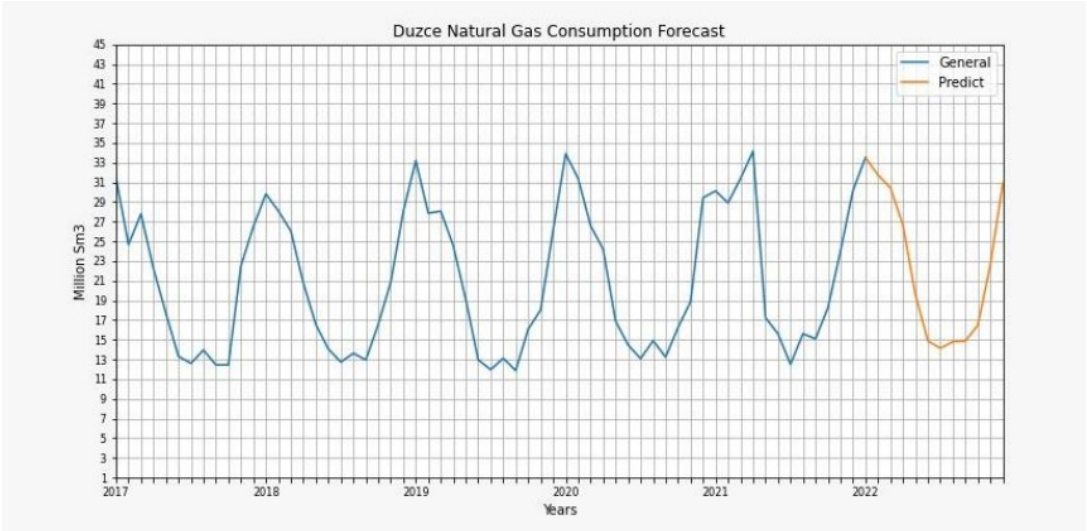

Figure 4. Tbats(Predict)

5. Conclusions

Düzce's need for natural gas in areas such as housing, industry, electricity generation; It is necessary to be able to produce permanent solutions in order to be affected by this situation as little as possible in an increase or decrease that may be experienced in line with this need. For this reason, it is very important to make future forecasts for the natural gas industry and to estimate the consumption values as accurately as possible in this forecast.

In this study, a natural gas demand forecasting study for 2022 was made by using monthly natural gas consumption values for the period of 2017-2021 for Düzce, where no estimation of natural gas consumption demand was made before. ARIMA and Tbats methods were used to obtain the predicted values.

As a result of these processes, it has been concluded that the increase in natural gas energy consumption in Düzce will continue seasonally.

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Sulfur Analysis in Apricot With Deep Learning Methods

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Abstract

In order to preserve the dried apricots for a long time without spoiling, dried apricots should be sulphurized in the heating chambers. However, this sulphurization must be within specific ppm value ranges. Therefore, there is a need to perform sulfur analysis in apricots. The sulfur analysis is carried out in the apricot research center and Malatya apricot stock exchange between 100₺ - 250₺ and the factories that export apricots employ chemists and perform apricot analysis. This analysis takes between 40 and 180 minutes and this process is a waste of time for those who demand apricots. In this process, approximately 60 liters of water is spent for only one experiment, which means a waste of water. Chemists also work on this process. This challenging apricot sulfur analysis process in this study was automated using deep learning and image processing techniques. Thus, it is aimed to minimize the time and labor loss experienced in the classical sulfur analysis process, and eliminate the waste of water and the use of chemicals. High performance was obtained in the models used in the study.
Keywords: Sulfur, Apricot, Analysis, Artificial Intelligence, Deep Learning

1. Introduction

Apricot is one of the fruits whose color changes the most during drying. Apricots are brought to the sulfuring room (islim room). During drying with sulphurization, color changes and darkening caused by the enzymes in the fruit are prevented. In addition, the sulfur dioxide gas formed during sulphurization protects the fruit against diseases and pests, as well as color change. On the other hand, mold, yeast, bacteria, and pests are prevented from working and they are allowed to be stored in the warehouse for a long time.

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Excess sulfur damages the kidneys. If the human body takes too much sulfur, it shows symptoms such as headache, throat, and heartburn, and vomiting. It also causes allergic skin diseases. Excess sulfur affects most asthma patients negatively. The daily amount of sulfur that the body needs to meet its sulfur needs is approximately 1000 mg. It is necessary to comply with the standards determined by the countries where dried apricots are exported. Sulfur amounts for import by country are 2000 ppm in EU countries, 3000 ppm in USA and Australia, and 2500 ppm in Canada (Anonim, 2020b).

Chemical treatment of the samples taken from dried apricots in each analysis and excessive water consumption leads to waste. Contrary to the classical sulfur analysis methods used, cost, time, and wastage have been avoided with our visual analysis methods. It has been a study that has great advantages in terms of being environmentally friendly and practical. Apricot producers; Due to the low prices in the years when the product is high, they do not sell their products and keep them in the warehouse. Therefore, it gives sulfur to apricots well above the sulfur limit, which causes many problems in exports. In order to prevent the apricots from returning due to high sulfur in exports, the producer should not give more than 2000 ppm of sulfur to the apricot that he will sell immediately.

In this study, deep learning-based classification of sulphurous apricots was carried out according to their sulfur ratios. With the proposed approach, it is aimed to eliminate the time, labor and water losses encountered in the classical sulfur analysis process. In addition, when compared to the classical sulfur analysis process, our proposed method can perform sulfur analysis in apricots with higher accuracy. Thus, it contributes to the realization of the sulfur analysis process, which is necessary in the process of exporting apricots both in our country and abroad, in a faster and higher quality.

Deep learning architecture is a new generation machine learning field that matches the relationships between its inputs and outputs thanks to its multi-layered architecture (Hodnett & Wiley, 2018). The reason why it is called deep here is because it contains non-linear and multiple feature converters. Thanks to the multi-layered structure in the deep

learning architecture, they can automatically learn many functions with complex features that are mapped between their inputs and outputs. Convolutional Neural Network (CNN) is a specialized deep learning type based on multi-layer perceptron network structure.

In the literature, there are many studies that perform classification and segmentation based on deep learning. One of them is the work carried out by Eroğlu & Yildirim. In the related study, it was aimed to evaluate the autoendoscopic images of the eardrum in patients with otitis media using deep learning models (Eroğlu & Yildirim, 2022). EfficientNetb0, DarkNet53 and DenseNet201 models were used in the study proposed by the authors. In the study carried out by Hayıt (2021). an approach was proposed for artificial intelligence-based classification of 6 types of infection types of wheat leaf images taken from the field environment for the purpose of investigating Yellow Rust (Puccinia Striiformis) disease in wheat. A deep learning-based approach has been developed by using texture analysis methods in the related approach and a combination of deep and structural methods in feature extraction. In the study carried out by Mercan & Kılıç (2020) it was aimed to perform deep learning-based colorimetric classification of glucose concentration using a smart phone. In the study performed by Mete & Ensari (2019) a classification approach was proposed for flower images using Deep CNN and Data Augmentation.

When the literature is reviewed, it is seen that many studies have solved important classification problems with deep learning. In this study, high performance classification process of sulphurized apricots was carried out by using deep learning models DenseNet201 and ResNet50. Thus, artificial intelligence has been provided to find a solution to an important problem in the biotechnological field.

The organization of this study is as follows: In Chapter 2, the basic information about deep learning, the CNN models used and the details of the proposed approach are presented. Experimental results are given in Chapter 3 and conclusions are given in Chapter 4.

2. Material and Method

2.1. Structure of Deep Learning and Convolutional Neural Network

Deep learning architecture is a new generation artificial intelligence field that matches the relationships between its inputs and outputs thanks to its multi-layered architecture (Hodnett & Wiley,2018). The reason why it is called deep here is that it contains non-linear and multiple feature converters. Thanks to the multi-layered structure in the deep learning architecture, they can automatically learn many functions with complex features that are mapped between their inputs and outputs. CNN is a specialized type of deep learning based on a multilayer perceptron network.

CNN has the ability to extract hidden attributes. Successful results are obtained in applications such as object recognition, classification, and segmentation with CNN. The main advantages of CNN are listed below:

- Achieve extremely high performances without the need for pre-processing
- Working with superior performance compared to classification and segmentation approaches using many classical preprocessing methods.
- Automatic feature extraction and no need for expert knowledge in this process.
- CNN architectures provide very successful results on big data (Bhardwaj, Di & Wei, 2018).

2.2. Deep Learning Architectures Used

In this study, DenseNet201 and ResNet50, which are CNN models, were used. Information about these models is presented below.

DenseNet201: In the DenseNet201 architecture proposed by Huang et al., each layer is forward-connected directly to all other layers. For each layer, the feature maps of all previous layers are treated as separate inputs, while their own feature maps are transferred to all subsequent layers. DenseNet201 architecture is logically similar to ResNet architecture. Instead of being added to subsequent layers, activation functions generated by the DenseNet201 design are simply combined. The original data is thus kept in all types

of layers together with activations from earlier layers. Because of the shorter connections between layers that are close to the input and output in this architecture, it is claimed that this model is denser and more effective (Huang, Liu, Van Der Maaten & Weinberger, 2017).

ResNet50: It was developed by He et al to train deeper networks. The high number of layers in deep learning architectures does not increase the performance of the network. However, increasing mesh depth brings along the gradient problem. The gradients from the previous layers approach zero when calculated as a chain. Therefore, as the number of layers increases, the gradient values get smaller and approach zero, which is undesirable. In the ResNet model, this problem has been tried to be overcome by using residual blocks. ResNet model. In the ILSVRC ImageNet competition held in 2015, the error rate of the ResNet architecture in this competition was 3.6%. The most important difference that distinguishes the ResNet model from the previous models is that it has a deeper structure (He, Zhang, Ren & Sun, 2016).

2.3. Proposed Deep Learning Based Sulfurized Apricot Classification System

In our study, a light cabin was initially designed. A camera capable of displaying images with a resolution of 2590 x 2048 and 80 lumens LED light power supplies (DC 12 V) are used at the top of the light cabinet. With this light booth, images of 465 apricots were taken. 80% of these 465 images were used to train DenseNet201 and ResNet50 deep learning architectures. Then, 20% of these images were used for the test process, and the test process was carried out with the trained DenseNet201 and ResNet50 deep learning architectures. The flow diagram of the proposed deep learning-based sulfur analysis system is given in Figure 1. As can be seen in the related figure, the method we propose classifies the given apricot images into two classes: Standard Compliant and Non-standard.

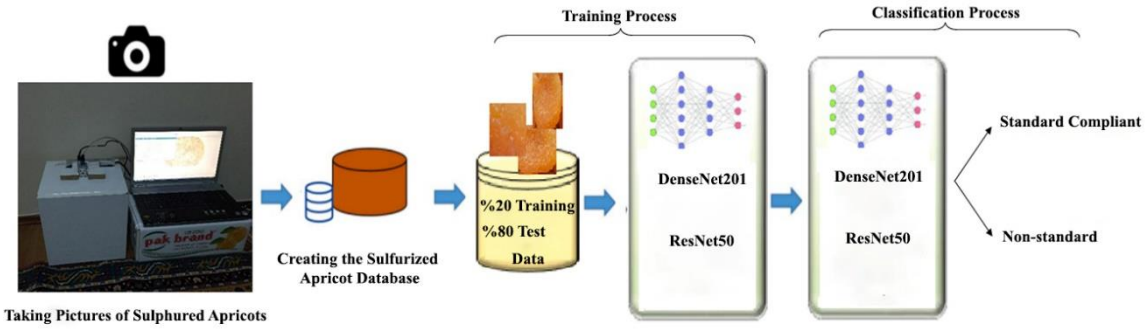


Figure 1. Flow diagram of the proposed deep learning based sulfur analysis system

In Figure 2, 4 sample pictures are given for the relationship between the apricot image and the sulfur content in ppm. As can be seen in the pictures, the color tones change according to the ppm values. In our proposed approach, deep learning architectures are trained with a large number of images labeled according to ppm values. Thus, deep learning architectures perform the feature extraction process according to the ppm of the images. Accordingly, the training process of deep learning architectures is carried out by making the picture ppm connection automatically. At the end of this process, it is automatically deduced whether the sulfurous apricot images with different ppm values given from the inputs of the trained deep learning architectures are in accordance with the standard or not.

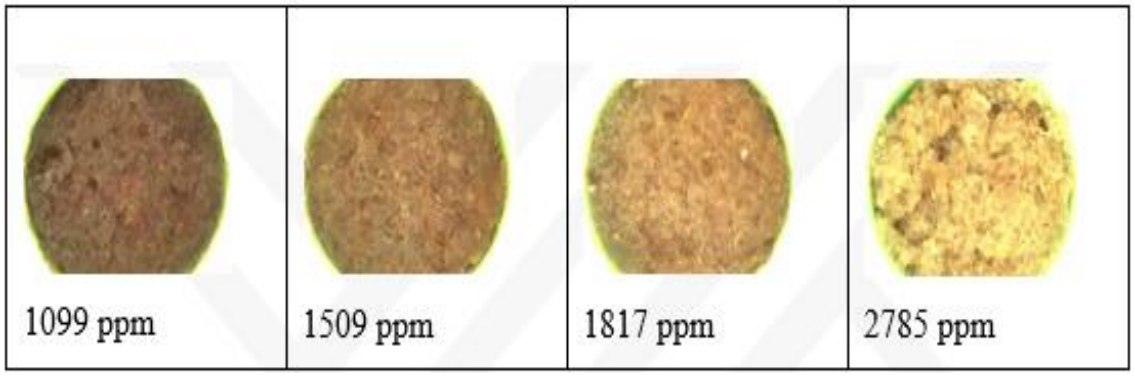


Figure 2. Images of sulphurized apricots according to ppm values

3. Experimental Results

Of the 465 apricot images that were photographed, 80% were used for training DenseNet201 and ResNet50 deep learning architectures. After the completion of this

process, 20% of these images were used for the testing process, and the testing process of this trained DenseNet201 and ResNet50 deep learning models was carried out. The accuracy, sensitivity, specificity and F1-score metrics are most frequently used to evaluate the performance of a CNN model. These metrics are formulated as follows (Kızıloluk & Sert, 2022; Sert, 2021).

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

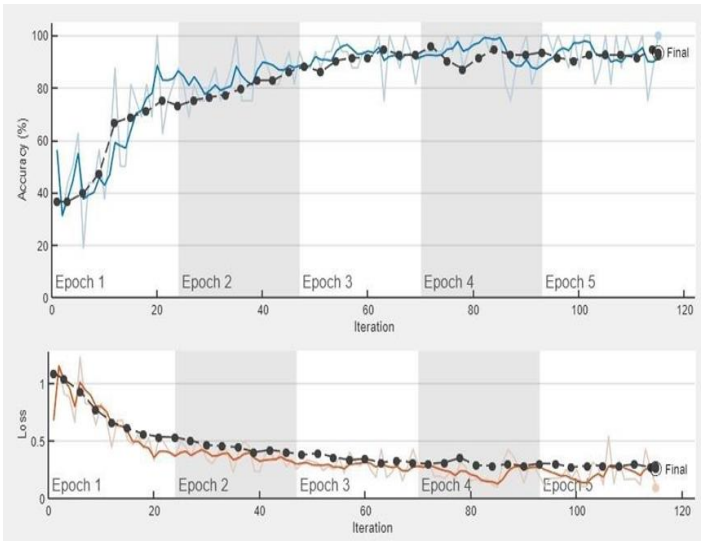
$$Sensitivity = \frac{TP + TN}{TP + TN + FP + FN} \quad (2)$$

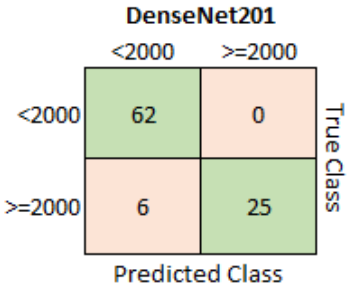
$$Specificity = \frac{TP + TN}{TP + TN + FP + FN} \quad (3)$$

$$F1 - Score = \frac{TP + TN}{TP + TN + FP + FN} \quad (4)$$

TN = True Negative, TP = True Positive, FN = False Negative, and FP = False Positive.

The training process graph and complexity matrix are frequently used to evaluate the performance of deep learning architecture. The training process graph and complexity matrix of the DenseNet201 deep learning architecture are presented in Figure 3. With this architecture, 93.55% accuracy has been achieved. DenseNet201 architecture correctly predicted 87 out of 93 test images, and incorrectly predicted 6 test images. While 6 incorrectly predicted images actually belonged to the >=2000 class, the DenseNet201 model predicted these images as if they were in the <2000 class.

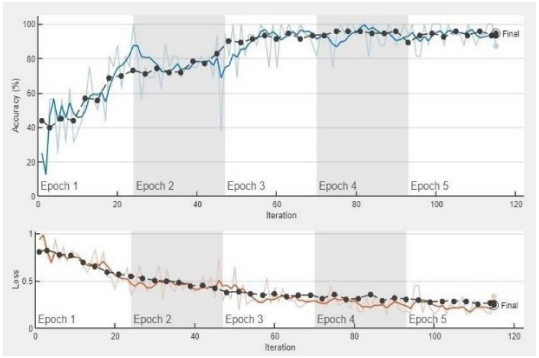


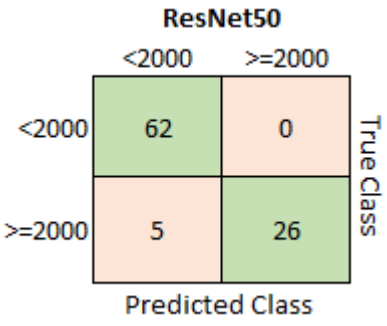


a) Accuracy and loss curves b) Confusion matrix

Figure 3. Results of the DenseNet201 architecture

The training process graph and complexity matrix of the ResNet50 deep learning architecture is presented in Figure 4. With this architecture, 94.62% of accuracy has been achieved. ResNet50 architecture correctly predicted 88 out of 93 test images, while it predicted 5 test images incorrectly. Incorrectly predicted images actually belonged to class >=2000, while the model predicted as to class <2000.





a) Accuracy and loss curves b) Confusion matrix

Figure 4. Results of the Resnet50 architecture

In Table 1, achievements are presented collectively depending on the architectures presented in detail above. From the relevant chart, it is seen that the best performance is obtained with ResNet50.

Table 1. Achievements based on architectures (%)

CNN Model	Accuracy	Sensitivity	Specificity	F1-score
DenseNet201	93.55	91.18	100	95.38
ResNet50	94.62	92.54	100	96.12

4. Conclusions

The fact that the apricot is sulphurized at the appropriate rate is of great importance in the import of dried apricots. Therefore, in this study, an approach that can perform the analysis of curdled apricot on a deep learning basis is proposed. In the study, the apricot database was created by us. In our proposed approach, the apricot sulfur analysis process was performed based on DenseNet201 and ResNet50. As a result, 93.55% and 94.62% accuracy were obtained with DenseNet201 and ResNet50 architectures, respectively. These ratios show that our approach performs apricot sulfur analysis with very high performance. Thus, it has been ensured that sulfur analysis, which is quite laborious and costly, can be carried out in a very short time and with high performance, with the deep learning-based approaches.

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Yerel Yönetimlerde Elektronik İhale (E-İhale) Süreçleri ve Yapı Bilgi Modellemesi (BIM) Entegrasyonu

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ÖZET

Ülkemizde, diğer devlet kurumlarında olduğu gibi, yerel yönetimlerde de her türlü mal ve hizmet alımı yöntemlerinde de yapılan ihaleler için, Türkiye Elektronik Kamu Alımları Platformu (EKAP) adı verilen bir uygulama kullanılmaktadır. Özellikle yerel yönetimlerde hizmet çeşitliliğinin tek bir kurumda toplanması ve söz konusu taleplere hızlı bir şekilde cevap verilmesi zorunluluğu ortaya çıkması sonucu bu süreçlerin hızlı ve sağlıklı bir şekilde çözülmesi gerekmektedir. Yapılan bu çalışma kapsamında da EKAP konusunda uzmanların yapmış olduğu çalışmalar incelenmiş, yapılan literatür araştırması sonucu bunlara örnek verilmiştir. Yerel yönetimlerde yapılan çalışmaların ise daha çok geleneksel yöntemler ile yürütüldüğü gözlemlenmiş, özellikle belediyelerde EKAP sistemi ile entegre edilebilecek bir YBM uygulaması ile öncelikle proje yönetimlerinin daha profesyonel yapılacağı görülmüştür. Bu uygulamaların sağlıklı bir şekilde entegre edilebilmesi durumunda, sonuçlarının nasıl olacağına dair örnekler çalışma içerisinde paylaşılmıştır. Ayrıca pilot bir uygulama ile söz konusu çalışmaların desteklenebileceği ve sahadaki uygulama sonuçları ile yapılan akademik açıklamaların birbiri ile örtüşeceği görülmüştür.

Keywords: Elektronik kamu alımları platformu (EKAP), yapı bilgi modellemesi (YBM), belediyeler, süreç yönetimi, proje yönetimi

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I.Giriş

İnşaat sektöründe, uluslararası pazardan kaynaklı rekabeti artırıcı ve daha kaliteli işçiliklerin yapılması açısından büyük önem arz eden E- İhale işlemlerinin etkin ve yetkin şekilde uygulanamayışı, özellikle yerel yönetimlerde ortaya çıkan iş ve işlemlerin, gelişimi açısından veya nitelikli imalatların yapılması açısından büyük bir engel olarak ortaya çıkmaktadır (Çıracıoğlu & Yaman, 2020). Yapılan işlemlerin çok farklı miktarlarda çeşitlilik göstermesi ve yaşanan bazı gündelik olaylara istinaden çıkan anlık ihtiyaçlarda bazı süreçlerin kontrol edilmesini zorlaştırmaktadır. Her ne kadar kanunen yapılan alımlar ve ihalelerin EKAP' a girişi zorunlu olsa da bunlar uygulamaya dönük hamlelere dönüştüğü zaman bazı sorunlar ortaya çıkarmaktadır. Bunun önüne geçmek açısından özellikle dünyanın geri kalanında olduğu gibi ülkemizde de yaşanan dijitalleşme gelişmeleri ile beraber, son 10 yılda büyük ilerlemeler yaşanmıştır. Lakin başta da belirtildiği üzere EKAP tek başına artan talepler ve değişen ihtiyaçlar karşısında yeterli ve sağlıklı tepkiler verememektedir.

EKAP sisteminin sağlıklı tepkiler vermeyişinin altında birçok sebep yatmaktadır. Örneğin yerel yönetimlerin sağladığı hizmetler göz önüne alındığı zaman; sosyal devlet anlayışı sebebi ile yapılan yiyecek, giyecek ve sosyal yardımlar bambaşka alımlar gerektirirken, yapılacak olan inşai faaliyetler, alt yapı ve üst yapı anlamında bambaşka bir süreç gerektirmektedir. Sadece kurum dışı değil ayrıca kurum içinde de alınması ve yapılması gereken alımlar olduğu gibi, genel tadilatlar, hizmet sürekliliğini sağlamak için hizmet araçlarının kiralanması veya alınması gibi işlemlerde olmaktadır. Bütün bu alımlar ve süreçlerde tek bir çatı altında yapılamamakta aynı kurumun birden çok biriminin müdahil olduğu ve bir bütünlüğün oluşmadığı iş süreçlerini doğurmaktadır. Günümüzde ekonomik göstergelerinde verdiği zorluklar neticesinde aslında takibi zor ve kontrol edilebilirliği imkansız hale gelen süreçler ortaya çıkınca, devlet kaynaklarının etkili bir şekilde kullanılamayışı ortaya çıkmaktadır. Tüm bu ve benzer sebeplerden yola çıkarak, yapılan literatür araştırmaları sonucunda öncelikle ülkemizde kullanılan EKAP sistemi çok yönlü bir şekilde ele alınmış ve en temel anlamda EKAP sisteminin nasıl çalıştığına dair bilgiler verilerek, bu sistemle beraber uygulanacak proje teslim

yönteminin nasıl seçileceğine dair bilgiler sunularak sistemin en temel anlamda neleri içermesi gerektiği anlatılmıştır.

Verilen mevcut bilgilerden sonra yapılan bu çalışma ile nitelikli bir şekilde EKAP ve YBM entegrasyonu için hangi bilgilere gerek olduğu dizin olarak oluşturulmuştur. YBM içerisinde yapılacak proje teslim yöntemine dair bilgiler verilerek seçilecek olan proje teslim yönteminin projeye nasıl entegre edileceği anlatılıp, YBM uygulama planı çerçevesinde yapılacak pilot uygulamaya nasıl entegre edileceği ve hangi aşamalardan geçeceğinin bilgisi verilecek ve son aşamada önerilen bu kavramsal modelin diğer hizmet alımı veya mal alımı taleplerine nasıl uygulanabileceğinin önermesi yapılacak sonuç kısmında yapılan önerme sonucunda neleri elde edeceğimizin somut doneleri ortaya koyulacaktır.

2. Materyal ve Yöntem

Dijitalleşme çalışmalarının ülkemizde daha yaygın hale gelmesi ve hemen tüm kamu kurum ve kuruluşlarımızda daha etkin kullanılması ile beraber, ülkemizin kamu kurumları arasındaki bilgi alışverişi daha nitelikli bir hale gelmiştir. Bu süreçlerin gelişmesi ile birlikte kamu içerisinde de tıpkı özel sektördeki gibi performans kriterleri evrim geçirmiş, zaman – maliyet yönetimleri kamu kurumlarının stratejilerinde büyük bir önem arz etmeye başlamıştır. Bu durum zamanın ve paranın giderek daha da önem kazandığı dünya içerisinde kurumlar ile ilgili – ilgisiz her kesimin merakını çeker bir hal almasına sebep olmuştur. Kamu kurumları da artık çalışan yapıları dahi bu sistemlere göre evrilmeye başlamıştır. Çalışmanın bu bölümü içerisinde de mevcut süreçler derinlemesine incelenmiş Türkiye' de ki Elektronik ihale süreç tanımları verilmiş bu sistemlerin tanımları yapılmış, akabinde proje teslim süreçleri incelenerek bunların yerel yönetimlerde uygulanışı ve geleneksel yöntemlerle nasıl yürütüldüğüne dair paylaşımlar yapılmış ve yerel yönetimlerde yapılan mal ve hizmet alım süreçlerine dair bilgiler verilmiştir.

Metodolojik olarak söz konusu süreç incelendiği takdirde öncelikle araştırma içerisinde mevcut durum analizi yapılarak geleneksel yöntemler ile idame ettirilen hizmet ve yapım

süreçlerinde yaşanılan aksaklıklar ile ilgili bilgiler verilmiştir. Yapılan literatür çalışmaları sonucunda aslında her bir kurumda mevcut teknolojik verilere ulaşmada herhangi bir aksaklık veya eksiklik yaşanmadığı fakat bu bilgileri verimli bir şekilde kullanma yönünde bir takım aksaklıklar yaşandığı saptanmış ve bu konuya dair bir önerme getirilmiştir. Yani kullanılan geleneksel yöntemdeki süreç ve maliyet bazlı yaşanan aksaklıklar göz önüne serilmiştir. Yaşanan bu aksaklıklardan ötürü öncelikle mevcut sistemden yaşanan aksaklıkların çözümü için bir yöntem geliştirilmiştir. Geliştirilen yöntem ile birlikte birlikte çalışılabilirlik sorunu ortaya çıkarılmıştır. Birlikte çalışılabilirlik kavramı yine yapılan literatür çalışmaları ile incelenmiş söz konusu entegrasyon için öncelikli hedef olarak belirlenmiştir. Akabinde yine birçok kurumda kullanılan CAD tabanlı çizim programları vasıtası ile elde edilen bulguların IFC formatında çıktı olarak EKAP ortamına aktarılması ile ilgili model üzerinden bilgiler verilmiş ve bütün bunların oluşturulacak bir Kavramsal Model vasıtası ile BIM – EKAP entegrasyonunu sağlamak için ve bütün birim veya kurumların eş zamanlı ulaşım sağlayacağı bir bulut sistem ile eş zamanlı çözümler sağlanabileceği anlatılmıştır.

Bütün bu süreçler için kullanılacak olan materyaller ise yine yapılan literatür çalışmaları sonucu ortaya çıkan ve özellikle BIM kullanımında daha yaygın olan paket programlardan seçilmiş ve bu programların EKAP sistemi ile entegrasyonu üzerinde durulmuştur. Söz konusu paket programlardan elde edilen verilen EXCEL, Word v.b. dosyalara dönüştürüleceği ve bu sayede ortak kullanıma engel teşkil edebilecek her türlü organizasyondan uzak kalabilmek amaçlanmıştır.

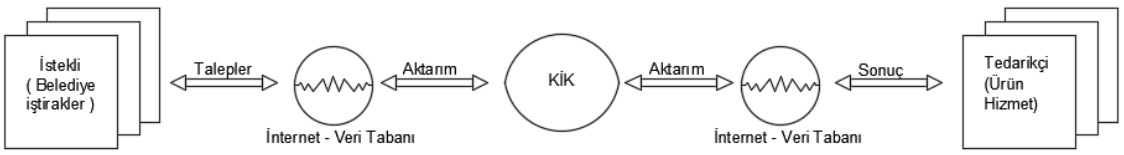
2.1. Elektronik İhale Süreci

Elektronik ihale süreçleri, günümüzde gelişmiş ve gelişmekte olan ülkelerin kurumsallaşma anlamındaki dijitalleşme çabaları içerisinde önemli bir yer tutmaktadır. Bu hususun altlığını oluşturma çabaları ülkemiz resmî kurumlarında E-Devlet çalışmaları ile başlayıp, süreç içerisinde kurumlara gerekli olan bütün iş ve işlemlerde elektronik ihale süreçlerinin uygulanmaya başlaması ile devam etmiştir. Özellikle kamu alımlarının

yüksek oranda arttığı bir süreç yaşadığımız şu ortamda kontrol edilebilir süreçlerin olması hem kamu çalışanları için bir kolaylık hem de söz konusu ihalelere talep kâr olanlar için büyük bir kolaylıktır. Ekonomik İş birliği ve Kalkınma Teşkilatı (OECD) tahminlerine göre, tüm kamu alımlarına konu olan piyasa hacmi ülkelerin Gayri Safi Milli Hasıla (GSYH)' larına oranı %15 gibi devasa bir rakama geldiği şu ortamda, kamu alımlarının denetlenebilir ve şeffaf olması herkes açısından daha sağlıklı olacak sonuçlar ortaya çıkaracaktır (İmamoğlu & Özbilgin, 2012).

2.2. Türkiye' e ki Elektronik İhale Sistemleri ve Süreçleri

Ülkemizde ihale sisteminin geliştirilmesi, yaygın olarak ve nitelikli bir şekilde kullanılması ile ilgili gerekli düzenlemeleri yapmakla mükellef olan kurum Kamu İhale Kurumu (KİK)'dur. Tüm kamu kuruluşlarında daha şeffaf, çoğulcu, hesap verilebilir ve sürdürülebilir bir ihale sisteminin geliştirilmesi adına, 04.01.2002 tarih ve 4734 sayılı "Kamu İhale Kanunu" ile söz konusu kurumun tüzüğü yürürlüğe girmiştir. Dijitalleşme çabaları ile beraber gelişen elektronik ihale sistemi de yine aynı kuruma tabi olarak geliştirilen bir elektronik formattır. Mevcut platformda her türlü mal ve hizmet alımı şeklinde tertipler yapılabilir niteliktedir. Bu hususta gerek AB gerekse diğer dünya modelleri incelenmiştir. Ülkemizde daha efektif bir şekilde kullanılması için incelenen tüm maddelerin ortak noktaları tespit edilmiştir. Uygulamaya yönelik herhangi bir sıkıntı çıkmaması içinde Güney Kore Elektronik Kamu İhale Modeli referans olarak ülkemizde kabul görmüştür. Yerel yönetimlerde de sıklıkla başvurulan bu sistem aktörleri ile beraber Şekil 1' de gösterilmiştir. Şekil 1 üzerinde verildiği şekliyle mevcut sistemin yapı taşları belirtilmiştir.



Şekil 1. KİK aktörleri

2.3. Yerel Yönetimlerde Elektronik İhale Sistemleri ve Etkileri

Yapılan literatür taramaları sonucunda, dünyada ve ülkemizde insanların daha müreffeh bir yaşam sürebilmeleri adına yerel yöneticilik kavramının çok önem arz ettiği görülmektedir. İnsanların kendi bölgelerindeki gerek alt yapı ve üstyapı ihtiyaçlarını gerekse sosyal belediyecilik anlamındaki ihtiyaçlarının nitelikli bir şekilde belirlenmesi ve bu ihtiyaçlara nitelikli bir şekilde geri dönüş yapılabilmesi açısından, belirleyecekleri yönetim çok büyük önem arz etmektedir. Zira merkezi yönetimler her zaman mevcut bölgelerin ihtiyaçlarını net bir şekilde bilemeyebilir, çünkü her bölgenin kendine has dinamitleri ve ihtiyaçları göz önüne alındığı zaman, bahsedildiği üzere merkezi yönetimlerin hizmetleri yerine ulaştırma anlamında daha pasif kalabileceği gerçeği herkes tarafından bilinen bir gerçektir. Lakin bu hizmetlerin söz konusu yerlere götürülmesi hususunda kamu bütçelerinin düzenli bir şekilde kullanılması da zaruri bir durumdur. İşte tam olarak bu noktada ulusal ve yerel anlamda rekabeti tam olarak sağlamak ve daha şeffaf bir süreç yönetmek adına elektronik ihale süreçleri daha verimli olabilmektedir. Yerelde ihtiyaç olan herhangi bir mal veya hizmet ulusal anlamdaki tedarikçilerden sağlanabilmekte ve daha verimli piyasa takip süreçleri yaşanabilmektedir. Ayrıca yine daha şeffaf süreçler yaşanıp, süreçlerin herkese açık bir hal alması sağlanabilmektedir. En temel anlamda bir mal veya hizmet alınması süreçleri Şekil 2 ve Şekil 3'te ifade edilerek söz konusu platform üzerinden bu süreçlerin ilerleyişi gösterilmektedir (Hamdi, 2016).

2.4. Proje Teslim Yöntem Seçimleri ve YBM (BIM) Uygulama Planına Genel Bakış

En genel anlamda ihale mevzuat ve tanımları incelendikten sonra, özellikle yerel yönetimlerde yapılan yapım ihaleleri ve bu ihaleler sonucunda ürünün ortaya çıkış sürecinde yaşanan gelişmeler irdelenmiştir. Birçok yerel yönetimde mevcut bölgenin ihtiyaçlarına göre hazırlanan altyapı ve üst yapı projelerinde, sürecin başlangıcından

bitişine kadar kurum yararı ve bütçe kontrolleri ön planda olduğu için özellikle minimum fiyatlı işler yapılmak istenilmektedir. Burada da seçilecek proje teslim yöntemi çok önem arz etmektedir (Atabay & Öztürk, 2019). Özellikle resmî kurumlarda bu sebepten dolayı Tasarla- Teklif et- İnşa et yöntemi tercih edilmektedir. Design- Bid- Build (DBB) yöntemi olarak literatürde adlandırılan bu yöntem ile aslında hep minimum fiyat hedeflenir. DBB aynı zamanda sabit birim fiyatlı teklif olarak da adlandırılabilir. Özellikle sınırlı kurum bütçeleri düşünüldüğünde en düşük inşaat fiyatıyla sonuçlanacağı düşünülebilir (Killough, 2022). Burada tasarım tamamlandıktan sonra proje bilgilerine göre fiyatların toplanması aslında temel mantık olarak yer almaktadır. Bir diğer husus ise talipliler iyi bir fiyatlama için proje hazırlayanlara sorular soracak ve bir bakıma söz konusu iş başlamadan önce mimar ve mühendislerle beraber çalışacaklardır. Yine kurum kendi yararı için tasarımın yapıldığı ve yüklenici – alt-yüklenicilerin belirlendiği bu süreçte mal sahibi olarak daha kaliteli ürün ortaya çıkmasına yardımcı olacaktır (Gordian, 2022).

Proje teslim yöntemi belirlendikten sonra, herhangi bir proje için aslında YBM (BIM) uygulama planı uygulamaya koyulabilir (Akkoyunlu, 2015). Aslında temel de bu bir inşai süreç için olmak zorunda da olmayabilir. Lakin bu çalışmada da irdelendiği kadarıyla, BIM "Building information modelling", binaların tasarımı, inşası, işletilmesi, güçlendirilmesi ve yıkımı için gerekli tüm verilerin birleştirilmesine ve değiş-tokuş edilmesine izin veren bir metodoloji olduğu kadar, ileri bir teknoloji olarak da adlandırılabilir. Bu teknolojik yapı çok esnek bir şekilde verilerin saklanmasına ve yorumlanmasına izin verir (Domer, 2017). Aslında kurum tarafında da düşünüldüğü zaman daha iyi bir iş birliği yoluyla daha iyi kalite ortaya çıkar ve kurum kontrolü sayesinde daha az hata ortaya çıkar.

2.5. Yerel Yönetimlerde E-İhale ve Proje Yönetim Süreçlerinde Yaşanan Aksaklıklar

Ülkemizde diğer kamu kurumlarında olduğu gibi, yerel yönetimlerde de belge ve bilgi yönetim süreçleri incelendiği zaman, söz konusu yönetim süreçlerine ulaşmak için

teknolojiye erişim imkanında bir sorun yaşanmadığı fakat söz konusu teknolojiyi kullanımda birtakım aksaklıklar yaşandığı gözlemlenmiştir (İmamoğlu & Özbilgin, 2012). Diğer bir ifade ile, belge yönetimlerini ve bilgi akışını nitelikli yapabilecek iş gücü oluşturulabilir iken bazı kaygılar sebebi ile aşırı işgücü istihdamı ve bu istihdam üzerindeki karmaşıklık söz konusu süreçleri aksamalara uğratmaktadır. Belli bir sistemin olmayışı, söz konusu kurum içerisinde çalışan her bir yönetici ve çalışanın kendi insiyatifleri sonucunda parça parça ve birbirinden kopuk bir şekilde disiplinlerarası koordinasyonu sağlama dürtüleri bu durumun oluşmasına sebep olan bir diğer faktördür. Bu birbirinden kopuk çalışma metotları ise;

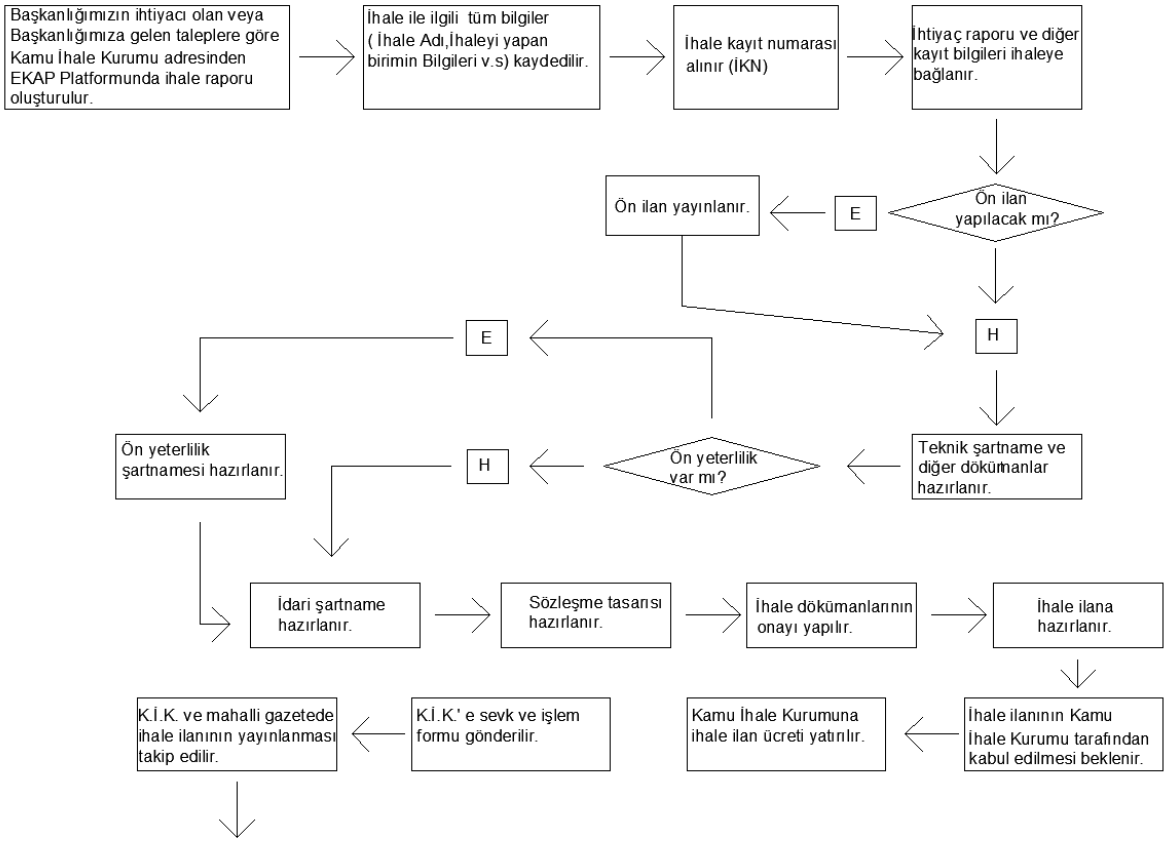
- Süreçlerin uzun ve yorucu olmasına,
- Maliyetlerin artmasına,
- Kontrol mekanizmalarının niteliksiz kalmasına,
- Niceliksiz ürünlerin ortaya çıkmasına,
- Kurum olanaklarının liyakatsiz bir şekilde kişilerin inisiyatifine bırakılmasına,

Sebep olduğu görülmüştür. Her ne kadar E-İhale sistemleri kullanılarak, hizmet alımı veya mal alımı işleri otomatize edilmeye çalışılsa da bu bahsi geçen aksaklıkların temelde devam etmesi, yapılması istenilen şeylerin gerçekleşememesine sebep olmaktadır. Zira, E-İhale sistemleri kurum içinde nihayete ermeden bir otokontrol sistemi ile kontrol edilmemesi sonucunda yapılan şey, eski geleneksel sistemleri sadece fazladan bir iş yükü olarak bilgisayar sistemine aktarmaktan başka bir şey olamamaktadır. Özellikle bu makale içerisinde de verildiği üzere, yerel yönetimlerde de geçerli olan inşaat sektöründe E-İhale sistemleri 3 yolla faydalı olmaktadır. Bu 3 yolunda daha aktif bir şekilde ortaya çıkması da E-İhale sistemlerinin nitelikli bir şekilde uygulanmayışına bağlıdır (McIntosh & Sloan, 2001). Bunlar Etkinlik, Etkililik ve Başarım konularında sağladığı faydalardır (Çıracıoğlu & Yaman, 2020).

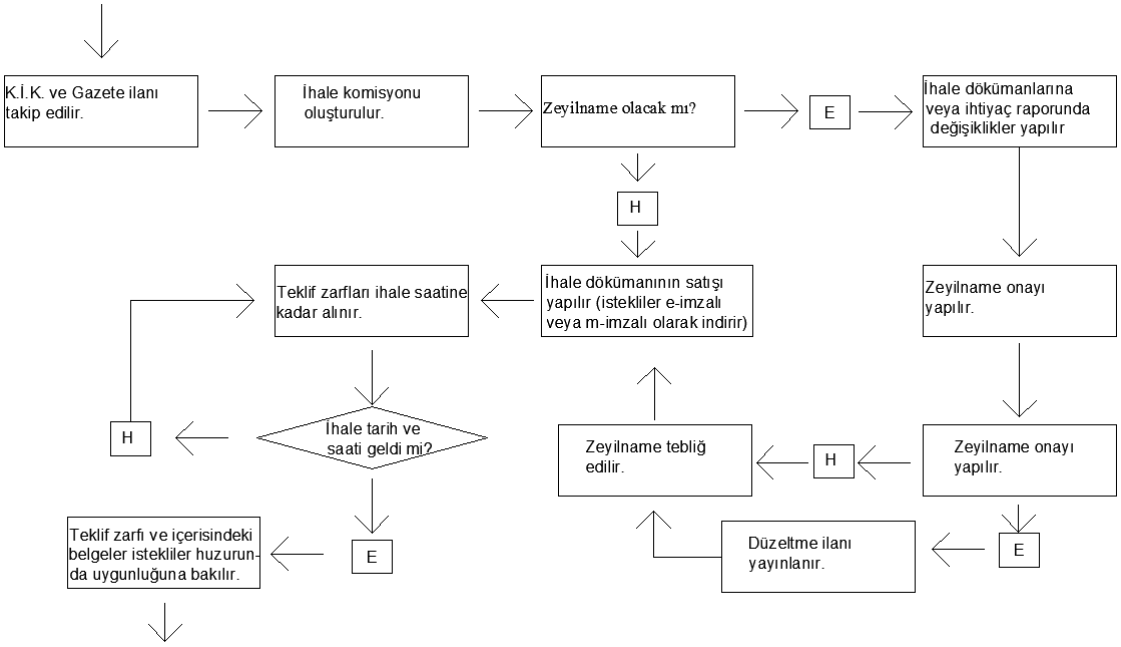
1. Etkinlik (efficiency)
    - Depolama gereksinimlerinin azalması
    - İşlem zamanının kısalması

- İşlem maliyetlerinin düşmesi

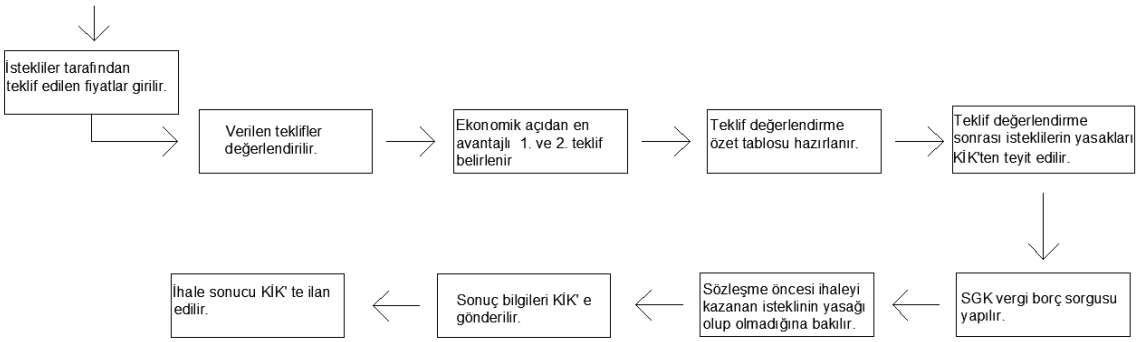
2. Etkililik (effectiveness)
   - Rekabetçi kapasitenin artırılması
   - Tedarikçi fiyat tekliflerinin hızlı cevaplanması
   - Müşterileri fiyat konusunda hemen bilgilendirme
3. Başarım (performance)
   - Stok ve fiyat bilgisine dışardan ulaşılabilirlik
   - Yeni tedarikçileri sisteme entegre edip, ulaşılabilirliği



Şekil 2. Yerel yönetimlerde açık ihale yöntemi süreç 1 (Hamdi, 2016).



Şekil 3. Yerel yönetimlerde açık ihale yöntemi süreç 2 (Hamdi, 2016).



Şekil 4. Yerel yönetimlerde açık ihale yöntemi süreç 3 (Hamdi, 2016).

2.6. Yerel Yönetimlerde proje Yönetim Süreçleri

Birçok devlet kurumunda olduğu gibi yerel yönetimlerde de yapılacak olan herhangi bir mal veya hizmet alım işi ve bunun içinde de incelenmesi gerekli olacak olan yapım işleri

ile alakalı olarak yapılan incelemelerde EKAP süreçleri takip edilse de proje yönetim süreçleri ile bağımsız bir şekilde geleneksel yöntemlere bağlı kalınarak bir süreç koordinesinin sağlandığı görülecektir. E- İhale'nin de tanımına bağlı kalarak, proje yönetim süreçleri söz konusu ürünün tanımı, tedarikçilerin araştırılması ve seçim, seçilen tedarikçiler ile görüşmeler, ayrıca yapılan görüşmeler sonucunda olumlu bir gelişme var ise kamu menfaatine olan durumlarda, yapılan görüşmelere bağlı olarak sözleşme oluşturma gibi süreçleri satın almayla entegre ederek yeni bir teknoloji oluşturulmuş olur. Fakat, bu bahsedilen süreçler belli bir senkronizasyon yapılmadan birbirinden kopuk bir şekilde oluşturulduğu için sonuçta yine geleneksel yöntemlere paralel çalışmalar ortaya çıkmaktadır. Tüm bu anlatılan süreçler Şekil 2 ve Şekil 3' de gösterildiği şekilde (Hamdi, 2016) yerel yönetim özelinde irdelendiği zaman, başkanlık makamının ihtiyaç olarak gördüğü veya yine başkanlık makamına vatandaşlar tarafından direkt olarak iletilen ihtiyaçlara istinaden KİK kurumu adresinden EKAP platformu kullanılarak bir ihale raporu oluşturulur. Bu rapor oluşturulurken, ihale ile ilgili tüm bilgiler başka bir birimden tedarik edilir. Bu bilgiler alınırken yine aynı birimden ihtiyaç raporu ve diğer bilgiler alınarak ihaleye bağlanır. Söz konusu bilgilerin, ihale birimi tarafından ön kontrolleri yapılır ve bunun akabinde teknik şartname ve varsa diğer dokümanlar talep edilir. Elde edilen bilgiler ön yeterlilik incelemesine tabi tutulur. Bunun sonucuna göre, diğer bürokratik ve idari süreçler hazırlanır. Buraya kadar hazırlanan tüm süreçlerde birbirinden bağımsız bir şekilde farklı birimlerin kontrolünde süreçler devam eder. Yani bireysel hatalardan kaynaklı bir sorun varsa bir diğer işlem bu hatanın üzerine inşa edilerek, disiplinler arası koordinasyon ve uyum sağlanmamış olur. Erken süreçte ortaya çıkmayan bir hata, ileride veya ihale incelendikten sonra ortaya çıkacak ve kurum adına telafisi güç durumlar oluşacaktır. Tüm bu olumsuzluklara rağmen sonuç olarak mevcut dosya KİK ilan ücreti yatırılarak ve gerekli formlar servis edilerek aslında bakıldığı zaman EKAP sistemine girilecektir. Şekil 2 ve Şekil 3' den de görüleceği üzere aslında birçok süreç birbirine bağlı şekilde ve farklı birimler tarafından gerçekleştirilmektedir. Üzerine bir de sözde dijitalleşme ile beraber bu süreçler EKAP platformunda takip edilip herhangi bir aksaklığa meal verilmemeye dikkat edilmektedir. Sonuçta kullanılan

sistemin adı elektronik bir sistemde olsa yapılan işler sadece iş yükünü artırıp sistem efektif bir şekilde kullanılamamaktadır (Aydın & Koman, 2021).

3. Bulgular ve Tartışma

3.1. Örnek Bir Çalışma ile Yapı Bilgi Modellemesi ve EKAP Entegrasyonu

Yapılan bu çalışmada, yine geleneksel yöntemde de benzer olan ve çıkış noktası Belediye Başkanının mevcut bölgenin ihtiyacına yönelik hazırlanması yönünde bir talimat vermesi ile başlamıştır. Yapılacak olan proje en basit anlamda bir yapı ruhsatı gerektirmemesi, alt yapısal anlamda ekstra bir imalata gerek duyulmaması, mevsim şartlarının uygun olması gibi şartlarda düşünülerek bir yol rehabilitesi projesi seçilmiştir. Yapının ilk projesi YBM sistemine uyumlu bir şekilde çalışacak CAD tabanlı bir programdan türetilecek ve bu proje bilgileri EKAP sistemine yüklenirken DWG uzantılı dosyalar halinde yüklenecek ve çıkarılan keşif özeti CAD tabanlı programdan otomatize edilerek çıkarılacaktır. Söz konusu proje verileri EKAP-YBM entegrasyonunun temelini oluşturması adına Kavramsal Model oluşturulacak ve sistem gereksinimleri de anlatılarak yine bu Kavramsal Model üzerinden ifade edilecektir. Burada temel olarak aslında YBM'nin proje süreçlerindeki kullanım sahalarına itafen oluşturulmuş olan Kavramsal Model' in akabinde EKAP sistemine etkileri içinde bir model önerisi getirilecektir. Sonuç olarak model önerisi genelleştirilecek kavramsal tasarım, analiz, belgeleme, imalat 4D/5D üretim, lojistik, işletme ve bakım-yenileme gibi (Dortek, 2018). safhalarında model üzerinden gösterimi yapılabilecek ve uygulanmak istenilen sistemin tüm verileri anlatılacaktır.

3.2. YBM ve E-İhale Entegrasyonu İçin Gerekli Sistemler

Önceki bölümlerde de anlatıldığı gibi, E-İhale sistemleri özellikle kamu kurumlarında da gelişen ve büyüyen dijitalleşmeye rağmen çeşitli sınırlandırmalara maruz kalmaktadır. Aslında bunun altında yatan sebeplerden biri de inşaat sektöründeki birlikte çalışılabilirlik probleminin yani disiplinler arası koordinasyon sorununun birçok kamu

kurumundaki aşırıya varan bürokratik temayüller ile birleşmesi sonucunda, dijitalleşmeye adapte olmanın zorlaşmasıdır. Özellikle kamu kurumlarında yaşanan bu birlikte çalışılabilirlik sorunu, kurumların bilgi ve iletişim teknolojilerinden (ICT) faydalanmasına engel olmaktadır. Bu tarzdaki sorunlardan sıyrılmak, yani elektronik ihale hizmetlerinde YBM'i kullanabilmek içinde bu araç ve yazılımlar arasında büyük bir iş birliğinin olması gerekmektedir. Yani, modelleme bilgilerine ek olarak hazırlanan teklife çağrı, siparişler, fatura edilmesi ve bütün bunlara ek olarak kullanılabilecek diğer sayısal bilgilerinde eklenmesi gerekmektedir. Tüm bunlar için, proje başlangıcından itibaren, Elektronik İhale sistemlerine tüm proje işlemlerinin eksiksiz bir şekilde girilmesi ve bunların otomatize edilerek çalışmasını sağlayacak bir data alt yapısı oluşturulmalıdır.

Burada unutulmaması gereken husus, her inşaat projesinin kendine has özelliklerinin olduğu için, oluşturulacak YBM ve E-İhale entegrasyonunun birlikte çalışmasını sağlayan, yazılım ve standartları oluşturmak gereklidir. Lakin söz konusu yazılımın sadece elektronik yolla teklif oluşturma, elektronik yolla sipariş girme, kataloglardan ürün seçme veya fatura oluşturmayı değil, aynı zamanda da proje modellemesi ve süreç koordinesini sağlamak içinde kullanılabilmesi gerekmektedir. Bu teknolojik gereksinimler sağlanırken oluşturulması düşünülen Kavramsal Model'in mimari modeli içermesi, söz konusu hizmetleri sağlayacak bir servis ağının olması ve bütün bunlara istenilen zamanda ulaşılabilmesi için Bulut Bilişim Ağı olması gerekmektedir. EKAP içerisinde YBM kullanımına yönelik mevcut bir stratejinin olmaması, temelde bu makalede anlatıldığı gibi uygulanması halinde, YBM sistemlerinin E-İhale sistemleri ile bütünleşmesi ile, inşaat sektörü farklı bir boyuta ulaşacaktır.

3.3. YBM ve EKAP Entegrasyonu

Yerel yönetimlerin yürüttüğü inşai projelerde, EKAP sistemine mevcut ihale dosyaları içerisinde AUTOCAD çalışmaları eklenir. Bu ihaleye talepli olacak firmalarda bu CAD dosyalarını baz alarak teklifler hazırlar. Lakin bu teklifler çoğu zaman eksik ve muğlak

kalmaktadır. Mevcut durumda da, yerel yönetimler tarafından oluşturulan ihale dosyalarına bakıldığı zaman; Şekil 2 ve Şekil 3'de de görüldüğü üzere söz konusu evrak yığınları oluşmakta, gerekli görüldüğü durumlarda da yapım işlerinde mevcut dosyalara AUTOCAD dosyaları eklenmektedir, fakat bu konuda yasal bir zorunluluk yoktur. Tam olarak burada da özellikle, EKAP' ın inşaat sektörü içinde barındırdığı müthiş potansiyelden yararlanmanın önünde engellerin var olduğu ortaya çıkmaktadır. Bunlardan en önemlisi ise sistemin 40 Mb dan yüksek dosyaların yüklenmesine izin vermiyor oluşudur. Entegrasyon hususunda en büyük engellerden biri budur. Bu sorun çözüldükten sonra, bu sistemi kullanacak olan kullanıcılar BIM projeleri üzerinde çalışabilecek ve teklifler bilinçli bir şekilde gönderilebilecektir. Entegrasyon hususunda bir diğer aşılması gereken husus da, kullanıcıların talep edilen ürünleri ve nitelikli tedarikçileri EKAP içerisinde aramasını sağlamaktır.

Kullanılacak olan E-İhale sistemi için bu işlemlerin çok önemli ve işlevsel olacağı açıktır. Çünkü söz konusu entegrasyon süreci basitleştirilmeli, şeffaflık sağlanmalı, kontrol edilebilirliği sağlanmalı, daha düşük fiyat ve daha iyi bir kaliteyi sağlamalıdır. YBM, yapım işleri konusunda EKAP ile bütünleşmesi durumunda, yerel yönetimlerdeki bütün süreçler ivme kazanacak ve kamu yararı daha verimli bir şekilde sağlanacaktır. Kurum menfaati sağlanarak teklifler daha ciddi bir şekilde hazırlanacak, şirketler bütün analizlerini daha efektif bir şekilde yapacak ve sonuçta kontrol ve değerlendirme süreçleri geleneksel sistemlere göre daha iyi yapılacaktır. Tüm bu entegrasyonun sağlanabilmesi için EKAP' ın kullanmış olduğu Özel Bulut Sistemi ve oluşturulacak Mimari Model birlikte kullanılacaktır.

3.4. Kavramsal Model

Kavramsal Model oluşturulmadan önce aslında sistemin entegre edilebilmesi adına bütün sistemin birlikte çalışılabilirliğinin altlığını oluşturmak gerekmektedir. Aslında temelde birlikte çalışılabilirlik terimi, "iki ya da daha fazla sistem yada bileşenin bilgi değiş tokuş etmesi ve değiş tokuş edilen bilginin kullanılmasıdır" (Grilo & Jardim-Goncalves, 2010). Buna benzer olarak Şekil 4' de inşaat sektöründe farklı işletmeler arasında ne türde ve

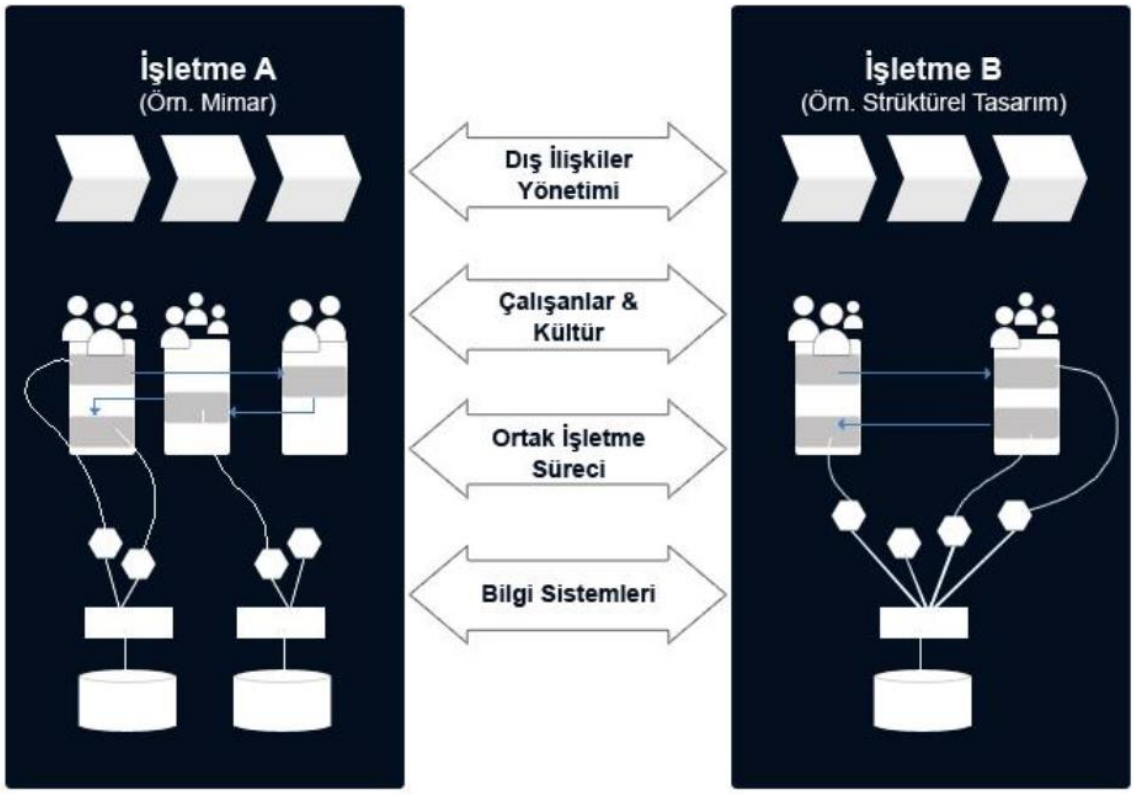
nasıl birlikte çalışılabilirlik ilişkileri kurulabileceği gösterilmektedir. Buradan da görüleceği üzere şirketler veya kurumlar kendi verilerini kurumsal anlamda kendi iç işleyişlerinde paylaşsalar dahi olay dış ilişki yönetimine veya diğer bir ifade ile farklı paydaşlar ile bu süreçleri paylaşıp yönetme durumuna geldiğinde bu ilişkileri yönetme, çalışanlar ve bunlara bağlı kültürel farklılıkları aktarma, ortak olarak işletme süreçleri ve bilgi sistemleri seviyelerindeki paylaşımlar olmamaktadır. Nitelikli kavramsal modelin oluşması içinde Şekil 4'de verildiği üzere nitelikli bir birlikte çalışılabilirliğin oluşması gerekmekte ve bununda oluşması için karşılıklı olarak anlatılan süreçlerin oturması gerekmektedir (Çıracıoğlu & Yaman, 2020).

Birlikte çalışılabilirlik sisteminde yaşanan sorunların çözümü için, YBM'nin araçları, aplikasyonları ve başka platformlar arasında gerçekleşecek dosya alışverişinin çözülmesi gerekmektedir. Bu anlamda da yapılan araştırma sonucunda bu tarzdaki sorunların aslında temelinde sosyo-kültürel ve teknolojik sebeplerin yattığı görülmektedir. Yine kavramsal modele altlık oluşturması adına YBM etrafında gerçekleşen ve ortak veri tabanında YBM ile etkileşimde bir şekilde ortak veri çalışmasını gösteren plan şeması Şekil 5'te verilmiştir (Kumar, Cheng & McGibbney, 2010).

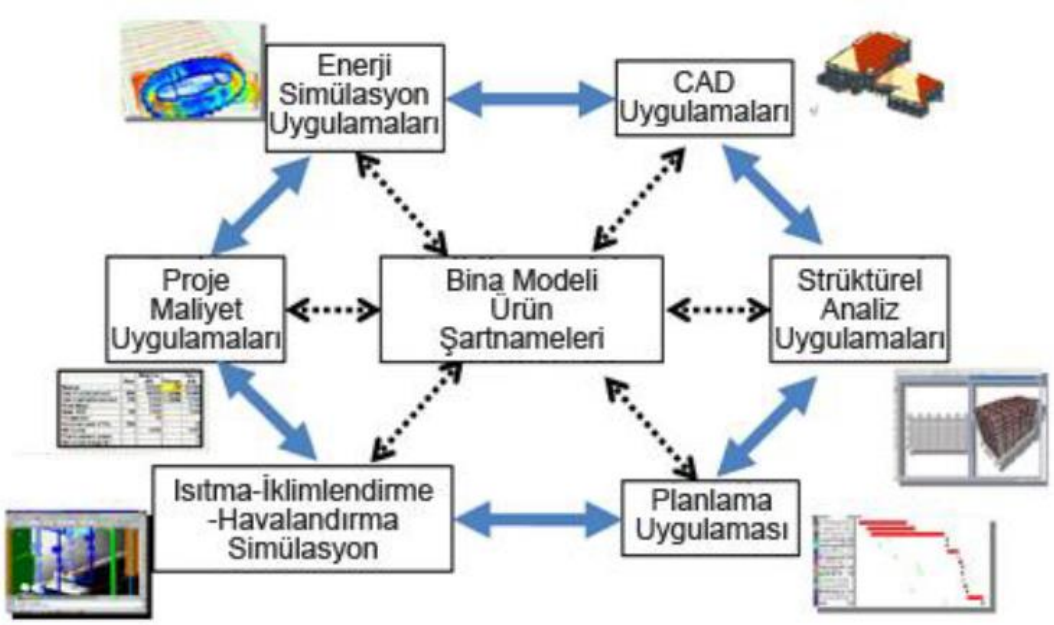
3.4.1. E-İhale ve YBM Bütünleşik Model Önerisi

Daha önceki bölümlerde de genişçe anlatıldığı gibi, her bir inşaat projesi yerel yönetimlerin birbirinden bağımsız olarak ihtiyaçlara yönelik yaptığı ve yapmak istediği işler olduğu için birbirleri ile benzerlik göstermemektedir, bu yüzden YBM ve Elektronik İhale sistemlerinin bir arada çalışmasını sağlayan ve birlikte işlev gören birden çok yazılım ve standardının oluşturulması gerekmektedir. Bu anlamda yapılan literatür çalışmaları sonucunda, Model Odaklı Yazılım Mimarisi (MYOM), Servis Odaklı Mimari (SOM) ve Bulut Bilişim (Cloud Computing) kullanılabilir olduğu gözlemlenmiştir. Nihai Kavramsal Modelin oluşturulabilmesi için bu tekniklerinde anlaşılması gerekmektedir. Bahsedildiği üzere en son teknolojik verilerle üretilen MYOM, SOM ve Bulut Bilişim' in yanı sıra, YBM yaklaşımının da entegre edilmesiyle SOM4BIM sistemi geliştirilmiştir (Jardim-Goncalves & Grilo, 2010). SOM4BIM, Model

Odaklı Yazılım Mimarisi yaklaşımı ve Servis Odaklı Yazılım Mimarisi yazılımlarının bütünleştirilmesinden oluşmaktadır. Yani bu örnekte de görüldüğü gibi, E-İhale – YBM entegrasyonu, ortak kullanımı sağlayan IFC gibi standartlarla gerçekleşebilir ve entegrasyonda paydaşların sisteme bulut bilişim kullanarak bağlanması sayesinde söz konusu teknolojilerden faydalanabilir. Öncelikle bilinmesi gereken husus YBM araçları arasında kullanılan çeşitli temel modelleme, ileri modelleme, analizler, bu verilerden alınacak 4D/5D veriler gibi çıkarımlar IFC formatına dönüştürülebilir ve bu sayede farklı araçlar tarafından kullanılabilir olduğudur.

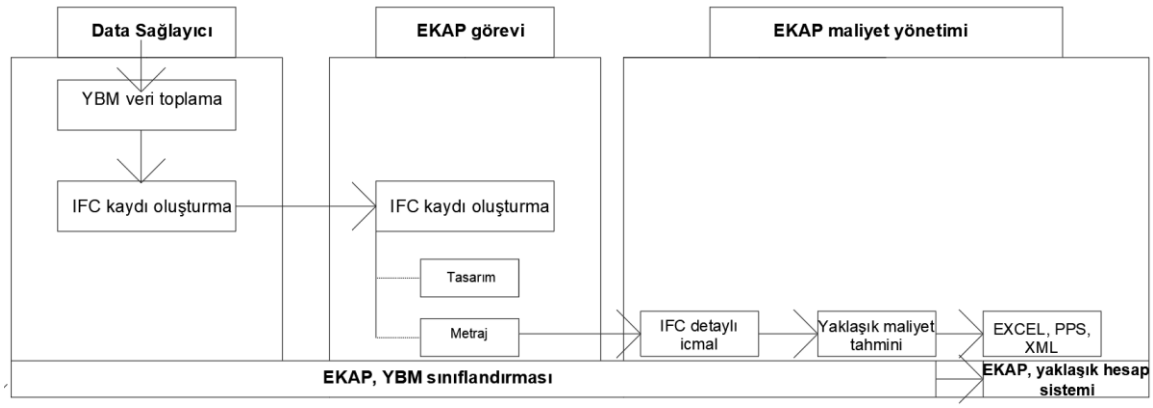


Şekil 5. Birlikte çalışılabilirlik çerçevesi (Saraç, 2013)



Şekil 6. Ortak veri çalışması (Kumar, Cheng & McGibbney, 2010).

Kullanılacak temel çizim programlarından olan Revit de oluşturulan YBM verisi, IFC dijital veri çıktısı olarak sağlanabilir. Oluşturulacak bir yazılım ilede, söz konusu yazılımla beraber çizimlerin de parametrik kontrolü yine yapılan bu yazılım ile sağlanabilir. Akabinde söz konusu yazılım ile beraber görselleştirme, 4D/5D dijital çıktılar, metraj ve yapı çizimleri gerçekleştirilebilir. Bu aşamadan sonra söz konusu IFC kaydı E-İhale sistemine kolayca aktarılır. Burada kalite onayları, metrajlar incelenir. Artık bu süreçten sonra E-İhale sisteminin maliyet yönetimi devreye girer. Burada yine yazılım bize IFC bazlı metrajı (detaylı icmal), yaklaşık maliyeti EXCEL, PPS, XML dosyası olarak sağlar (Kim, 2012). Böylece, hem YBM sınıflandırma sistemi kurulmuş olur, hem yapılan entegrasyon ile maliyet hesap sistemi kurulmuş duruma gelir. Tüm bu anlatılan süreç Kavramsal Model olarak Şekil 6' da ifade edilmiştir.



Şekil 7. EKAP – YBM entegrasyonu kavramsal model

Yapılan ihalelerin fazlalığı aslında hizmetlerin çeşitliliğinden kaynaklanmakla beraber günlük ve acil ihtiyaçların doğması ve değişen dünya düzeni ile birçok farklılık gösterebilmektedir. Bütün bu iş ve işlemleri EKAP ile entegre edilebilecek bir Yapı Bilgi Modellemesi (YBM - BIM) kavramı ile bütünleştirilebilirse, çok daha verimli sonuçlarda elde edilebilecektir. Diğer bir deyişle EKAP uygulamasının oluşturulacak bir YBM ile entegrasyonu başarılı bir şekilde sağlanabilirse yerel yönetimler açısından zaman ve maddi kayıpların önüne geçilebilir, özellikle vatandaş memnuniyeti yüksek oranda sağlanacağı için hizmet devamlılığı ve verimliliği daha fazla olacaktır (Pınar, 2022).

Mevcut durumda, devlet kurumlarında idareler tarafından oluşturulan söz konusu ihale ve eki dosyalara bakıldığında; idari şartname, sözleşme tasarısı, söz konusu alımın türü ve uygulanacak ihale türüne göre ilgili uygulama yönetmelik eki tip idari şartname ve teknik şartname gibi dosyaların olduğu görülür. Ayrıca buna ek olarak yapım işlerinde kurum gerekli gördüğü takdirde CAD tabanlı çizim dosyalarında da olduğu görülür. Fakat bu konuda herhangi bir zorunluluk olmadığı gibi sisteme yüklenilebilen dosya boyutu da 40 Mb ‘ı geçememektedir. Özellikle yerel yönetimlerin genellikle muhatap olduğu küçük ve orta ölçekli inşaat şirketleri, söz konusu dosyalar ekindeki AUTOCAD dosyalarını baz alarak teklifleri hazırladıklarında, bu teklifler eksik, muğlak ve hatta çoğu zaman yanlış olabilmekte ve ihaleler neticelendiğinde telafisi güç durumlar oluşabilmektedir. Diğer bir deyişle, proje bilgilerine kısıtlı ulaşım olduğunda, projeyle ilgili olarak yapısal anlamda

bir bilgi oluşsa da, yapısal olmayan ürünler hakkında bir bilgi oluşmamaktadır. Bu şekilde oluşturulan yüzeysel teklifler, temelde EKAP'ın amacını tam manasıyla gerçekleştirmesine engel olmaktadır. Bu makale içerisinde anlatılan kavramsal model, yazılım geliştirilmesi ve yazılım mimarilerinin uygulanması ile birlikte, EKAP-YBM entegrasyonu yapılabilecektir (Eroğlu & Tunç, 2018/2). Böylece entegre edilmiş bir sistem ile herhangi bir ihalede talipliler söz konusu dosyalara daha ciddi bir şekilde hazırlanacak, daha detaylı bir analiz yapabileceklerdir. Ayrıca bu sisteme erişim için belli bir teknik altyapıya sahip olunması gerektiği için, herkes teklif gönderemeyecek, YBM entegrasyonu ile beraber süreçler daha şeffaf bir hal alacaktır. Geleneksel yöntemlerden daha kolay ve ulaşılabilir, denetlenebilir bu sistem ile beraber kamu kaynakları daha doğru bir şekilde kullanılacak, ayrıca işgücü yönetimi daha verimli bir şekilde yapılabilecektir.

4. Sonuç ve Öneriler

Anlatılan sistem entegrasyonu için, öncelikle buna ön ayak olacak şekilde basit ve uygulanabilir pilot projeler geliştirilmelidir. Lakin bu pilot projelerinde uygulanabilmesi açısından, mevcut Kamu İhale Kanunu'nda birtakım değişiklikler yapılıp, belli bir limitin üzerindeki projelerde YBM kullanılması zorunlu hale getirilmelidir. Özellikle birçok ihtiyacın iletildiği ve hızlı bir devinimin olduğu yerel yönetimlerde söz konusu pilot projelerin geliştirilmesi ile birlikte analizlerin nitelikli bir şekilde yapılması sonucu çok hızlı gelişmeler olabilecektir. Pilot projeler seçildikten sonra, yine makale içerisinde anlatıldığı gibi bir YBM-EKAP entegrasyonu özel bir bulut bilişim havuzuna entegre edilip maliyet hesapları, performans analizleri, planlama süreçleri vb. konular hızlı bir şekilde yapılabilir. En temel anlamda bu süreçler Şekil 6' da gösterildiği şekliyle dizayn edilebilir. Verilen şekilde örnek model önerisinin bir parçası olarak sunulmuş olan şema, kurulacak olan entegrasyona altlık oluşturacak şekilde dizayn edilmiştir. Tüm bu süreçler nitelikli şekilde organize edildiği takdirde yapım sektörü için ve yerel yönetimlerin kurumsal hafızaları için önemli bir veri tabanı oluşturulacak ve geriye dönük her türlü bilgiye ulaşılabilecektir.

Söz konusu araştırmalar sonucunda yapılan çalışma ile sektöre ve literatüre yapacağı düşünülen katkılar ise şu şekilde sıralanabilmektedir;

- İlk iş emrinin kurum amiri tarafından verilmesi ile beraber süreç daha kontrol edilebilir bir şekilde başlayacaktır.
- BIM sorumlusu tarafından sistemin paydaşları ile oluşturulan kapalı sistem ve EKAP entegrasyonu ile birbirinden farklı kurum ve aynı kurum içinde görev alan farklı birimlerde görev tanımları belirgin şekilde yapılarak gereksiz iş gücü harcanmasının önüne geçilecektir.
- Geleneksel yöntemlerden farklı olarak hem iş gücünün daha nitelikli kullanılması hem de sürelerin azalmasıyla bütçesel anlamda kamu bütçelerine olumlu yansımaları olacağı ve bütçelerin daha doğru kullanımının önü açılacaktır.
- Özellikle EKAP sürecinin sisteme entegrasyonu ile inşaat pozların nitelikli şekilde araştırmalarının yapılması ve metrajların kontrol edilebilirliği ile gereksiz ihale bütçelerinin önüne geçilip kamu adına şeffaflık, rekabet, eşit muamele, güvenirlilik ve gizlilik etkenleri daha nitelikli sağlanmış olacak ve nitelikli bir şekilde hesap sorulabilirlik ortaya çıkacaktır.
- BIM tarafından sağlanan bu iş bölümü ile, yaşanabilecek zaman kayıplarının hangi birimlerden ve nelerden kaynaklandığı raporlanmış ve sorun hızlıca giderilmiş olacaktır.
- Kamu kurumlarının birlikte çalışılabilirlik sorunları ortadan kaldırılacak ve her kurumun kendi menfaatine değil de bir bütün olarak devlet menfaatine çalışmalar ortaya çıkacaktır.

Yapılan bu araştırma sonucunda elde edilen bulgular ve önerilen Kavramsal Model çalışması ile birlikte bir adım ötesine taşındığı taktirde uygulanacak bir uygulama projesi ile beraber bahsi geçen model içeriğindeki programlar vasıtası ile uygulama safhasına geçilebilecektir. Ayrıca EKAP gibi bir uygulamanın tabi olduğu kurum ile bu modeli uygulayacak kurumlar arasında yapılacak olan protokoller ile uygulama genelleştirilebilecek ve daha yaygın hale gelecektir. Ayrıca söz konusu kavramsal model üzerinden bu uygulamaya altlık teşkil edilecek şartnameler hazırlanıp özellikle BIM

uygulamalarının devlet ihalelerinde zorunla hale getirilmesi başlangıç olarak maliyet kontrollerinin ve yeterlilik seviyelerinin iyi bir noktaya gelmesine olanak tanıyacaktır. Bu sayede özellikle kamu ihalelerinde nitelikli müteahhit firmalarının artmasına ve kamuda daha nitelikli işler yapılmasına olanak tanıyacaktır.

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Customer Segmentation with Data from Various Markets Using K-Means Clustering

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Abstract

In today's competitive environment, it is important to meet consumer demands and needs in the best way. In this process, it has become a necessity for modern marketing efforts to know consumer behaviour well for businesses to develop strategies. Today, it is critical for companies to divide the targeted market into homogeneous sub-markets including similar behaviours, needs and expectations for customers, to aim to differentiate marketing strategies and actions in terms of the sub-market, to know the customer better, and to follow customer trends easily. For this purpose, in order to cluster the customers, questions including factors such as brand loyalty, quality and price, which are among the factors affecting the purchasing decisions of consumers, were asked to 1037 customers from various brands in the categories of white goods, furniture, clothing, and demographic data such as age, gender, education, income status were collected. Data analytics techniques have been used extensively in customer segmentation that is grouping objects together based on the difference in similarity on each object and providing a high level of homogeneity in the same cluster or a high level of heterogeneity between each group. In this paper, a customer segmentation model based on the clustering method is demonstrated, such as K-means method. According to the findings obtained as a result of the analysis, customers are divided into 7 clusters. The proposed model is expected to provide precise customer segmentation for customer strategy decision making.

Keywords: Customer Segmentation, Customer Data, Clustering, K-Means, Data Science.

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1.Introduction

Customer segmentation is the process of grouping consumers based on traits they have in common. The goal of customer segmentation is to decide how to interact with consumers in each category in order to maximize each customer's profitability to the company. The customer can be categorized using cluster analysis based on their spending patterns, buying patterns, or the specific brand or product they are interested in. The gathered data is processed, and customer segments are created using an unsupervised learning approach called Kmeans clustering (Nie, Li, Wang & Li, 2022). Shirole et al. (2021) state that the foundation of customer segmentation is the identification of key distinctions that divide customers into target groups.

Factors such as demographic, sociological, economic (Aktuğlu & Temel, 2006), brand loyalty, price (Kurtuluş & Okumuş, 2006) and product quality (Dunk, 2002) are main determinant on of consumers' purchasing behaviour.

Aktuğlu & Temel (2006) stated that factors such as demographic, sociological, economic, etc. Another concept that forms the basis of economic factors is income level. The ability of young people to meet their purchasing behaviour is completely proportional to the family budget, and therefore, the pricing of the product is very important in product selection. In the study conducted by Kurtuluş & Okumuş. It was explained that one of the important determinants in the formation of consumers' purchasing behaviour is the "price phenomenon".

Brand loyalty brings some strategic advantages if it can be managed correctly for companies. These advantages can be listed as decreasing marketing expenditures, being more dominant at retail points, attracting new customers and saving time against competitor activities (Aaker & David, 1996). Brand loyalty is an attitude with behavioural and cognitive roots that emerges in the purchasing process of consumers. In order to create brand loyalty, first, it is necessary to define it correctly and to determine the factors that create it correctly (Karabulut & Kaya, 1991).

Brand loyalty is key factor in predicting consumer behaviour. Given that perception influences customer behaviour, it is vital to take consumer perception into account when predicting consumer behaviour (Cobb-Walgren, Ruble & Donthu, 1995). Considering how the four stages of loyalty develop, it's important to keep in mind that 'cognitive-emotional' loyalty, which occurs sequentially, rather than simultaneous allegiance, occurs at each step. According to this viewpoint, the initial degree of cognitive loyalty is crucial and significant (Ahn & Back, 2018). At this point, information on pricing, quality, and image are used to gauge customer loyalty (Hinson, VanZyl, Nimako, Chinje & Asiamah, 2016).

Product quality is often cited as the source of competitive advantage. Thus, design and production dimensions that meet customer demands should also increase quality performance. Quality provides an axis for strategic advantage. Therefore, improvements in product quality can lead to better performance (Dunk, 2002). One of the most crucial factors in a company's success is the quality of its products. One of the primary elements influencing business performance over the long term is the product quality of the company's offerings in comparison to those of its rivals (Buzzell & Gale, 1987).

Studies in related to customer segmentation are summarized. In the study conducted by Wei et al. (2013) it was stated that the hairdressing industry plays an increasingly important role in the service sector. In their study, they performed customer profile analysis in a hairdresser in Taiwan by applying two-stage clustering method by combining SOM (Self Organizing Maps) and K-means algorithm. According to the analysis results of the model, customers in the hairdresser; loyal customers, potential customers, new customers and lost customers divided into four groups. Maryani et al. (2018) segmented the customer k-means algorithm based on RFM model using 82648 data based on credit from company Nine reload. As a result of the study, the data were divided into 2 clusters. A study was conducted by Dzulhaq et al. (2019), a local wood products company, to identify the profitable customer and develop the marketing strategy

accordingly. Using k-means based on the RMF model, segmentation was done according to the sales process, a cluster of 3 was created.

In this study, questions including factors such as brand loyalty, quality and price, which are among the factors affecting the purchasing decisions of consumers, were asked to 1037 customers from various brands in Turkey's leading white goods, furniture and clothing categories. The dataset containing the answers to these questions and the demographic data such as age, gender, education, income status was obtained from a private research firm.

This study aims to segment customers in an efficient manner. The K-Means clustering algorithm is used in the consumer segmentation that is suggested for this study. The goals and contributions of this study are to examine the relationship between consumer segmentation and buying behaviour.

2. Methods and Materials

2.1. K-Means Clustering Method

Clustering, in its simplest definition, is the division of data with similar characteristics into groups among themselves. The general purpose of cluster analysis is to provide within-cluster homogeneity and inter-cluster heterogeneity. This can be achieved by gathering similar individuals in the same cluster. The clustering problem is also an optimization problem, and optimum clustering is achieved by minimizing the sum of the distances of the cluster elements from the cluster mean. The similarities of individuals are related to their position in space. Individuals who are less distant from each other in terms of their positions in space will be gathered in the same cluster.

The literature contains a wide variety of clustering algorithms. The adoption of a clustering technique depends on the objective and type of data. In general, the primary clustering techniques include partitioning techniques, hierarchical techniques, density-based techniques, grid-based techniques, and model-based techniques (Özekes, 2003).

The most commonly used distance measures to calculate distances between units are Minkowski, Euclid, Pearson, Manhattan, Mahalanobis, and Canberra Distance (Cengiz & Oztürk, 2012).

The K-means algorithm is one of the most widely used algorithms, as well as one of the most well-known algorithms. K-means, which is a clustering algorithm, is used to classify data. The purpose of use is to divide the data to be classified into k classes or clusters in terms of their properties. Classification is achieved by the distribution of the selected data around the centre points of the clusters, which show the closest features in terms of similarity to each other. The reason why the name of the algorithm is k-means is that it works by requiring the number of clusters to be constant. The number of clusters is expressed with the letter k, and it is also the representation of the number of clusters that will be formed according to the similarity between the data. From this point of view, it is deduced that k is a positive integer that has not changed in value until the end of the clustering study (Kaufman & Rosseeauw, 1990)

The steps of the K-means algorithm are indicating on the following (Hartigan & Wong, 1979):
Step 1: First, cluster centers are determined. There are two different ways for this. In the first, k random points with the number of clusters are selected from among the objects, or the center points are determined by taking the average of all objects.
Step 2: By calculating the distance of each object to the selected center points, all objects are placed in the closest cluster of k clusters.
Step 3: The new center points of the clusters are replaced with the average value of all objects in that cluster.
Step 4: Repeat steps 2 and 3 until the center points do not change

2.2. Elbow method to Select Number of Clusters (k)

The elbow method is simple and meaningful decision solution looking for the optimal K number.

The elbow method depends on the degree of deterioration. Distortion implies to the sum of the squares of the distance between the centre and all the elements in the same cluster. For a cluster, the lower the degree of distortion, the higher the density and the closer the elements are. In other words, as the K value increases, the distortion level decreases.

2. 3. Evaluation

2.3.1. Davies Bouldin

Davies Bouldin method tries to make the distance between the cluster's minimum and the distance between clusters maximum:

$$db = \frac{1}{k}\sum_{i=1}^{k} R_i \quad (1)$$

I = 1, 2, …, k and j = 1, 2, …, k. and the maximum comparison ratio between other clusters is calculated by the following equation:

$$R_{ij} = \frac{S_i + S_j}{d_{ij}} \quad (2)$$

d_{ij} : distance between centres in clusters

S_i & S_j : the average distance to the centres of the cluster where the cluster observations are located.

Small db values indicate good clustering (Davies & Bouldin, 1979).

3.Experiments and Results

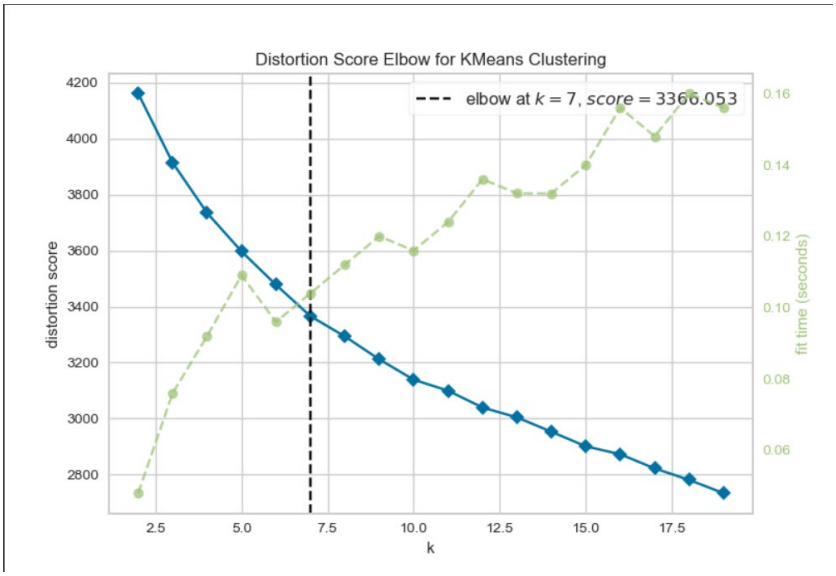

Figure 1. Elbow method

The optimal k in the K-means clustering algorithm can be determined using the elbow criterion. As shown in Figure 1, the optimal k number is 7.

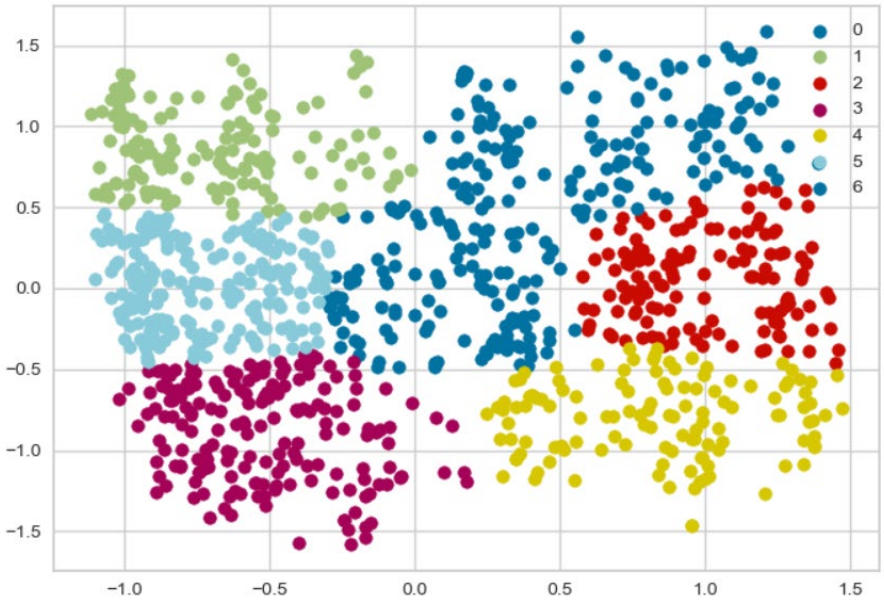

Figure 2. PCA scatter plot of K-Means

The Figure 2 presents the scatter plot of the new 2D feature space resulted from K-Means within the 7 resulted clusters.

3.1. Analysis

To examine the behaviour of customers in each cluster, the demographics of customers and brand perception are clustered separately as follows:

Cluster 0: Customers in this cluster, most high school graduates, over the age of 25, are craft or wage- earner.

Cluster 1: Customers in this segment, mostly high school graduate women, over 35 years old and mostly housewives or retired.

Cluster 2: This is the cluster of women between the ages of 25-45 with a bachelor's degree, more than half of whom are wage- earners.

Cluster 3: In this cluster customers are men, aged 25-45 with undergraduate degrees are mostly wage- earner.
Cluster 4: Customers in this cluster, retired men, over the age of 45 with high school and undergraduate degrees.
Cluster 5: Customers in this segment, women over the age of 25 with undergraduate and graduate degrees.
Cluster 6: In this cluster customers undergraduate and graduate men aged 25-45, employers and wage earners.

Clusters in terms of Brand quality, price and loyalty:

Cluster 0: Customers who prefer average and high quality in terms of white goods, generally high quality in furniture, absolutely high quality as a sports brand, absolutely high quality in women's clothing, absolutely high quality in men's clothing, medium in hijab brand, absolutely high quality in children's clothing.
Cluster 1: Customers who choose high quality in terms of white goods, average in furniture, completely high quality in sportswear, completely high quality in women's clothing, medium and high quality in men's clothing, medium in hijab, average and below in children's clothing.
Cluster 2: Customers who prefer medium and high quality as white goods, medium and high-quality furniture, sports brand quality, women's clothing medium and quality, men's clothing medium and below, hijab medium, children's clothing completely high quality.
Cluster 3: Customers who select white goods is medium, furniture is medium, sports are completely quality, women's clothing is average and mostly of poor quality, men's clothing is absolutely quality, hijab is medium, children's clothing is completely poor quality.
Cluster 4: Customers who prefer white goods is medium, furniture is medium and quality, sports are completely quality, women's clothing is completely quality, men's clothing is medium and poor quality, hijab is high quality, children's clothing is completely poor quality.

Cluster 5: Customers who choose white goods is medium, furniture is medium, sportswear is above average, women's clothing is almost completely poor quality, men's clothing is of poor quality, hijab is of poor quality and medium, children's clothing is completely poor quality.
Cluster 6: Customers who prefer white goods is medium and medium quality, furniture is medium, sports quality, women's clothing is of poor quality, men's clothing is medium and poor quality, hijab is absolutely high quality, children's clothing is of poor quality.

The demographic and brand perception clusters can be combined. For example;
Cluster 0: Customers in this cluster, the majority of high school graduates over the age of 25, are craft or wage earners and prefer average and high quality in terms of white goods, generally high quality in furniture, absolutely completely high quality as a sports brand, absolutely completely high quality in women's clothing, absolutely completely high quality in men's clothing, medium in hijab brand, absolutely completely high quality in children's clothing.

3.2. Evaluation of K-Means

The K-Means cluster analysis results were assessed using Davies Bouldin. A perfect clustering results from internal distance being very small and intermediate distance being quite large, which is indicated by a low Davies Bouldin Index. The experiment's Davies Bouldin measure has a value of 1.526.

4. Conclusions

Cluster analysis aims to find groups or clusters of observations that are close to each other in multidimensional space. In other words, the analysis divides the sample data into the most appropriate clusters according to the similarities of the observations. Cluster Analysis does not make any assumptions regarding the number of clusters or cluster structures. In this study, a clustering algorithm has been developed by making an assumption about the number of clusters. The automatic k-means algorithm determines the most appropriate k value and performs clustering. Determining the appropriate cluster value is very important for correct classification. How many different customer profiles

in the banking sector, how many different regions are in the picture, how many different patient types in medicine can be determined with the correct number of clusters.

In this study, demographic data, product quality, loyalty and price parameters of 1037 customers collected from a private research firm from various markets such as white goods, furniture and clothing, which are among the leading companies in Turkey, were clustered and 7 clusters were obtained.

By this study, systematic customer profile and customer types can be created, so that the process of developing unique marketing strategies suitable for the type of customers in the various market can be made to progress more accurately. In this way, it is possible to target valuable customers and implement different marketing strategies. For future studies, this study can also be adapted to the fuzzy c-means algorithm from other clustering algorithms. Clustering performances are determined by testing on more complex data sets.

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The Application of MySejahtera in Decision Making by the Ministry of Health, Malaysia in the Battle Against Covid-19 Pandemic

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Abstract

Coronavirus (COVID-19) pandemic is considered a global public health challenge. Various measures are being taken globally to contain this pandemic. MySejahtera is a mobile software application for digital contact tracing and has been regarded as one of the most important tools to fight the spread of COVID-19 in Malaysia. Healthcare and business sectors are benefiting the most from this technology. This research presents a comprehensive review of the MySejahtera for contract tracing that is currently being used in Malaysia to accelerate measures against COVID-19. The expected advantages of this new technology over the traditional method of contact tracing include speed, specificity, and mass reach. Beyond its use for mitigating and containing COVID-19, digital technology can complement or even augment the traditional approach to health program implementation. It is hope that this research will also highlight issues and challenges and using of data analytics in implementing strategies for more accurate and granular decisions by the Government.

Keywords: MySejahtera, Tracking Apps, Big Data Analytics. COVID-19

1. Introduction

In December 2019, a new outbreak of pneumonia caused by a novel coronavirus began in Wuhan (Hubei Province, China). It subsequently spread to many countries around the world. The World Health Organization (WHO) announced that COVID-19 is a public health emergency of international concern (PHEIC) on January 30, 2020. To tackle this pandemic outbreak, decision-makers and national authorities in some countries presented a large-scale preventive and proactive measures such as, rapid identification of cases initiatives, contact tracing, and enforcing social distancing measures through imposing nation-wide lockdowns.

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These measures took place to help in processes such as diagnosis, confirmed cases management, clustering and isolation of confirmed cases, and estimating numbers of potential new cases.

COVID-19 started as a health crisis, which quickly evolved into a global economic crisis at a speed and magnitude we have not seen in our lifetime. The ripple effects are still unfolding on a global scale and it is unlikely that the true impact of this pandemic can be measured until the situation stabilizes. But once we come out of this challenging and uncertain time, how will we recover? Will we go back to business as usual, or will we see enduring changes at the individual, organisational and government levels?

There are four stages that outline the path towards recovery:

i. Reaction

All organizations are simultaneously impacted as professional and personal lives are disrupted. Volatility and uncertainty permeate society as the primary focus is on limiting damage to lives and livelihoods as we weather the unprecedented storm.

ii. Resilience

Controls loosen as contagion spread is contained. Consumer demand begins to return but is constrained by lost wages, investment losses and recession fears.

iii. Recovery

Anxiety passes and hiring, investment and consumer sentiment cautiously improve. Recovery paths for organizations will vary based on ability to limit damage from the Reaction stage, length and severity of recession, post COVID-19 industry demand and willingness to adapt.

iv. New Reality

A number of enduring shifts will remain post recovery as many learnt behaviours born out of the crisis will become central to the new normal.

2. Scenario of COVID-19 in Malaysia and preventive measures taken by the Government

At the start of the outbreak, the National Security Council (NSC) commanded and mobilised the response at the national level, with technical guidance from the Ministry of Health (MOH). A movement control order (MCO) was implemented on 18 March 2020 and gradually adjusted in phases based on risk assessment.

To effectively control the current COVID-19 situation, the Malaysian government has implemented different Movement Control Order (MCO) levels. Conditional MCO for areas with the presence of COVID-19 cases; Enhanced MCO for areas with a high number of COVID-19 cases; Targeted Enhanced MCO for a much smaller space with the high number of COVID-19 cases, such as a residential complex or an office building; and Administrative Enhanced MCO for a specific high-risk area but with fewer restrictions. The preventive taken measures as below:

i. Phase 1 - Movement Control Order 1.0 (MCO 1.0) from 18th March 2020 till 3rd May 2020

ii. Phase 2 - Conditional Movement Control Order (CMCO) from 4th May 2020 till 9th June 2020

iii. Phase 3 - Recovery Movement Control Order (RMCO) from 10th June till 31st December 2020

iv. Phase 4 – CMCO in the areas with high COVID-19 cases from 14th December 2020 till 31st December 2020

v. Phase 5 – RMCO nationwide from 1st January 2021 till 31st March 2021

vi. Current Measure - MCO 2.0 nationwide until 18th February 2021, except Sarawak, will continue to be under Conditional Movement Control Order (CMCO). Sibu and Kapit & Song Districts in Sarawak are under MCO2.0 until 14th February 2021 and 15th February 2021 respectively.

Malaysia ramped up its testing capacity from around 1000 tests per day in January 2020 and increasing to over 38 000 tests per day to date. COVID-19 cases were contained by isolating all symptomatic and asymptomatic patients to hospitals for free regardless of citizenship. Some government hospitals were converted into full or partial COVID-19 hospitals. Quarantine centres were also made available, utilising existing training institutes, nursing dormitories, non-specialist hospitals and hotels.

3. Conventional Method of Contact Tracing

Contact tracing is a monitoring process for individuals who have been exposed to someone infected with a virus and are at higher risk of infecting themselves and others (WHO 2020). The process involves three basic steps, namely contact identification, where the infected person recalls activities and the roles of persons involved since the onset of the infectious disease; contact listing, which provides the names of potentially infected contacts, and contact follow-up, to monitor any onset of symptoms associated with the viral infection (WHO 2011).

Contact tracing has conventionally been implemented by an “Investigation Team” through an iterative process of interviews with the case, or if unable to talk or death has occurred, then with his or her family members (WHO 2020). The team proceeds to locate and notify all persons identified as contacts with the infected person. This investigative method of contact tracing may be inherently challenging in that it poses a logistical burden on the Investigation Team, is time consuming, and potentially stigmatizes the contacts and their associations who may wish to maintain the private status of their infection.

4. Emerging Use of Digital Technology During COVID-19 Pandemic

The COVID -19 pandemic introduced lockdown measures that have not previously been experienced by society around the globe. It also resulted in an unprecedented number of health-monitoring apps deployed by governments in the name of more effective and efficient contact tracing and public health monitoring. Such tracing and health applications were first adopted in several Asian countries, first hit by the new coronavirus, namely China, Hong Kong, Singapore and South Korea. Malaysia shortly after jumped into the bandwagon.

The demand for technology integration in the healthcare sector is on the rise worldwide. The quest to adopt the latest tools to make pathogen tracking, early diagnosis, and treatment more efficient. Numerous digital technologies have been used worldwide as an aggressive measure to control, monitor and prevent the spread of COVID-19.

4.1 Digital Tracing and Tracking Systems

Contact tracing is an essential public health measure and a critical component of comprehensive strategies to control the spread of COVID-19. Contact tracing breaks the chains of human-to-human transmission by identifying people exposed to confirmed cases, quarantining them, monitoring them to ensure rapid isolation, and testing and treatment if symptoms develop. When implemented systematically and effectively, these actions can ensure that the number of new cases generated by each confirmed case remains below one.

In the context of COVID-19, contact tracing requires identifying persons who may have been exposed to a person with COVID-19 and following them up daily for 14 days from the last point of exposure. Since COVID-19 transmission can occur before symptoms develop, contacts should remain in self-quarantine during the 14-day monitoring period to limit the possibility of exposing other people to infection should they become ill.

Critical elements in the implementation of contact tracing include community engagement and public support; careful planning and consideration of local contexts, communities, and cultures; a workforce of trained contact tracers and supervisors; logistics support to contact tracing teams; and well-designed information systems to collect, manage, and analyse data in real-time.

Challenges for contact tracing include incomplete identification of contacts, inefficiencies in paper-based reporting systems, complex data management requirements, and delays in steps from identification of contacts to isolation of suspected cases among contacts. Digital tools can play a role in overcoming some of these challenges when part of a sufficiently resourced contact tracing programme. Digital tools for contact tracing can only be effective when integrated into an existing public health system that includes health services personnel, testing services, and manual contact tracing infrastructure.

For some global health experts, the use of digital technology in the context of COVID-19 marks the beginning of a promising new milestone in the implementation of mass interventions. Besides contact tracing, diverse digital infrastructure taking the form of Internet of Healthcare Things (IoHT), big data, and machine learning have played integral roles in the efficient prevention and management of the new SARS-CoV-2 disease (Vaisya R, 2020). Present applications of this technology are expanding to include the development of precision treatments for patients with COVID-19, streamlining of clinical workload, drug and vaccine discovery efforts, and predictive analytics to forecast the trajectory of outbreaks (Vaisya R, 2020).

Recently, phone-based tracking and tracing methods used in some other regions of the world have shown promising potential in the fight against COVID-19. For example, South Korea's attempt to reduce the spread of COVID-19 by using a centralized tracking and tracking system has shown how tracking and tracking mobile applications would have a significant impact on reducing the overall number of infections. Similarly, in Taiwan, the alarm system signals when quarantine residents leave their homes by tracking the radio signals of their phones. In United States, Apple and Google companies are announcing the use of contact tracing by cooperating with health agencies to reduce the spread of COVID-19 outbreak.

In Singapore, tracing and tracking assets are put in place to combat the spread of COVID-19 outbreaks using real-time location tracking for medical equipment, surgical masks and sanitizers shipments. Furthermore, the Centre for Systems Science and Engineering at Johns Hopkins University has developed a real-time tracking map for COVID-19 cases tracking and tracing across the globe.

In Singapore, track and traces assets is implemented to battle the spread of COVID-19 outbreak by using real-time location tracking for medical equipment, surgical masks and sanitizers shipments. Furthermore, the Centre for Systems Science and Engineering at Johns Hopkins University has developed a real-time tracking map for COVID-19 cases tracking and tracing across the globe. This monitoring system was developed on the basis of data collected from the Centres for Disease Prevention and Control in the United States, Europe and China, as well as from the WHO and other parties.

5. Malaysian Government Developed Apps to Monitor and Combat COVID-19

5.1 MyTrace Malaysia

Lead Ministry: MOSTI

Apps Developer: International Islamic University Malaysia assisted by MIMOS, MaGIC and Google Malaysia.

5.1.1 Description:

MyTrace, which was launched on 3 May 2020, is a contact tracking app that uses Bluetooth technology to detect distance and time of contact between users. It is a community-driven approach where participating devices exchange proximity information whenever an app detects another device with MyTrace app installed. This application allows the identification of people who were in close proximity to COVID-19 infected individual. MyTrace apps is complementing MySejahtera to combat the Covid-19 pandemic in Malaysia.

5.2 Gerak Malaysia

Institution In charge: Malaysian Communications and Multimedia Commission (MCMC) and Royal Malaysia Police

5.2.1 Description:

Gerak Malaysia supports the Government of Malaysia in its efforts to combat COVID-19 and to mitigate the spread of the virus through contact tracing. Gerak Malaysia is an application that uses mobility data for near-real-time movement tracking and tracking as well as a travel authorisation system during the Movement Control Order (MCO). Gerak Malaysia will also provide additional features, such as the latest information from the relevant authorities, as well as general preventive and advisory measures for COVID-19.

5.3 e-COVID19

e-COVID19 was developed through a strategic cooperation between Ministry of Health (MOH), National Security Council (NSC), and Malaysian Communications and Multimedia Commission (MCMC). The system is owned by MOH and the users of the system are:

i. HQ, Crisis Preparedness and Response Centre (CPRC), Disease Control Division, MOH

ii. CPRC State Health Office, MOH

iii. CPRC District Health Office, MOH

iv. National Public Health Laboratory, MOH

5.3.1 Description:

National Crisis Preparedness and Response Centre (CPRC), Disease Control Division, Ministry of Health is the centre responsible for managing and monitoring of COVID-19 outbreak. During the COVID outbreak, CPRC faced a number of challenges in reporting and managing COVID-19 cases due to the manual process used to manage and monitor COVID-19 patients, the COVID-19 management process is dynamic, constantly changing and inefficient.

NSC and SKMM have developed a web-based e-COVID19 system to help overcome these challenges. The objectives of the system are as follows:

1. To ensure COVID-19 data reporting is accurate and real-time;

2. To ensure uniformity of information reported from the field;

3. To avoid overlapping of reporting;

4. To become the main source of data for COVID-19 outbreaks at all levels.

5.4 Apart from the contact tracing apps developed by the federal government, states like Selangor (SELangkah), Penang (PgCARE) and Sarawak (Qmunity) have also developed their own Covid-19 contact tracing apps. The Penang state government has decided to phase out its PgCARE contact tracing app in favour of MySejahtera, after Senior Defence Minister Ismail Sabri Yaakob announced last August 3 2020 that legislation would be enacted to make MySejahtera mandatory for businesses.

6. Launching of MySejahtera

6.1 Development and usage of the app

Governments and private sector organisations have been continuously developing and launching applications (apps) since the coronavirus outbreak, with the aim of helping to combat the spread of COVID-19. These apps provide services such as providing citizens with updates to COVID-19, situation reports, enabling them to make health risk assessments and to be used as a tracker for the spread of the disease across the country, as well as documenting the rate and number of infected people.

The Malaysian Government officially launched the MySejahtera app on 20 April 2020 to monitor and control, assess and manage the outbreak of COVID-19 during and post Movement Control Order (MCO). It is a mobile software applications for digital contact tracing during the pandemic.

It was developed through a strategic collaboration between the National Security Council (NSC), the Ministry of Health, the Malaysian Administrative Modernisation and Management Planning Unit and the Malaysian Communications and Multimedia Commission. MySejahtera was developed under the Prevention and Control of Infectious Diseases Act 1988 [Act 342]. It is supported by all Android smartphone users running version 4.4 and above, as well as iPhone users running iOS 11 and above. MySejahtera was developed using Ionic platform with geo-location technology. MySejahtera in available in Gallery of Malaysian Government Mobile Application (GAMMA), Apple App Store, Google Play Store and Huawei AppGallery.

In addition to the development of the MySejahtera contact tracking application, the Malaysian Government and its partners have implemented various innovations, including drive-through screening services and the Field Hybrid Intensive Care Unit (ICU). Risk communication has also been strengthened through regular media briefings and the sharing of trusted messaging via websites, social media and SMS. Cegah dan Didik, Amal, Patuh dan Pantau (preventing and educating, practicing, complying and monitoring) have also been launched to boost community engagement.

6.2 Five ways the MySejahtera app has supported the country's efforts to reign in the spread of Covid-19

Figure 1. MySejahtera Facebook page

6.2.1 Risk assessments

One of the main functions of the app allows citizens to assess their risk of contracting COVID-19. It allows users to perform health self-assessment on themselves and their family members. Users can also monitor their health throughout COVID-19 outbreak and help them to get treatment if they are infected with COVID-19. The app asks citizens to fill in a basic survey on symptoms, travel history, and whether they have been in contact with a confirmed case recently. It then classifies them into risk categories and informs them of the next steps to take.

Those under surveillance would have to stay at home for 14 days and complete the survey every day. If the users do not comply, the app will ping the users. If they ignore the notifications for too long, they might get a ring from the local health authority. People who are likely to have contracted the coronavirus will have to be tested at a hospital. The app shows the nearest healthcare facilities where they can be screened.

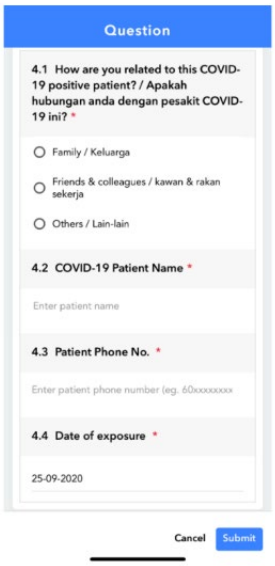

Figure 2. Questions

In addition, MySejahtera enables the Ministry of Health (MOH) to monitor the health of users and to take immediate action to provide the necessary treatments. Essentially, the information of users will be used by the MOH to help them plan their resources and effectively take immediate action. The app will also help the Ministry of Health monitor the spread of the virus and will act as a detector for trends in the outbreak. The app's self-assessment asks whether users have symptoms of COVID-19.

6.2.2 Contact tracing

The app's second main function is contact tracing. Users scan a QR code before they enter a premise, and the system logs where they have visited in the last 14 days. They can register dependents who do not have a smartphone on their app, so they can be accounted for as well.

The Ministry of Health only pulls this data out after a patient test positive. The data is archived after 30 days and flushed out after 90 days. On top of the recording where citizens have been, the app assigns individual QR codes that show whether someone is high risk or low risk. This depends on whether they live near a COVID-19 hotspot, and the number of vulnerable people in their household. Premise owners can choose to scan this QR code to decide if citizens are allowed to enter.

6.2.3 Future Research

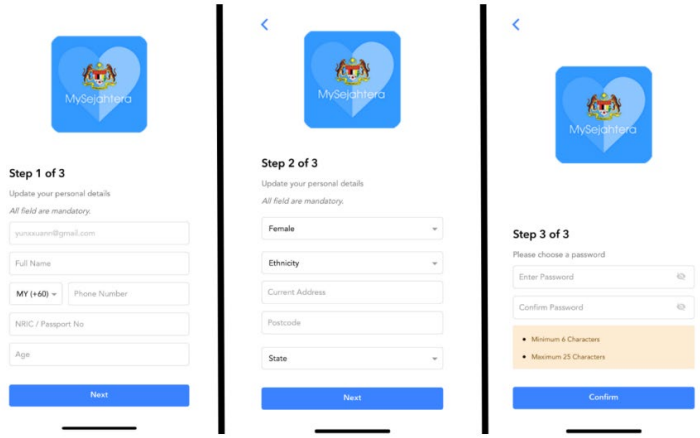

Figure 3. Steps

Citizens have to include detailed demographic information, including age, gender and ethnicity, when they register for the MySejahtera app. This can be used for future analysis and medical research. For example, the predominant ethnicity that might have a higher affinity to contract a particular disease. These data would be very useful later.

6.2.4 Teleconsultations and online appointments

Malaysians can chat with an online doctor through the app. If they are worried about their symptoms, they can get a teleconsultation without having to leave the house. This reduces the risk of transmission and eases the demand for healthcare services in hospitals.

Users can also book doctor's appointments online, including for non-COVID related matters. These two features have helped to reduce congestion in clinics. Now Ministry of Health have to be very particular about the number of people coming into hospitals and clinics.

6.2.5 Educate and Inform

Finally, the app includes a hotspot tracker that shows where confirmed patients likely contracted the disease. It uses machine learning to come up with a probable source of infection for every

positive case. This is a dynamic map – red zones turn blue after 14 days with no new cases, then green after 28 COVID-free days. This feature helps citizens plan their travels better. They might choose to avoid going to a hotspot, or ensure they bring along a bottle of hand sanitiser. The map has millions of requests per day and people of Malaysia actually use this particular function to plan their travel.

Citizens can also check the number of COVID-19 cases in each state, nationally and globally. This keeps them updated on the latest spread of the virus.

6.3 Application and Contact Tracing Abilities

Essentially, MySejahtera enables users to carry out self-health assessments on themselves and their family members from time to time and allows users to share their locations. Information is collected by the government to help individuals assess and monitor their health status and that of their dependents, determine and identify COVID-19 hotspots, and track the spread of the virus for prompt and effective action where possible infections are detected.

Upon completion of the self-assessment, users will be informed of their health status, which is classified as low risk, casual contact, close contact, person under surveillance, person under investigation or confirmed case. Users will be advised of any further action to be taken if they have been diagnosed with COVID-19 symptoms and will be notified if they are near a high-risk zone. The Government has ensured that the personal information collected will only be used to monitor and prevent the outbreak of COVID-19 and will not be disclosed to any other party.

Following the reopening of economic sectors under the Conditional Movement Control Order ("CMCO") which ends on 9 June 2020, the government has urged the public to download and register MySejahtera to enhance contact tracing efforts. Although not mandatory, the importance of MySejahtera was emphasized in the standard operating procedures as being a mitigation strategy to support the government's economic recovery efforts.

The MySejahtera profile is an individual's personal account with a digital ID in the form of a QR code, that discloses the name, user ID which may be mobile number or email address and the state in which the individual resides, which are all personal data. It also discloses the health status or classification of individuals which are known as sensitive personal data for where more

stringent and additional safeguards apply. The health screening being conducted via MySejahtera involves the collection and use of user's personal information.

6.4 Contact Tracing Using MySejahtera

The MySejahtera National CPRC team has a two-hour turnaround time to identify close contacts from MySejahtera once a positive Covid-19 case has been confirmed. A request for the retrieval of data on persons believed to have been in physical contact or proximity to a COVID-19 infected person within the past 14 days goes to the MOH Disease Control Director, after which NACSA gives permission. The COVID-19 patient's name, IC number, or phone number is entered to produce a log of their MySejahtera check-ins.

Close contacts are then determined by looking at the COVID-19 patient's timestamped check-in at a specific location, perhaps half an hour before or after the check-in, to see which other people were in that area at about the same time as the person with coronavirus.

Close contacts from specific locations are chosen on the basis of the likelihood of contracting COVID-19, like crowded and enclosed areas where one spends a considerable amount of time, such as a restaurant. Places with a low risk of transmission are likely to be omitted, depending on individual cases and epidemiological investigations.

Data from MySejahtera is corroborated from an investigator's interview with the COVID-19 patient on the location the latter has visited in the past 14 days. Once close contacts have been identified, a notification is sent through their MySejahtera app telling them to visit the nearest district health office. They will also be called by the relevant district health offices.

Currently 149 District Health Offices (PKD) across Malaysia are still using manual method of contact tracing and reporting to the national CPRC which will then look for close contacts on MySejahtera. The PKD will do the groundwork and set up a risk assessment team, which will call or go down to check what is needed and inform the response team. The PKD will do the groundwork and set up a risk assessment team, who will call or go down and check the necessary and inform the response team The response team will get the details and forward the information to CPRC. Manual contact tracing is still necessary because not everyone has downloaded MySejahtera.

Digital tracing methods become essential as asymptomatic patients, or those who do not display symptoms, tend to spread the virus at a much faster rate, especially in areas with a denser population.

6. Digital Data (Big Data)

Due to recording, processing and analysis of mass data, high-quality and more predictable forecasts and decisions are possible. The structure of big data is (Goes P., 2014)

i. Volume: measured in Giga or Terabyte
ii. Velocity: one-time snapshot frequency streams
iii. Variety: structured, numeric, alpha, instructed, text, voice / sound, image / video, genomics
iv. Veracity: validation, noise level, deception, detection, relevance, ranking

7.1 Fighting COVID-19 using Big Data Analytics

The rapid, global spread of COVID-19 has brought forward advanced tools for big data analytics, with entities from all sectors of the healthcare industry looking to monitor and reduce the impact of this virus. Researchers and developers are increasingly using artificial intelligence, machine learning and natural language processing to track and contain coronavirus, as well as to gain a more comprehensive understanding of the disease. At the heart of these efforts is something that the healthcare industry is very familiar with: data.

Researchers use big data and analytics to better understand coronavirus from a variety of angles. The Institute recently announced that it would provide government entities, research organizations and industry with access to innovative AI tools as well as data and public health experts to help fight COVID-19.

Between the recognition of signs and symptoms, the monitoring of the virus, and the monitoring of the availability of hospital resources, researchers are dealing with vast amoun ints of information – too much for humans to understand and analyse on their own. It's a situation that seems to be tailored to advanced analytical technologies.

The COVID-19 pandemic has provided advanced tools for big data analytics with entities from all sectors of the healthcare industry seeking to monitor and reduce the impact of this virus. Artificial intelligence, machine learning and deep learning have increasingly been used by scientists, researchers and developers to track and contain COVID-19.

Some big data components and advanced big data analytics tools used for COVID-19 research are:

i. Biomedical research – Artificial Intelligence can eliminate many false tracks and allow us to identify potential targets.
ii. Natural language processing – Machine learning is able to cater multifactor learning on how people are bearing the burdens and stresses of the pandemic.
iii. Virology research – Deep learning is applied to gain a more comprehensive understanding of the virus.

The use of Big Data and Machine Learning would then make it possible for the government to conduct communal screening and contact tracing in a more efficient and organised manner. The Government of Malaysia is taking a step forward by launching an application called MySejahtera, which has been developed to help monitor this outbreak in the country by enabling users to assess their health risks against COVID-19. Data captured using this app enables the government to conduct complex research using Big Data Analytics to assist the government to control this pandemic in this country.

8.Malaysian Government using Big Data Analytics to better manage and mitigate the spread COVID-19

Big data has been used effectively in countries like South Korea and China to manage infection rates, and MySejahtera has access to pretty big data with 24.5 million (one of the highest adoption rates in the world) registered users as at Dec 4 2020 and there are now between 20,000 and 30,000 daily downloads while the app records an average of 17 million check-ins per day.

With the exponential increase in the number of coronavirus cases, there is potential for big data to help detect outbreaks. Bringing together data from a variety of sources, the Government can use algorithms to analyse health records and trace the contact history of patients to help identify patterns of virus spread. These applications may be able to demarcate not just current zones

with high number of cases but also help in predicting future outbreaks with the help of movement and contact tracing. Table 1 show list of countries which has developed their own mobile-based application to fight the pandemic.

Table 1. Mobile Based Application

Country	Mobile-based Application
Australia	COVIDSafe
Israel	Hamagen
Singapore	TraceTogether
France	StopCovid
Germany	Corona-Warn
India	Aarogya Setu
Iran	Mask.ir

Many countries around the world are trying to blunt the pandemic curve with the help of smartphone applications. These applications monitor the movement of people to determine whether they are in high-risk locations or have come into contact with high-risk people.

The authorities can provide official, reliable and timely information and advice on COVID-19 through digital platforms. Of the 193 United Nations member states, 167 countries provided information on their national portals, mobile apps or through social media platforms covering outbreak statistics, travel restrictions, practical guidance on protection and governmental responses. Reliable information from the governments helps people make informed decisions about their daily routines and build public trust.

MySejahtera a simple digital log system that used QR technology. Every shop and premise is assigned to a unique QR code for visitors to scan when they visit. When they do so, their phone numbers would be logged, along with other contextual information like location and time. The visitor's name would be recorded when they use the app and there are no other personal information tied to it. It is just a collection of phone numbers, like a fingerprint of phone numbers at every premise.

8.1 Data analytics for accurate and granular decisions

Advanced analysis involves data mining, statistical analysis, forecasting and much more. It also utilises technologies such as artificial intelligence (AI) and machine learning to create more sophisticated predictive models. This can be useful for identifying trends that one would not notice when analysing huge amounts of data.

By tapping into different sets of non-healthcare data from MySejahtera, the Government will be able to create a prioritisation map of where the population at risk, are mostly concentrated. Certain data, such as the dataset of the Elderly Care Scheme and the database of the Pensioner Fund, were managed in siloes prior to the pandemic. But the coronavirus outbreak caused pressure to create a quasi-open data platform.

The Government will be able to develop area profiling and risk ranking for the entire country and pool resources to carry out the detection of active cases. When a cluster of cases took place in a neighbourhood, they were able to identify other neighbourhoods that would face an outbreak of similar magnitude.

In practice, this will help the Ministry of Health (MOH) to allocate limited test kits more efficiently. It allowed the government to have more granular lockdowns at the neighbourhood level with more manageable numbers to distribute aid and allowed MOH to do door-to-door screening even though they had very limited test kits.

More importantly, data analytics helps the Government to catch early budding cases before they can become a larger cluster of patients. Something worth noting is that 80% of the cases identified were asymptomatic. People walked around not realizing that they were carrying the virus and able to transmit it to other people. But they were caught early and isolated from early on, so the rest of the community could re-open. Therefore a collaborative data sharing network with non-health players is very beneficial at enabling all these to happen.

Operational advantages of well-designed digital tools for contact tracing include improved data quality, being able to trace larger numbers of contacts in a shorter time period, the ability to provide analysis and real-time situation awareness, and the ability to perform coordination and management of contact tracing teams. Moreover, digital tools can provide important information for monitoring and evaluation of the contact tracing approach.

8.2 Linking data sets

Data for making decisions as accurate as possible are not only contained in the health system, but in other systems such as urban planning, education, and so on. Under the MCO, a special committee was set up and given the mandate to obtain data from another agency for the purpose of combating COVID-19.

In Malaysia, any data collection and analysis, as long as it is not for commercial purposes and as long as it is carried out by the State Government or related agencies, is generally excluded from the PDPA, the Personal Data Privacy Act of the count.

9. Issues and Challenges

Government must leverage on MySejahtera's big data to fight COVID-19. There is a need for a complete overhaul of the MySejahtera application and to leverage on big data analytics using data collected through the application and other data available in their systems.

It is reported that only 4 per cent of the total reported cases of COVID-19 in Malaysia have been detected directly through MySejahtera, indicating that the government may still rely on manual contact tracing, e.g., asking positive patients who their close contact and for them to be tested accordingly.

Health experts also emphasize this, as they urged the Government to allocate more people and employ digital solutions to reduce the difficulty of MOH in contact tracing efforts. Since the Government are also facing the scarcity of healthcare resources, many close contacts of

COVID-19 patients would have to undergo self-monitoring, as quarantine centres have been fully occupied. This is where a fully functional Mysejahtera app could probably address the issue.

It also shows that the government does not fully (or at all) leverage big data analytics using data collected through MySejahtera and combines it with other data available in the government system as well as public data that can be mined, such as meta-data posts and social media tags, etc., and develops a more sophisticated way to track positive cases in the community.

Malaysian Government might also need to consider and implement:
i. Big data in COVID-19 analysis
ii. Machine learning for COVID-19 tracking and prediction models
iii. Social network analysis for contact tracing
iv. Simulation of coronavirus outbreak events
v. Sentiment Analysis related to the coronavirus outbreak
vi. Predictive Analytics in COVID-19 risk profiling
vii. Knowledge representation in COVID-19 analysis
viii. Other topics related to the tracking. modelling and understanding of the coronavirus spread and transmission.

There should be more active data mining and analysis, especially after a MySejahtera app user is found positive. Conducting data mining and analysis will be beneficial for the government to trace a patient's previous movements in the past 48 hours.

Government must set up an analytical platform powered by Big Data Analytics and Machine Intelligence so that it can make solid recommendations amid the rapidly changing epidemic of the unknown coronavirus.

However, the Government too must realise that the increasing use of big data has raised ethical concerns and posed legal challenges. These mobile phone applications have access to a

considerable amount of personal information. Ethical issues include compromised privacy, lack of personal autonomy and public demand for transparency and fairness while using big data. It is therefore very important that the data are carefully considered and implemented.

Despite the privacy challenges, big data has a promising future in the health sector. As travel restrictions persist in many countries, there may be more and more opportunities for using big data to compensate for the lack of in-person data collection. However, financial investment is needed to make this happen. If the government wants to fully utilise big data, it will need to invest in the necessary technology, infrastructure and staff training. They would need smartphone applications with robust privacy protection and the necessary computing infrastructure to work safely with large amounts of data. Most importantly, staff would need to be trained in data analysis techniques. A more systematic evaluation of the0020available methodologies by the research community is needed in order to explore
the potential of big data in healthcare. Given the current public health crisis, it will be
useful to see whether big data can be used to predict future outbreaks of disease.

The data collected through MySejahtera is useful for COVID-19 researchers,
however the data keeper must fulfil these criteria:

i. Data must be as complete as possible, as determined by the analytical objectives

ii. Because COVID-19 spreads very quickly, data must be logged and shared as quickly as possible so that results can be produced as soon as possible

iii. Collection of data and definition of variables in the data must be transparent and ethically approved. This can avoid misleading and malicious findings

iv. Data should be organised and easily shared among various agencies in the government

v. Responsible agencies must vet the data to ensure reliability and validity.

Another area where data is essential is COVID-19 surveillance. The World Health Organization has published a document titled ‘Public health surveillance for COVID-19: interim guidance’

(WHO 2020). The general objective of COVID-19 surveillance is to enable public health authorities to reduce the transmission of COVID-19, thereby limiting associated morbidity and mortality. Specifically, surveillance data from COVID-19 will enable epidemiologists, physicians and health workers to:

i. Enable rapid detection, isolation, testing and management of cases;
ii. Monitor trends in COVID-19 deaths;
iii. Identify, follow up with and quarantine contacts;
iv. Detect and contain clusters and outbreaks, especially among vulnerable populations;
v. Guide the implementation and adjustment of targeted control measures while enabling the safe resumption of economic and social activities;
vi. Evaluate the pandemic's impact on healthcare systems and society;
vii. Monitor longer-term epidemiologic trends and the evolution of the SARS-CoV-2; and virus; and
viii. Contribute to the understanding of the co-circulation of the SARS-CoV-2 virus, influenza and other respiratory viruses and pathogens.

Data is fundamental to everyday life. For the public, data can help people to adjust their behaviours to minimise the risk of spreading SARS-CoV-2. For health professionals, sharing COVID-19 data helps them to quantify the impact of non-pharmacological interventions (NPI). For COVID-19 researchers, data is paramount to understand the infection dynamics, make projections and identify the high-risk populations. Due to the Industrial Revolution 4.0, the world is connected with high-speed data and the rise of data science; data is critical every second of every day. Data must be taken seriously and must be shared with skilled people who can harness it, including every COVID-19 scientist, clinician, epidemiologist and public health expert for them to fight COVID-19. At the national level, Malaysia launched the Malaysian Government Central Data Exchange (MyGDX) platform in 2018. If the government of Malaysia enables this platform for the sharing of COVID-19, we could be one of the countries at the forefront of COVID-19 data sharing.

9.1 Gaining Public Participation and Trust

Governments and public health officials agree that contact tracing is essential to controlling the spread of Covid-19 and allowing for measured reopening. But successful contact tracing depends on public trust and participation.

Although digital contact tracing tools initially received an enthusiastic reception from state governments eager to contain the spread of COVID-19, experts have cautioned that digital tools cannot replace traditional methods, and the potential for violation of data security and privacy rights is high.

Regardless of which method of contact tracing is used, robust protection of privacy is essential. Ensuring that contact tracing information remains confidential and out of the hands of law enforcement is crucial to fostering community trust and Therefore participation in contact tracing programs.

9.2 Beyond Contact Tracing, Plus Upcoming Features

In addition to contact tracking, MySejahtera has other features such as a hotspot tracker and a travellers' module for Malaysians who are quarantined upon returning home from overseas.

They can monitor their health, there is a hotspot tracker, a list of health facilities and daily news updates. Those under the Home Surveillance Order (HSO) must use it every day to monitor their health and submit it during their 14-day quarantine period.

The hotspot tracker states that if COVID-19 cases have been detected within a 1 km radius of the location within the last 14 days, it will be entered in the app.

MySejahtera does not indicate the number of cases of coronavirus in a particular area, or exactly where people with COVID-19 have travelled within that 1km radius. The COVID-19 cases identified by MySejahtera in a particular area on its hotspot tracker are based on a possible

source of infection, such as the the place of detection and locations visited by a person with coronavirus.

As for the travellers' module, Malaysians returning from overseas are required to perform daily MySejahtera health assessments every 14 days during their quarantine so that those with coronavirus symptoms such as fever, sore throat, cough, and shortness of breath can be identified and told to seek medical attention. Other users can also check their own risk of coronavirus by completing a simple 5-question assessment.

MySejahtera lists COVID-19 screening of near-user health facilities, including private GP clinics, that MOH has allowed rapid antigen testing to be performed for low-risk people (not a person-under-investigation and no history of close contact with positive cases). The app also lists a few digital health providers that can be booked for clinical appointments.

Users can also list MySejahtera dependents who do not have an app and may soon be able to check-in their dependents through a future group check-in feature.

MySejahtera provides daily official updates on the situation of COVID-19 in Malaysia, such as new cases, fatalities or recoveries reported, the number of active cases, as well as the total number of official coronavirus cases and deaths.

MySejahtera is even helpful to businesses registered with the app, as they have a dashboard to monitor the number of check-ins across a time series throughout the day. This enables business premises to plan and gain insight into the management of visitors.

MOH plans to add more features such as voice-assisting technology to MySejahtera to make it more user-friendly for people with disabilities. MySejahtera may also introduce a complaint feature that allows users to send photos of violations of social distancing or other standard operating procedures (SOPs) to any location or outlet.

Such complaints may be used for investigations.

The COVID-19 vaccines have arrived and everyone in Malaysia can soon register to get vaccinated starting from 1st March 2021. Among the 5 ways to register, MySejahtera is the easiest way and can get it done within a few minutes.The MySejahtera app has been updated (version number 1.0.28) with a new section for vaccine registration, but it is only for iOS at the

moment. The Android version of MySejahtera is not updated yet and we expect the new version to be released soon.

Conclusion

With digital contact tracing becoming a priority for the government and an integral part of the government's strategy to combat this pandemic, these smartphone apps could lead to a significant number of lives being saved and critical to protecting public safety.

Significant application of the MySejahtera app in COVID-19 is capable of quickly helping to detect the affected patient at an early stage and helping to analyse and identify individuals who might have this virus in the future.

As more data is generated, artificial intelligence (AI) will help the Government to develop predictive measures. Data is a set of raw, unorganised facts that must be processed to be useful. Data is seemingly random and useless until it is captured, cleaned, collated, organised and analysed. This transformation, from information to insights, is at the core of data science.

Embracing Data Analytics

If the COVID-19 situation has taught everyone anything it is that disruption is unpredictable and can have long-lasting effects. Although AI-driven data analytics helps business, government, organizations etc to anticipate and adapt to disruption and upheaval, its impact can also be long-lasting.

Data analytics does not need to be yet another intensive IT infrastructure project, built to meet one need but unable to adapt to the next. Instead, data analytics is a crucial part of a suite of on-demand services that business, government, organizations etc are likely to rely on to remain nimble as they address complex challenges and hidden opportunities in the weeks and months ahead.

MySejahtera is the first government-built app of this scale in Malaysia, and everyone is excited about the possibilities in digital health in the future. Everyone is looking forward on how the Government can empower Malaysians to take charge of their health, not only for COVID-19 but for other diseases like non-communicable diseases.

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