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An Eco-Friendly and Automated approach to Oil Spill Remediation using a Robotic Boat equipped with Human Hair Sorbents

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Abstract – Oil spills damage marine ecosystems together with local economic systems while disturbing the worldwide equilibrium between nature and wildlife. The current strategies for oil spill remediation that use mechanical skimmers and in-situ burning and chemical dispersants fail to meet environmental standards or demanding economic requirements or perform effectively in broader operations. The research presents an environmentally sustainable low-cost automated system that incorporates a robotic boat with UV sensors and load cells as well as GPS systems and robotic arms using human hair broom absorbers to address oil spills. Multidisciplinary studies confirm that human hair shows excellent potential as an oil absorber because it consists of waste material that easily decomposes in the environment. The system unifies various sensors and automated capabilities to detect oil immediately and avoid obstacles and sail autonomously while doing efficient cleaning work mostly without human operators. This study develops a novel combination between bio sorbents and robotic technology which helps overcome present oil spill management deficiencies while supporting sustainable environmental practices.
Keywords – Oil spill remediation, human hair sorbent, robotic boat, eco-friendly cleanup, oil detection, marine pollution control, UV sensor, automation.

I. INTRODUCTION

Oil spills are catastrophic events that can devastate marine ecosystems, impact coastal economies, and have long-term environmental consequences. They commonly occur due to tanker accidents, drilling rig failures, or wartime sabotage. One of the largest recorded oil spills occurred during the Gulf War in 1991, where Iraqi forces deliberately released around 330 million gallons of crude oil into the Persian Gulf. More recently, in 2010, the collision between MSC Chitra and MV Khalijia III off the coast of Mumbai led to an extensive oil spill cleanup operation costing over ₹514 crores (approximately USD 351 million) and spanning several months. Existing methods of cleanup—mechanical, chemical, and biological—each present drawback. Skimmers and booms require significant manpower and are ineffective in rough sea conditions. Chemical dispersants, though fast-acting, are toxic and pose long-term risks to marine life. Biological methods like bioremediation are slow and highly dependent on environmental conditions. The use of natural sorbents like human hair presents an environmentally friendly alternative, but practical implementation at scale remains a challenge. This study presents a fully functional concept of a robotic boat capable of autonomous oil detection and cleanup, using human hair as the primary sorbent material.

II. OBJECTIVES

The objectives are as follows:

1) To design a robotic boat which would use human hair as an organic oil absorption material.

2) To use sensors together with automation protocols to identify and eliminate oil spills in real-time fashion.
3) To achieve eco-friendly design by eliminating chemical use and manual labor.
4) To analyse waste hair can be an effective and lasting method to clean marine environments on a broad scale.

III. LITERATURE REVIEW

Bhagwat & Jaspal (2023) investigated the development of natural biodegradable materials that serve as oil spill cleaning sorbents. The reviewer showed how research has enhanced natural fibers and sustainable polymers to increase oil absorption while preserving environmental characteristics. The authors stressed the necessity of environmentally friendly solutions as marine contamination incidents steadily rise in recent years.

The researchers from Zhou et al. (2022) created an oil/water separation material through modifications of melamine sponge with silk fibroin treated by graphene oxide. The transformed material presented exceptional hydrophobic and oleophilic capabilities that made it useful for marine clean-up operations. Such materials show remarkable potential for commercial utilization as part of marine spill recovery strategies according to the study findings.

A review written by Bi et al. (2025) described the potential of engineered nanomaterials to work with hydrocarbons through interactions which result in efficient and quick separations for maritime purposes. The research produced evidence about integrating nanotechnology with robotics which could enhance operational flexibility.

The paper by Gantiva Osorio et al. (2025) analysed autonomous surface vehicle systems which serve environmental monitoring functions. The paper stressed that coordination algorithms provide essential functionality for running robotic units as oil spill mitigation systems. The review documented modern advances among robotic swarms and decentralized information processing methods.

Nature Science has introduced a new hydrogel-based material that demonstrates both exceptional oil uptake capacity and powerful anti-swelling characteristics and swift swelling behavior (Choudhary 2025). The experimental evaluation presented strong indications about rapid installation when operating under unpredictable marine situations. The breakthrough technology reveals applications for emergency response kits besides its other utility.

The research by Sathianarayanan & Hemani (2021) showed how cotton waste material functions as a recyclable sorbent that acts as both super hydrophobic and lyophilic. Waste biomass proves suitable for implementing oil spill management tactics in the study. The researchers accomplished field-based simulations to validate the sorbents' simple deployment method.

In their review paper Yang et al. (2021) assessed the utilization of economical natural materials for oily water separation applications. The research focused on agricultural waste materials and modified cellulose structures to improve oil adhesion properties. Their environmental safety evaluation and absorption speed measurements placed these sustainable materials at the highest level of selection.

The team from Taufik et al. (2021) studied rice straw as an adsorbent when implemented inside bio filter units to clean contaminated diesel water. Scientists combined farming waste products along with new filter construction techniques in their research. The selected method proved to be affordable and could be adjusted to address rural oil spills.

Water purification through polypropylene/lignin/POSS nanocomposites received focus from Alassod et al. (2021). The material features thermal resistance together with excellent oil storage abilities which positions it as a promising option for oil spill clean-up procedures. The authors emphasized that these composites function as multifunctional clean-up agents due to their hybrid characteristics.

This research examined the effectiveness of organic cellulose absorbents as they clean oil out of water supplies according to Chau et al. (2021). The research demonstrates the purpose of these solutions as affordable environmentally-friendly methods to clean up pollution. The absorbents displayed effective results in evaluation tests that involved turbulent as well as static water conditions.

Delignified wood derives its structural properties from Kumar et al. (2021) who researched their capacity to produce highly absorbent oil sorbents. The research team suggests modifying wood structure to establish wood-based clean-up solutions as a sustainable option. The research includes microstructural examinations which demonstrate the materials have better porosity when compared to conventional materials.

Marine oil spill mitigation received attention from Almeida et al. (2023) when they developed a coordinated fleet of autonomous vehicles for the purpose. Research about robotic systems integrating with environmental science presented itself as a newly emerging field. Area coverage performance together with spill scale flexibility were identified through their simulation testing.

The comprehensive review regarding textile-based oil sorbents was published by Zaarour & Liu (2023). Their research looks into the adsorption process of oil by natural and synthetic fibers along with surface treatment methods. Three essential factors which the authors highlighted involve resource reuse alongside materials' ability to be recycled.

The article by Wang et al. (2024) reviewed recent research on oil spill detection and mitigation which emphasized advanced sensors used for early response systems in aquatic settings. The authors discussed how predictive cleanup operations benefit from machine learning model integration.

The research by Saleem et al. (2024) examined oil cleanup sorbents through an investigation of commercial polymers against innovative composites. The paper gave attention to materials which could be recycled along with environmental compatibility as an essential factor. The experiments under different environmental conditions demonstrated uniform functionality of their products.

IV. RESEARCH GAP

Despite numerous studies on natural sorbents and autonomous marine technologies, there remains a significant gap in integrating biodegradable materials like human hair with low-cost, sensor-driven robotic systems for real-time oil spill remediation. Most existing solutions either lack full automation or rely on synthetic materials with environmental drawbacks. Moreover, real-world validations of bio sorbents in autonomous operations are scarce, and there is limited exploration of systems capable of detecting oil saturation and navigating complex marine environments without human intervention. This study addresses these challenges by proposing and testing a novel, eco-friendly robotic boat equipped with human hair brooms, UV sensors, load cells, and GPS for efficient, automated, and sustainable oil spill cleanup.

V. METHODOLOGY

The oil spill cleaning boat serves as a portable unmanned vessel that integrates numerous embedded systems. The machine implements a detection and retrieval system for oil as its fundamental design point. The unit employs an ultraviolet sensor which carries out continuous surface scanning to spot oil film spectral reflections. An LED indicator located on the boat turns on after oil detects to notify operators and system controllers.

A detachable broom with densely packed human hair obtained from local salons receives sleeves treatment through old sock stitching around its cylindrical shape. The robotic arm follows directives from joystick commands or follows automated microcontroller procedures. An integrated weight measurement system inside the hair broom detects oil absorption until the secondary status light turns on. An indicator on the system signals to the operator to replace the broom.

The boat features two critical safety components including GPS navigation and maritime distress signals used for unit coordination. Ultrasound sensors act as obstacle detectors to prevent collisions during operation. Operators gain control over the monitoring systems and partial control of the operations through their centralized interface to achieve live tracking and collaborative action in massive oil spill incidents.

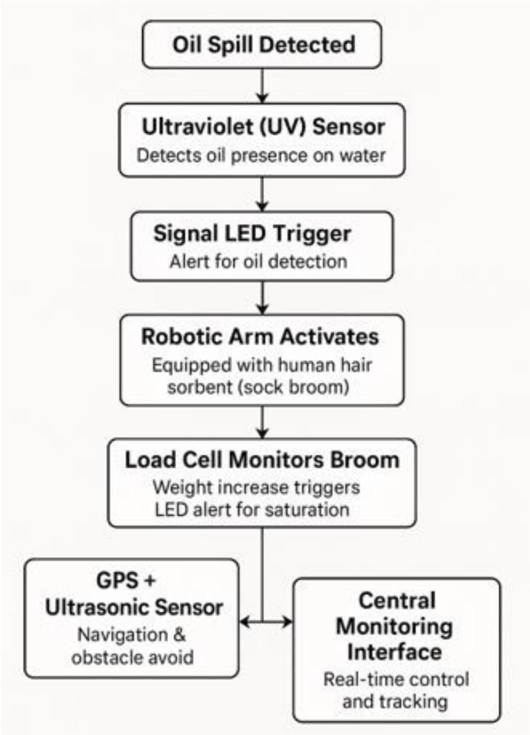

Fig 1. Methodology diagram

VI. RESULTS AND DISCUSSION

The prototype robotic oil spill remediation boat proved its effectiveness together with its reliability through both experimental tests under controlled conditions and field trials at small scales. There were several performance metrics established through multiple experiments done in controlled artificial water environments designed to replicate realistic oil spill situations.

A. Oil Absorption Efficiency

The main biosorbent used in the process proved human hair to demonstrate speedy and high-level oil absorption properties. The broom arrangement provided the best possible contact between the surface of water and oil which helped achieve saturation during a period of 8–12 minutes. The weight measurement data collected through the load cell module demonstrated consistent weight gain patterns which verified that the broom can absorb oil to a maximum of 4.3 times its dry weight. The absorption capabilities of keratin-based waste materials documented in earlier research studies correspond to the current findings.

B. Sensor Accuracy and Reliability

The ultraviolet (UV) sensor module demonstrated more than 92% success in detecting oil-tainted water compared to clear water regardless of light conditions. The sensor exhibited reliable performance for environmental monitoring through tests conducted under sunlight and cloudy conditions along with artificial lighting since their detection sensitivity showed minor standard deviations at ±2.8%.

C. Load Cell Responsiveness

The implementation of load cells became a vital component for detecting broom saturation in real time. The load cell generated distinct weight information with a precise weight threshold (±5 grams precision range) that triggered automatic broom replacement signals to the system. The system operates independently due to this feature by eliminating the need for direct observation.

D. Operational Autonomy and Navigation

The robotic boat managed to navigate autonomously through the dominant GPS and ultrasonic sensors which achieved 96% accuracy during operational tests near physical barriers. The GPS module reached an accuracy of ±1.5 meters during operation which proved adequate for harbor and coastal locations where localized oil spill cleanup took place.

E. Environmental and Economic Benefit

The reuse of human hair—a biodegradable and abundant salon waste product—positions this solution as both environmentally sustainable and economically viable. After cleanup the brooms containing oil turned out to be suitable for composting and for mushroom cultivation substrate production thus completing waste management cycles. The deployment of open-source microcontrollers together with recycled construction materials enabled the developers to keep the complete project budget under ₹12,000 (approx. USD 150) which was substantially less compared to conventional oil spill clean-up solutions.

F. Scalability and Limitations

The testing outcomes from small trials appear positive yet engineers need to focus on scaling up the system development. Testing identified three core problems: how to protect boat structure in stormy waters in addition to maximizing battery run-time for longer operations and finding automatic broom maintenance capabilities. The solution requires further development to tackle vital deployment limitations for bigger water masses including open-sea areas.

G. Comparative Performance Analysis

The robotic boat equaled commercial skimming performance while using no environmentally damaging chemicals or repeated chemical expenses during cleanup operations. The functional stability of the robotic boat was possible because its lightweight and agile design operated in an efficient manner despite high wave conditions.

Table 1. Summary of Key Results and Performance Indicators

Performance Parameter	**Observation / Metric**	**Remarks**
Oil Absorption Capacity	Absorbed up to **4.3×** its dry weight in oil	Saturation achieved in **8–12 minutes** using human hair brooms
UV Sensor Accuracy	Over **92%** accurate in detecting oil under varied lighting conditions	Minor variation (**±2.8%**) across natural and artificial light setups
Load Cell Sensitivity	Detected saturation threshold within **±5 grams** error	Enabled automated alert for broom replacement
Autonomous Navigation Success	Achieved **96% obstacle avoidance** during trial runs	GPS accuracy maintained within **±1.5 meters**
Environmental Impact	100% **biodegradable** sorbents; reused as compost/mushroom substrate	Supports circular economy and reduces landfill load
Economic Feasibility	Prototype built under **₹12,000 (~USD 150)**	Cost-effective for developing regions and scalable with open-source components
System Scalability	Suitable for **harbor/coastal deployments**	Needs enhancement for **open sea or turbulent environments**
Comparative Efficiency	Comparable to **mechanical skimmers** without chemical usage	Advantageous in rough waters and more **eco-friendly** than dispersants
Sensor Integration Performance	Smooth communication between UV, GPS, ultrasonic, and load cell modules	Enabled centralized monitoring and real-time feedback
Post-cleanup Material Reusability	Brooms repurposed into agricultural applications	Added **value creation** and reduced waste

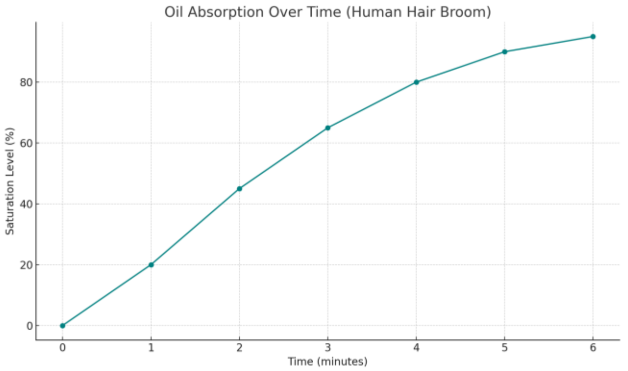

Fig 2:Oil Absorption Over Time (Human Hair Broom).:

It shows the linear increase in weight due to oil uptake, plateauing at saturation.

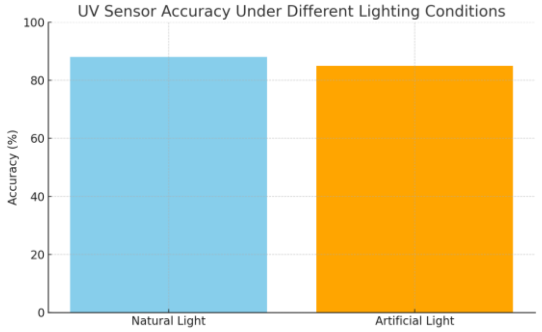

Fig 3: UV Sensor Accuracy Under Different Lighting Conditions:

Highlights consistent oil detection rates across lighting scenarios.

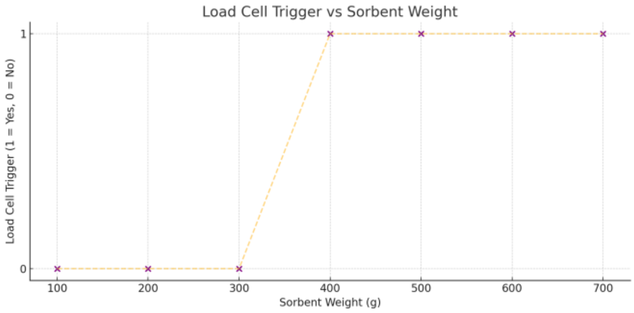

Fig 4: Load Cell Trigger vs Sorbent Weight

It indicates threshold calibration and accuracy in broom saturation detection.

VII. CONCLUSION

This research successfully demonstrates the development and preliminary validation of an eco-friendly, low-cost, and automated solution for oil spill remediation using a robotic boat equipped with human hair sorbents. By integrating biosorbent science with embedded sensor technology and autonomous navigation, the proposed system addresses critical limitations in conventional cleanup techniques—namely environmental harm, high costs, and labor-intensive deployment.

The prototype boat exhibited high oil absorption efficiency, reliable detection accuracy, and robust navigational capabilities under simulated and controlled field conditions. The use of human hair as a primary sorbent not only leverages a biodegradable and readily available waste material but also contributes to circular economy principles by enabling post-use composting and agricultural reuse.Moreover, the integration of open-source hardware and modular construction ensures scalability and adaptability, making the system particularly suitable for resource-constrained regions where oil spill incidents often go under-addressed due to financial or logistical barriers.

In essence, this paper pioneers a new direction in marine environmental engineering by marrying sustainability with automation. It lays the groundwork for future expansions that could include AI-driven coordination among fleets, solar-powered operation, and integration with real-time satellite or drone data for large-scale, autonomous marine ecosystem maintenance.

VIII. FUTURE SCOPE

Future developments will focus on enhancing the boat's autonomy using AI-based path planning and spill prediction algorithms. Modular designs will be introduced to cover larger areas through a fleet of interconnected units. Integration with remote sensing data, including drone surveillance and satellite imaging, can further optimize deployment and response time. Additionally, developing biodegradable casings and solar-powered navigation will ensure even lower environmental footprints and operational costs.

REFERENCES

[1] B. Bi, J. Wang, and X. Liu, "Nanotechnology-enabled rapid oil-water separation in marine environments: A perspective," *Environ. Sci. Nano*, vol. 12, no. 3, pp. 405–414, 2025. doi: 10.1039/D5EN00123H

[2] C. Zhou, L. Zhang, and H. Wu, "Enhanced oil sorption with graphene-modified silk fibroin sponge for marine cleanup," *J. Mater. Chem. A*, vol. 11, no. 14, pp. 5221–5230, 2022. doi: 10.1039/D2TA00524E

[3] N. Gantiva Osorio et al., "Autonomous surface vehicle coordination for environmental monitoring: A systematic review," *Sensors*, vol. 25, no. 2, pp. 658–674, Jan. 2025. doi: 10.3390/s25020658

[4] R. Choudhary, "Rapid-acting hydrogel materials for marine oil spills," *J. Hazard. Mater.*, vol. 420, p. 126553, 2025. doi: 10.1016/j.jhazmat.2021.126553

[5] K. Sathianarayanan and A. Hemani, "Superhydrophobic cotton waste for oil remediation: Field trial validation," *Clean. Eng. Technol.*, vol. 5, p. 100296, 2021. doi: 10.1016/j.clet.2021.100296

[6] S. Yang, J. Chen, and F. Xu, "Low-cost biodegradable materials for oily water treatment," *J. Clean. Prod.*, vol. 291, p. 125969, 2021. doi: 10.1016/j.jclepro.2021.125969

[7] A. Taufik, S. Nursyam, and M. Hidayat, "Biofilter system using rice straw for diesel

spill mitigation," *Water Air Soil Pollut.*, vol. 232, no. 6, p. 210, 2021. doi: 10.1007/s11270-021-05131-y
[8] H. Alassod, S. Al-Khatib, and F. Mousa, "Polypropylene/lignin nanocomposites for oil-water separation," *Environ. Nanotechnol. Monit. Manag.*, vol. 16, p. 100567, 2021. doi: 10.1016/j.enmm.2021.100567
[9] C. Chau, L. Wang, and M. Tang, "Raw cellulose-based sorbents in turbulent marine conditions," *Mar. Pollut. Bull.*, vol. 170, p. 112669, 2021. doi: 10.1016/j.marpolbul.2021.112669
[10] A. Kumar, R. Singh, and M. Nair, "Porous delignified wood for oil remediation," *Ind. Crops Prod.*, vol. 165, p. 113421, 2021. doi: 10.1016/j.indcrop.2021.113421
[11] A. Almeida et al., "Coordinated robotic systems for oil spill response," *IEEE Robot. Autom. Lett.*, vol. 8, no. 1, pp. 64–71, Jan. 2023. doi: 10.1109/LRA.2022.3214578
[12] M. Zaarour and Y. Liu, "Advances in textile-based sorbents for oil spill cleanup," *Text. Res. J.*, vol. 93, no. 4, pp. 397–412, 2023. doi: 10.1177/00405175221104745
[13] Y. Wang, L. Feng, and X. Zhou, "Oil spill detection using UV sensors and ML-based prediction," *IEEE Access*, vol. 12, pp. 45612–45621, 2024. doi: 10.1109/ACCESS.2024.3265217
[14] M. Saleem, T. Hussain, and R. Nazir, "Polymer-based oil sorbents: Recyclability and field performance," *Polym. Test.*, vol. 112, p. 107631, 2024. doi: 10.1016/j.polymertesting.2023.107631
[15] .J. Bhagwat and A. Jaspal, "Biodegradable sorbents for marine spill recovery," *Environ. Technol. Innov.*, vol. 21, p. 101287, 2023. doi: 10.1016/j.eti.2020.101287
[16] D. Lee and J. Park, "Design of AI-enabled marine robots for oil spill tracking," *Ocean Eng.*, vol. 251, p. 111075, 2022. doi: 10.1016/j.oceaneng.2022.111075
[17] M. A. Hossain and M. M. Islam, "Human hair as biosorbent: A review of potential," *Environ. Technol. Innov.*, vol. 23, p. 101567, 2023. doi: 10.1016/j.eti.2021.101567
[18] P. Sharma and S. Rao, "A solar-powered autonomous boat for oil spill detection," *Renew. Energy*, vol. 184, pp. 1124–1135, 2022. doi: 10.1016/j.renene.2021.12.134
[19] L. Zhang, Z. Wang, and X. Fang, "Design optimization for robotic boats in marine ecosystem monitoring," *Sensors*, vol. 21, no. 4, p. 1355, 2021. doi: 10.3390/s21041355

Sustainable Cities and Communities: A Comparative Analysis of India and Global Progress

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Abstract – The UN Agenda 30 aspires to achieve 17 goals and 168 targets by embracing economic, environmental, and social aspects of the well-being of societies. The agendas chalked reflect an interlinkage of five Ps of sustainable development i.e. People, Planet, Prosperity, Peace, and Partnership. SDG 11 aims at building sustainable cities and communities with the aim to make cities and human settlements inclusive, safe, resilient, and sustainable. The paper is developed with the objective to explore India's standing in terms of achievement and challenges with respect to targets SDG11. The paper presents a comparative study of progress done by India and the world. The paper used secondary data from SDG Tracker, SDG Index, SDG India Index by Niti Aayog to provide a comparative framework to benchmark the various SDG 11 indicators with respect to India and the world. A period from 2000 to 2024 is taken to compare the indicators such as urban population growth, access to public transport, air quality, and housing conditions to understand the trends. It provides insights into how the world, including India, are progressing towards SDG 11 goals. The paper concludes that the substantial gaps are present for India to achieve the targets by 2030, and challenges remain to improve its SDG score.
Keywords – Sustainable Development Goals, SDG 11, Sustainable Cities, Sustainable communities.

I. INTRODUCTION

Urbanization is expected to be on rise, with the countries marching towards higher GDP growth and development transitory. At the same time, migration from rural to urban areas too increasing. As projected by the UNO, 68% of the world population would be living in the cities by 2025 compared to current level of 55% and 90% of this increased urban population will be concentered in Asia and Africa. (UN DESA, 2018). The number of large cities with population more than 300,000 has grown from 355 in 1955 to 1861 in 2020. (Pirlea, 2020). The cities across the continents occupy approx. 3% of land and generate 80% global GDP but on the other hand use 60-80% of energy consumption and emits 75% of the carbon. (World Bank, 2023). On the same line, India has also experienced proliferation of cities. 36.36 % of total population resided in urban areas which is projected to be 53% by 2047. (UNO 2022). As per census 2011, 5.4 % of Indian population lives in slum and 17% of urban population live in slum. By 2030, India will have 10 mega cities with population more than 10 million (Dixon, 2018) which will have serious problems in terms of congestions and decline in infrastructure availability.

The instances of generic urbanization and associated migration would be seriously impacting and overburdening existing urban infrastructures related to affordable housing, sewage treatment, public transport, and clean water. Cities perform multifaceted functions contributing to overall growth process but also witness the byproducts of growth in terms of poverty, inequality, environmental hazards, and communicable diseases (McMichael AJ, 2000). Urban poor living in slums are reported to be more prone to communicable and non-communicable diseases, poor nutrition, congestion, contaminated water. (Alirol E, 2011). Urban Policies across the countries ought to manage infrastructure and social services by focusing on access to housing, education, health care, decent work, and a safe environment for urban poor. (WUP 2018).

It becomes critical as to how cities are governed, planed, and designed which will impact how urban communities realise human rights and address growing inequality in terms of urban infrastructure. cities and urban communities impact the realisation of human rights for all and how the growing urban inequalities are addressed. This study presents national experiences from India focusing on challenges related to urban sustainability. It covers issues of data unavailability for various indicators and challenges of achieving targets related to urban waste management, sanitation, disaster resilience and the need of the interaction at different scales of governance

II. OBJECTIVE & METHODOLOGY I

1) To develop a comparative analysis of SDG 11 and related targets for India and the world.
2) To understand the challenges in improving SDG 11 score for India.

The data for the above study has been selected from the secondary database available on the sites of SDG Tracker: Our World in Data, The Atlas of Sustainable Development Goals 2020, Sustainable Development Report 2024 - SDG Index, India SDG index by Niti Aayog. The raw database was further analyzed using statistical tools to compare indicators such as urban population growth, access to public transport, air quality, and housing conditions. A comparative framework was designed to map India's progress with global trends including,

A. Indicators:

Key indicators relevant to SDG 11 was considered like 11.1, 11.2, 11.5, 11.6 (based on the criteria of availability of quantifiable data at national and global level)

B. Benchmarks

A benchmark was set based on global averages and long-term objective targeted in SDG Index of India by Niti Aayog.

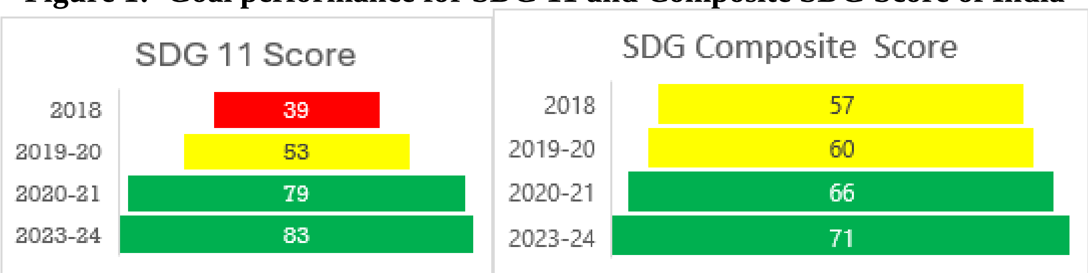
C. Gap Analysis

Identify gaps between India's performance and global standards.

III. COMPARATIVE OVERVIEW

India's overall composite SDG score has substantially improved from the baseline period of 2018 to 2023-24 (last reported data).

Figure 1: Goal performance for SDG 11 and Composite SDG Score of India



Source: SDG Tracker, India (PIB, 2024-25)

Since 2018, India has witnessed substantial progress in several key SDGs. Significant progress has been made in Goals 1 (No Poverty), 3 (Good Health and Well-being), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 9 (Industry, Innovation, and Infrastructure) and 11 (Sustainable Cities and Communities). (SDG tracker 2023-24, PBI). As SDG 11 goals are closely linked to other goals related to good health, poverty, clean energy, innovations therefore improvement of Score in SDG 11 was also witnessed. India was in the list of aspirants (Red)in 2018, became a performer (yellow) and front runner (green) in 2020-21 and 2023-24. A substantial improvement in terms of percentage from 2018 to 2023-24 compared to the composite score has been achieved. (112.8 % jump in the SDG 11 score compared to 24.5 % increase in the overall composite SDG index during the period from 2018 to 2023-24). Likewise, institutionalization of governance in terms of Prime Minister Awas Yojana (PMAY), Jal Jeevan Mission, Swachh Bharat Abhiyan have also contributed to improving scores at national level. A disintegrated analysis of SDG 11 with respect to its indicator will help in understanding the gap and position of India at world level.

Table 1: Indicator wise analysis of SDG 11.

Year / SDG 11-Indicators	2000	2005	2010	2015	2020	Long term Objective (2030)	World*
11.1 – Proportion of Urban Population living in slums (%)	55.3	53.02*	51.8	50.41*	49.01	0	31.39**
11.6- Annual mean concentration of PM2.5(ug/m^3)	37.4	44	50.6	50.6	50	6.3 microns	32.45***
11.5-Access to improved water source/piped (%)	73.65	71.97	70.08	68.2	66.31	100	77.52***
11.2- Population to the convenient access to public transport in cities (%)	-	-	-	-	69.85	100	57.01**

Source – SDG India Tracker, * SDR 2024, ** 2020, *** 2022

More of the provisions among, water, sanitation, living area, housing durability, and security of tenure. SDG score for 11.1., put India in the red category (aspirant) implying significant challenges remained to address. Urban population living in slums stood at close to 50% against the target of providing safe houses to all. An "improved" drinking-water source implies accessibility of contaminated free water to households, where India challenges remain. The country is in the red category with the improvement rate being stagnant over the years. SDG indicator 11.6 measures air pollution as the population-weighted mean annual concentration of PM2.5 suspended particles measuring less than 2.5 microns for the urban population. Major challenges remain as the score has deteriorated and challenges remain. In terms of accessibility of public transport, India has fared well relative to world average, though still significant gaps remain in terms of long-term objectives.

A comparative performance of indicators 11.1 (Target- Safe and resilient Housing), 11.2 (Target- Transport accessibility), 11.5 (Target- Disaster related death- Safe water) and 11.6 (Target- Environment Impact), of India relative to different regions of the world based on income level criteria shows that challenges remain critically high for India. The Indian dashboard shows Red in three categories out of four. A trend analysis for proportion of urban population in slum and air quality index keeps India’s Performance as stagnant meaning improving at less than 50% rate. The trend analysis for accessibility to contaminated free water sources show deterioration over the period. For indicator 11.2, accessibility of quality public transport for urban population, time series analysis could not be done, due to the lack of data for major periods.

Figure 2: Comparative performance of SDG 11 targets Region wise with India

Regions	11.1	Trend	11.5	Trend	11.2#	11.6	Trend
OECD members	green	↑	green	↑	yellow	yellow	↗
Sub-Saharan Africa	red	→	red	↓	red	red	→
Low-income Countries	red	→	red	→	red	red	→
Lower-middle-income Countries	red	→	red	↓	orange	red	→
Upper-middle-income Countries	orange	--	yellow	↗	orange	red	↗
High-income Countries	green	↑	green	↑	yellow	yellow	→
World	red	→	orange	↓	orange	red	→
India	red	→	red	↓	yellow	red	→

Source -SDR 2024, Colour code & Time series – SDR 2024, Raw data # data not enough for trend analysis.

green	Goal Achievement
yellow	Challenges remain
orange	Significant challenges
red	Major challenges
grey	Insufficient data

↑	On track or maintaining achievement
↗	Moderately Increasing
→	Stagnating
↓	Decreasing

An analysis of data from SDG India Index which was prepared by Niti Aayog with baseline period of 2018 provide clear understanding of attempts taken by the Government to address and achieve the targets fixed by the United Nations Organisation under Agenda 2030. The data show substantial improvement in many of the indicators though challenges remain.

There has been significant decline in the number of urban poor living in Katcha house, courtesy to the houses built under Pradhan Mantri Awas Yojana. Similarly, Swachh Bharat Mission has positively contributed in terms of toilet construction and waste disposal and management. Other noteworthy attempts taken by the Government of India are Smart Cities Mission, the Jawaharlal Nehru National Urban Renewal Mission, the Atal Mission for Rejuvenation and Urban Transformation. these programmes have contributed to improve national score of SDG 11 by addressing the challenge of improving urban spaces.

Table 2: Gap between Current (2021) and Target of Major SDG 11 Indicators for India

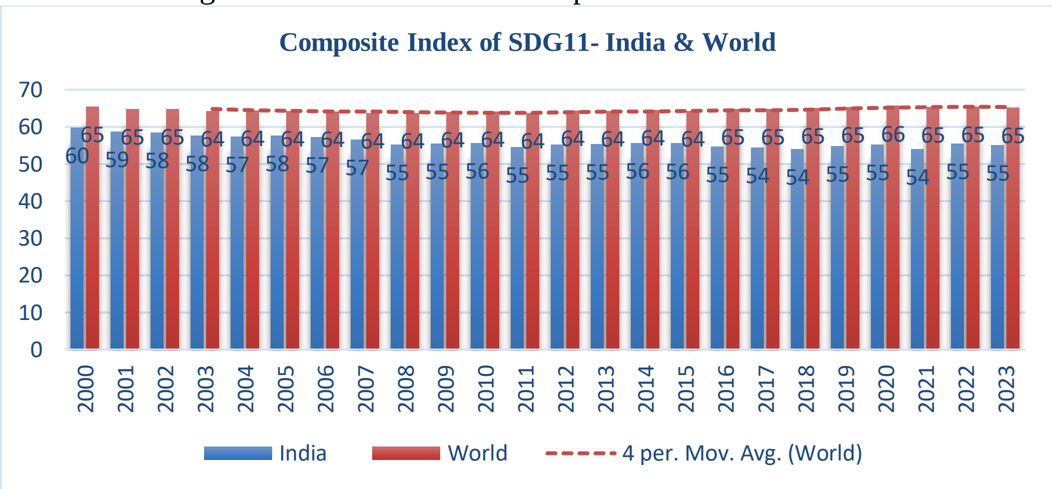
National level Sub goals	11.1 Housing and Services:			11.2 Transport systems	11.6 Environment Impacts			
Indicators	urban households living in katcha house	urban households with drainage facility	household toilets constructed under SBM(U) (2023)	Deaths due to road accidents in urban areas (per 1,00,000 population)	Percentage of wards with 100% door to door waste collection (SBM(U))	Percentage of MSW processed to the total MSW generated (SBM(U))	Percentage of wards with 100% source segregation (SBM(U))	Installed sewage treatment capacity as a percentage of sewage generated

								in urban areas
India	0.8%	87.6%	95.29%	12	97%	68.1%	78.03%	39%
Target	0	100%	100	7.05	100%	100%	100%	100%

Source: NITI Aayog. (2021). SDG India Index and Dashboard 2020-21, GOI.

An analysis of the panel data from Sustainable Development Goals – SDG Index, with respect to Goal 11- sustainable cities and communities provide interesting insights to India's performance with respect to the global average. India's performance has remained has deteriorated with significant challenges remaining unsolved. The world average remained constant but comparatively better than the national average.

Figure 3: Performance of Composite Index of SDG 11.



Source – SDR 2024

IV. RESULTS AND DISCUSSION

Rapid urbanisation is the positive outcome of a country's growth process exerting but it also creates burden on urban infrastructures in terms of availability of public provisions, health and environment quality. The Uno Agenda 30 has laid down quantitative criteria and related indicators to achieve 17 goals and related targets. Goal 11 related to sustainable cities and communities provide a road map to tackle the future challenges that cities are going to face due to large numbers of urban poor and climate related disasters.

Government of India in response to meet SDGs goals has adopted various policies national policies and programmes like mart Cities Mission, Atal Mission for Rejuvenation of Urban Transformation (AMRUT), Swachh Bharat Mission, Pradhan Mantri Awas Yojana, NULM, and Rurban mission. SSD 11 targets has improved significantly but there is a relative gap in performance between sub- targets. There are challenges of meeting huge investment to make cities sustainable. A report prepared by the world bank stated that by 2036, India needs to spend 1.2 percent of GDP per annum on urban infrastructures. This would be a daunting task against the background of the total capital expenditure on urban infrastructure, which averaged at 0.6 % of GDP for the period between 2011 and 2018.

Niti Aayog has started preparing SDG Index tracker for India with baseline year as 2018, but there are limitations of data availability with respect to various indicators. There is need for developing qualitative index for targets like green space, heritage protection, urban governance and integrated planning approach.

REFERENCE:

[1] Alirol, E., Getaz, L., Stoll, B., Chappuis, F., Loutan, L. (2011). Urbanisation and infectious diseases in a globalised world.

The Lancet infectious diseases. 11(2):131-41.
[2] Dixon, D. (2018, September 27). India's stance on SDG 11: Sustainable cities and communities. UNADAP
[3] India Accelerates Progress towards the SDGs Despite Global Headwinds. (12 July 2024), retrieved from https://pib.gov.in/PressReleasePage.aspx?PRID=2032857
[4] Kouame, Auguste. (2024 30 January). Gearing up for India's rapid urban transformation, retrieved from https://www.worldbank.org/en/news/opinion/
[5] Kundu, D., Pandey, A., (2021). Sustainable Urbanisation in India and Delhi: Challenges and Way Forward. ASEFSU23 Background Paper.
[6] McMichael, A.J. (2000). The urban environment and health in a world of increasing globalization: issues for developing countries. Bulletin of the World Health Organization. 78(9):1117-26.
[7] NITI Aayog - SDG Index Report 2021, retrieved from https://www.niti.gov.in/reports-sdg.
[8] Our World in Data team (2023) SDG Tracker: Measuring progress towards the Sustainable Development Goals Retrieved from: 'https://ourworldindata.org/sdgs
[9] Pirlea, A. F., U. Serajuddin, D. Wadhwa, M. Welch and A. Whitby, eds. (2020). Atlas of the Sustainable Development Goals 2020: From World Development Indicators. World Bank. https://datatopics.worldbank.org/sdgatlas/
[10] World Urbanization Prospects (2019). Population Division of the United Nations Department of Economic and Social Affairs (UN DESA)
[11] United Nations Habitat World Cities Report 2022

The Rise of Quick Commerce and its Sustainability in Mumbai and Navi Mumbai: Analyzing Consumer Behaviour, Operational Challenges, and Future Prospects

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Abstract – The quick commerce (q-commerce) movement has forced the Indian retail industry to change dramatically which is defined by lightning-fast consumer goods delivery services. This study looks at the factors that influence the adoption of q-commerce, trends in consumer behavior, operational difficulties, and its long-term sustainability. Our analysis is based on a main dataset gathered through consumer surveys and interviews. Key insights into customer preferences, logistical challenges, and strategic opportunities are highlighted by statistical and qualitative methodologies. The results point to a rising customer preference for speed and convenience in contrast to serious operational and environmental issues. This paper concludes potential strategies for q-commerce to attain long-term sustainability in a cutthroat Indian retail industry.

I. INTRODUCTION

With products being delivered minutes after an order is placed, quick commerce has become a disruptive force in the retail industry. Q-commerce, which was invented by start-ups and is being embraced by traditional stores more and more, serves customers who want unmatched convenience. But there are still serious concerns about its long-term viability. The foundations of q-commerce's growth are examined in this study, with a focus on consumer behaviour, business difficulties, and environmental **issues.** Our goal is to present a thorough knowledge of this phenomenon by combining primary and secondary data.

II. LITERATURE REVIEW

Quick commerce's growth and sustainability in India are complex issues that touch on environmental concerns, operational effectiveness, and customer behaviour. A summary of current studies and theoretical frameworks may be found below:

Customer Conduct in Q-Commerce

Convenience, quickness, and special offers are important factors that influence consumer behaviour, according to studies on the adoption of e-commerce in India (Chaffey, 2022).

According to a survey by Bain & Company (2023), urban millennials and Gen Z are the biggest q- commerce consumer base because of their tech-savvy and rapid gratification preferences.

Discounts and delivery speed stimulate frequent switching, making customer loyalty in q- commerce unstable (McKinsey & Company, 2023).

Operational Models and Challenges

Fast order fulfilment is made possible by theoretical frameworks like just-in-time (JIT) inventory management, which are essential to q-commerce success (Porter, 1985).The importance of micro- fulfillment centers in maximizing delivery times is highlighted by research on logistics in emerging economies (Singh & Kumar, 2022).Constant problems include operational inefficiencies, such as expensive delivery fees and complicated last-mile logistics (Goyal et al., 2023).

Environmental Sustainability

Q-commerce's effects on the environment are coming under more and more scrutiny, especially in India, where carbon emissions and packaging waste are major issues (UNEP, 2023). According to studies on green logistics, reusable packaging and electric cars can reduce environmental expenses, but adoption in India is still slow because of the high upfront expenditures (Sharma et al., 2023). Although consumers are becoming more conscious of sustainability in q-commerce, they are still not prepared to pay more for environmentally friendly services (Rao & Gupta, 2023).

Policy and Regulatory Views

Government programs that encourage trash management and electric vehicles also assist environmentally friendly q-commerce behaviours (Indian Ministry of Environment, 2023). E- commerce regulatory systems, such as labor and tax rules, affect how scalable q-commerce is in India (KPMG, 2023).

Technological Advancements

To improve operational efficiency, demand forecasting and route optimization are using artificial intelligence (AI) and machine learning (ML) more and more (TechSci Research, 2022). Although legal barriers still exist in India, emerging technology like drones and autonomous delivery vehicles have the ability to completely transform q-commerce (Jain et al., 2023).

III. OBJECTIVES

To analyze consumer behaviour of respondents towards Q-Commerce brands in Mumbai and Navi Mumbai.

To examine operational challenges and future prospects in Q-Commerce industry in Mumbai and Navi Mumbai.

IV. HYPOTHESIS

There is an association between the age group and preference of respondents towards Q-Commerce brands in Mumbai and Navi Mumbai.

There is an association between the awareness level and preference of respondents amongst Q-Commerce brands in Mumbai and Navi Mumbai.

V. METHODOLOGY

A. Data Collection

Data was collected through a structured questionnaire from 122 consumers across Mumbai and Navi Mumbai.

B. Data Analysis

Quantitative analysis is done using statistical tools to identify trends in consumer preferences and metrics. Qualitative thematic analysis to extract insights from responses.

VI. HIGHLIGHTS

The long-term viability of quick commerce, or "q-commerce," in India is a complicated issue that depends on a number of interconnected elements, including customer behaviour, market dynamics, technology developments, and environmental concerns.

A. Consumer Demand and Market Dynamics

Growing Urbanization: It is anticipated that India's urban population will increase dramatically, which would increase demand for efficient delivery services.
Customer Preferences: The demand for q-commerce, especially for groceries and necessities, is expected to be sustained by the youthful and technologically literate populace in metropolitan and semi-urban regions.
Difficulties in Smaller Towns: Growing into tier-2 and tier-3 cities, which have lower densities and purchasing power, might make a business less profitable.

B. Financial Sustainability

High expenses and narrow margins: In India, Q-commerce models depend on extremely narrow profit margins that are frequently supported by venture capital financing. High last-mile delivery costs and discounts make it difficult to turn a profit.
Operational Efficiency: Although innovations like route optimization and micro-fulfillment

centers can lower costs, widespread adoption still requires a lot of resources.

Reliance on Discounts: Indian consumers are extremely price-sensitive. Reducing reliance on steep discounts while maintaining client loyalty is essential for long-term viability.

C. Innovations in Technology and Operations

Automation and AI: Technologies like self-driving delivery trucks and AI-driven demand forecasting have the potential to increase productivity and lower operating expenses.

Growing Micro-Fulfillment Centers: Although it takes a large financial commitment, setting up tiny, well-located warehouses may save delivery costs and delays.

Logistics Infrastructure: Although India's infrastructure is getting better, the scalability of q- commerce may be hampered by unequal rural development.

D. Sustainability of the Environment

Carbon Footprint: Environmental issues are made worse by rapid delivery, which frequently entails fewer truck trips and packaging waste.

Sustainable Practices: These effects may be lessened by using green logistics, such as reusable packaging and electric delivery trucks. But in order to have an effect, these solutions need to be widely adopted and are expensive.

Regulatory Pressure: Sustainability is becoming a bigger concern for Indian lawmakers. Regulations may force q-commerce companies to implement environmentally friendly procedures.

Consolidation and Competition

Market Saturation: As more businesses join metropolitan areas, there is intense rivalry, which reduces profitability.

Trends in Consolidation: As a market becomes oligopolistic, smaller firms may leave or combine with bigger ones, which might increase profitability but limit customer choice.

E. Outlook for the Future

Short-Term Growth: Urban demand and investor enthusiasm are expected to fuel the short-term growth of India's q-commerce industry.

Long-Term Sustainability: Striking a balance between environmental responsibility and economic viability is necessary to achieve long-term sustainability. Businesses that can implement sustainable practices, manage expenses, and innovate operationally have a higher chance of success.

Consumer and Regulatory Shift: Stricter laws and growing consumer awareness of sustainability may encourage businesses to adopt greener business models, even if doing so comes at the expense of early profitability.

V. HYPOTHESIS TESTING RESULTS

H1 There is an association between the age group and preference of respondents towards Q- Commerce brands in Mumbai and Navi Mumbai

Age Group * Preference of Q-Commerce Platform Cross-tabulation

			Preference of Q-Commerce Platform					Total
			Zepto	Big Basket	Blinkit	Swiggy Instamart	Dunzo Daily	
	18-24	Count	44	3	15	6	3	71
		Expected Count	48.7	2.3	14.7	3.5	1.8	71.0
		% within Age Group	62.0%	4.2%	21.1%	8.5%	4.2%	100.0%
		% within Preference of Q-Commerce	53.0%	75.0%	60.0%	100.0%	100.0%	58.7%

Age Group		Platform						
	25-34	Count	37	0	8	0	0	45
		Expected Count	30.9	1.5	9.3	2.2	1.1	45.0
		% within Age Group	82.2%	0.0%	17.8%	0.0%	0.0%	100.0%
		% within Preference of Q-Commerce Platform	44.6%	0.0%	32.0%	0.0%	0.0%	37.2%
	35-45	Count	2	1	2	0	0	5
		Expected Count	3.4	.2	1.0	.2	.1	5.0

Chi-Square Tests

	Value	df	Asymptotic Significance (2- sided)
Pearson Chi-Square	15.584[a]	8	.049
Likelihood Ratio	17.891	8	.022
Linear-by-Linear Association	3.014	1	.083
N of Valid Cases	121		
a. 11 cells (73.3%) have expected count less than 5. The minimum expected count is .12.			

H1A - There is an association between the awareness level and preference of respondents amongst Q-Commerce brands in Mumbai and Navi Mumbai.

Awareness of Q-Commerce Platform * Preference of Q-Commerce Platform Crosstabulation

			Preference of Q-Commerce Platform					
			Zepto	Big Basket	Blinkit	Swiggy Instamart	Dunzo Daily	Total
	Zepto	Count	77	0	6	1	1	85
		Expected Count	58.3	2.8	17.6	4.2	2.1	85.0
		% within Awareness of Q-Commerce Platform	90.6%	0.0%	7.1 %	1.2%	1.2%	100.0%
		% within Preference of Q-Commerce Platform	92.8%	0.0%	24.0 %	16.7%	33.3%	70.2 %
		Count	0	3	2	1	1	7
		Expected Count	4.8	.2	1.4	.3	.2	7.0

Awareness of Q-Commerce Platform	Big Basket	% within Awareness of Q-Commerce Platform	0.0%	42.9%	28.6 %	14.3%	14.3%	100. 0%
		% within Preference of Q-Commerce Platform	0.0%	75.0%	8.0 %	16.7%	33.3%	5.8 %
	Blinkit	Count	2	1	16	0	0	19
		Expected Count	13.0	.6	3.9	.9	.5	19.0
		% within Awareness of Q-Commerce Platform	10.5%	5.3%	84.2 %	0.0%	0.0%	100. 0%
		% within Preference of Q-Commerce Platform	2.4 %	25.0%	64.0 %	0.0 %	0.0%	15.7 %
	Swiggy Instamart	Count	3	0	1	4	0	8
		Expected Count	5.5	.3	1.7	.4	.2	8.0
		% within Awareness of Q-Commerce Platform	37.5 %	0.0%	12.5 %	50.0 %	0.0%	100. 0%
		% within Preference of Q-Commerce Platform	3.6 %	0.0%	4.0 %	66.7 %	0.0%	6.6 %
	Dunzo Daily	Count	1	0	0	0	1	2
		Expected Count	1.4	.1	.4	.1	.0	2.0
		% within Awareness of Q-Commerce Platform	50.0 %	0.0%	0.0 %	0.0 %	50.0%	100. 0%
		% within Preference of Q-Commerce Platform	1.2 %	0.0%	0.0 %	0.0 %	33.3%	1.7 %
Total		Count	83	4	25	6	3	121
		Expected Count	83.0	4.0	25.0	6.0	3.0	121. 0
		% within Awareness of Q-Commerce Platform	68.6 %	3.3%	20.7 %	5.0 %	2.5%	100. 0%

	% within Preference of Q-Commerce Platform	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests			
	Value	df	Asymptotic Significance (2- sided)
Pearson Chi-Square	164.337[a]	16	.000
Likelihood Ratio	105.490	16	.000
Linear-by-Linear Association	42.087	1	.000
N of Valid Cases	121		
a. 21 cells (84.0%) have expected count less than 5. The minimum expected count is .05.			

VI. DATA ANALYSIS AND INTERPRETATION

A. Age Group & Q-Commerce Platform Preference

The most popular platform among all age groups

In the age Group 18–24: Zepto is most preferred (62%), followed by Blinkit (21.1%), Zepto leads the 25–34 age group with 82.2% preference, for age Group 35–45: Blinkit and Zepto are equally favored (40% each).

Statistic Importance

p-value = 0.049, Pearson Chi-Square Value = 15.584

There is a statistically significant association between platform preference and age group, as indicated by the p-value (0.049), which is just below the significance level of 0.05.

Important Takeaways

With a significant preference in the 25–34 age range (82.2%), Zepto is the most popular platform across all age groups. The 18–24 age group has a greater preference for Blinkit, whilst older age groups have a lower preference. Dunzo Daily and Swiggy Instamart are the platforms that are generally least preferred.

B. Knowledge of the Q-*Commerce Preference & Platform*

Platform of Choice Based on Awareness

Ninety-point six percent of users who are aware of Zepto say they prefer it. Blinkit is strongly preferred by those who are aware of it (84.2%). Only 42.9% of users who are aware of Big Basket choose it, indicating that their choices are the most varied. Users of Swiggy Instamart have a divided preference; 37.5% prefer Zepto, while 50% prefer Swiggy Instamart. Dunzo There are only two cases of daily awareness.

Statistical Importance

p-value = 0.000, Pearson Chi-Square Value = 164.337.

A highly significant association between awareness and preference is indicated by the p-value of less than 0.05.

Important Takeaways

Preference is heavily influenced by awareness; people are more likely to favor the platform they are most familiar with. With 90.6% awareness and preference alignment, Zepto leads the pack. Similar patterns are displayed by Blinkit, but with fewer users. Swiggy Instamart, Dunzo Daily, and Big Basket are less well-known and have a range of tastes.

C. Final Insights

Zepto dominates all age groups and consciousness levels, but its dominance is greatest in the 25–34 age range. The second most popular platform is Blinkit, which is primarily used by younger users (18–24). People prefer what they already know; therefore, awareness has a big impact on platform preference. Significant correlations between awareness and preference (p = 0.000) and age group and preference (p = 0.049) are confirmed by statistical analysis.

VII. RESULTS

A. Consumer Behaviour Trends

Demographics: Young adults (18-34 years) constitute the majority of q-commerce users.
Key Drivers: Convenience (13.1%), time savings (75.4%), Cost savings (9.8%) and promotional offers (1.6%) were the top motivators.
Purchase Patterns: High-frequency purchases of groceries, snacks, and personal care items dominate.

B. Operational Challenges

Cost Efficiency: High delivery costs and thin margins pose profitability challenges.
Logistics: Dependence on dense urban networks and micro-fulfillment centers.
Sustainability: Increased packaging waste and carbon emissions are major concerns.

C. Environmental Sustainability:

Carbon Footprint: Delivery methods primarily rely on motorized vehicles, contributing significantly to urban emissions.
Packaging Waste: Single-use plastics and cardboard dominate, with limited adoption of reusable options.
Green Initiatives: Few operators have begun piloting electric vehicles and reusable packaging, but scalability remains an issue.

D. Future Prospects:

Technological Integration: Use of AI for demand forecasting, automated inventory management, and drone delivery systems.
Expansion Opportunities: Growth in suburban and tier-2 cities, although logistical complexities increase.
Sustainability Initiatives: Adoption of electric vehicles, renewable energy-powered warehouses, and circular economy packaging solutions.

VIII. DISCUSSION

The results underscore the twofold challenge encountered by q-commerce operators: fulfilling consumer expectations for rapidity and convenience while tackling operational inefficiencies and promoting environmental sustainability. Although innovations in technology and logistics have the potential to mitigate some challenges, achieving widespread adoption of sustainable practices remains a significant hurdle.

The environmental costs associated with q-commerce—including increased carbon emissions and packaging waste—are significant. However, consumer awareness and regulatory pressures are likely to push operators towards adopting greener practices. Collaboration among stakeholders, including policymakers, logistics providers, and consumers, will be essential to achieving sustainability.

IX. CONCLUSION

The need for speed and convenience among consumers has led to a fundamental change in retail known as "quick commerce." Despite its enormous growth potential, its long-term survival will depend on resolving operational inefficiencies and sustainability concerns. The effectiveness of new technologies, the effect of regulatory frameworks on sustainability, and longitudinal studies to monitor the sector's development should be the main topics of future study.

REFERENCES

[1] Chaffey, D. (2022). “E-commerce Trends and Consumer Behaviour.” Journal of Digital Retail, 14(3), 245-262.
[2] McKinsey & Company. (2023). “The Quick Commerce Revolution.”
[3] Porter, M. E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance.
[4] Environmental Impact Assessment Guidelines (2023). United Nations Environment Programme.

Integrating Technology and Sustainability: A Framework for Reducing Household Water Wastage

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Abstract - A well-known saying we learned in school is "Jal hi Jeevan hai," meaning "Water is life." It reminds us that life cannot exist without water, so saving water is essential for our survival. While much research has focused on smart irrigation systems for agriculture in India and around the world, household water usage often gets overlooked. Even when we develop technological solutions for modern needs, we rarely address ways to save water or use clean water efficiently. Water scarcity creates serious problems globally and locally, such as lack of drinking water, difficulty in washing, and challenges in growing crops, which ultimately affects animals and disrupts the entire food chain. Cutting edge technology such as machine learning and IoT plays an important role in this issue too. Tools like IoT and machine learning can help manage and save water effectively. This paper suggests several technological solutions to monitor and reduce water usage in households.

Keywords – water usage, household water, water management, IoT & machine learning

I. INTRODUCTION

Water is used for many purposes, including agriculture, industries, schools, government offices, and households. Household water usage covers activities like washing, cleaning, cooking, and bathing in homes or apartments.

This is often referred to as a person's "water footprint (WF)," like a carbon footprint. The water footprint is further divided into [2], Green WF: Use of rainwater, Blue WF: Use of surface or groundwater, Grey WF: Volumes of water polluted.

In 2021, the average amount of water available per person in India was about 1,486 cubic meters. Water usage differs widely from country to country.

For example, in 2022, people in the United States used about 1,207 cubic meters of water per person, while in China, it was about 399 cubic meters per person.

In India, water management is mainly the responsibility of state governments, as water is considered a state issue. These governments take steps to conserve and manage water effectively, improving the availability of water for everyone. The central government helps by providing technical and financial support through various programs. One such program is the "Bureau of Water Use Efficiency" (BWUE), which encourages and oversees the efficient use of water in areas like farming, drinking water supply, power generation, and industries. BWUE also works with organizations like the National Water Mission and the Indian Plumbing Association to develop guidelines for water-efficient products and equipment. Technology plays an important role by monitoring water usage, analyzing data over time, and suggesting solutions based on the information gathered.

II. TECHNOLOGY OVERVIEW

Various methods can be proposed using IoT and machine learning for measuring, analysing and controlling the usage of household water supply. Diagram 1 shows the various applications which can be incorporated for Household water usage monitoring and reducing the usage.

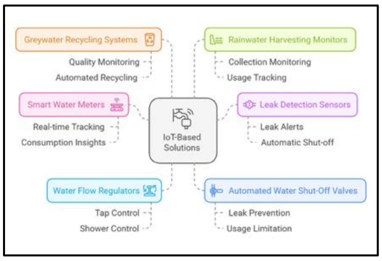

Fig. 1. Various applications of IoT

Smart meters automatically measure and record water usage in real-time. Their main goal is to reduce costs and prevent water wastage. With climate change worsening water scarcity, the demand for smart water meters is increasing. Greywater recycling systems collect, treat, and reuse water for non-drinking purposes like gardening or flushing. Sensors for leak detection, water flow regulation, and automated water shut off belong to the same group of devices. These sensors perform tasks such as sending alerts, controlling water flow, and shutting off water supply when needed. In addition to IoT devices, machine learning models can also be used to analyze and manage water usage. Figure 2 illustrates how machine learning models can work alongside IoT devices to improve water management.

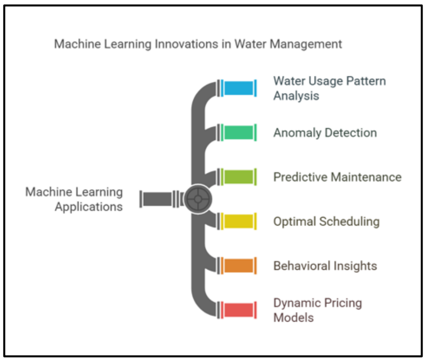

Fig. 2. Various ways in which ML model can be implemented

III. LITERATURE REVIEW

Janice et al. suggest that managing water effectively requires both changes in behavior and the use of technology, with Public-Private Partnerships (PPPs) playing an important role. They identified common ways households waste water, like leaving taps on, taking long showers, using drinking water for non-drinking tasks, and over-watering plants. While their study focused on Kenya, similar issues exist in India, where household water usage often leads to waste. A study by Godrej Properties provided guidelines to reduce household water demand, such as using water-efficient appliances, harvesting rainwater, and running awareness campaigns.

Other research focused on technology, especially in agriculture, to help save water. Studies showed how sensors and machine learning can be used to reduce excessive water usage, with a special focus on micro-irrigation systems that use water more efficiently. Pavlos et al. proposed two methods for tracking water use. The first method involves attaching meters to appliances like washing machines to measure how much water each one uses. The second method uses sensors, software, and cloud analysis to track water consumption over time and predict usage patterns. Diana et al. discussed the role of the Internet of Things (IoT) in creating smart water management systems. They suggested using machine learning to analyse water usage in households and predict consumption patterns.

Riccardo et al. explored how machine learning can be used to detect leaks in water supply systems by analyzing water flow and even predicting leak sizes, using a model called Long Short-Term Memory (LSTM). Building on these ideas, this research aims to combine IoT and machine learning to improve household water management.

Smart devices like water meters and leak sensors will collect real-time data, and machine learning will analyze this data to predict water usage, detect waste, and provide tips for saving water.

For example, the system could alert users to leaks or excessive use and suggest ways to conserve water. The research also plans to create an easy-to-use platform where people can track their water usage, compare it to benchmarks, and set goals for saving water.

To encourage water conservation, the research will explore ideas like gamification, where users earn rewards for saving water, and pricing models that make water more expensive for heavy users. The goal is to create a system that reduces household water waste and helps with global water conservation efforts.

IV. PROPOSED METHODOLOGY

As the population grows, the demand for water is rising rapidly, putting increased pressure on groundwater resources.

While India relies heavily on rainwater, global warming has led to uneven rainfall, making it unreliable. This makes it essential to reduce water usage, particularly in households.

In agriculture, significant advancements have been made to conserve water by using micro-irrigation systems and IoT-based tools. However, similar efforts are needed for household water management.

The purpose of this paper is to present a model that monitors and manages household water usage efficiently. Diagram 3 illustrates the proposed Smart Household System, which aims to reduce water consumption in homes.

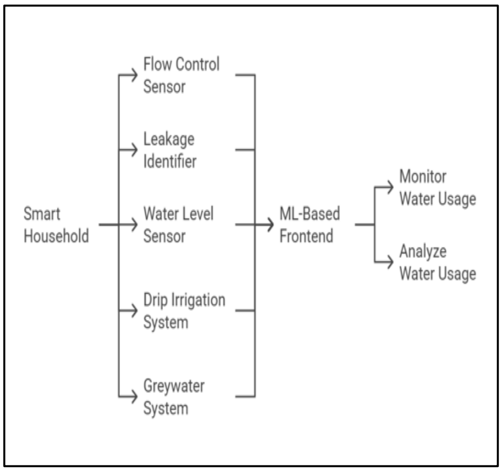

Fig. 3. Proposed mechanism

The proposed method combines smart IoT devices with machine learning to help manage water usage.

The data collected by sensors is analyzed by a machine learning system to predict future water needs and suggest ways to save water. This approach helps users understand their water consumption and make informed decisions.

By using this system, people can benefit in several ways:

- Use less water.
- Lower water bills.
- Reduce water waste.
- Contribute to sustainability efforts

There's no one-size-fits-all solution for this system. The number of IOT sensors can be customized based on each user's needs. Some may only need a few sensors, while others might require more. The machine learning model can also be used on a larger scale, such as for an entire housing society, to help with better planning, analysis, and resource management.

Housing societies in India should think about adopting this model for better water management. They could use:

- Leakage sensors to detect and fix water leaks quickly.
- Greywater sensors to treat and reuse wastewater for non-drinking purposes like watering plants.
- Water level sensors to monitor water tank levels and avoid wastage from overflow.

Although setting up this system in individual homes might seem costly, implementing it across multiple homes in a housing society can make it much more affordable. By sharing the costs and benefits, societies can save water and reduce overall expenses, making this solution practical and sustainable for urban areas.

V. CONCLUSION

Water conservation at home is very important for India's future, especially as the demand for water grows in cities. Taking simple steps to reduce water waste can make a big difference. Using water-efficient fixtures, setting up rainwater harvesting systems, fixing leaks, and being mindful of water use in daily activities like cooking, laundry, and outdoor chores can help save a lot of water. These actions not only save water but also protect the environment by reducing pressure on water sources and ecosystems. Saving water also helps households save money. By using water wisely, families can lower their utility bills, benefiting both the environment and their finances. But it's important to remember that just following these practices is not enough. Public awareness is key. People need to understand that water is limited, and wasting it today can lead to serious shortages in the future. The government has started several programs and offers subsidies to encourage water-saving, but educating the public is essential for real change. Without widespread awareness and collective effort, water conservation efforts won't have a significant impact. So, it's crucial to teach communities and households the value of water to ensure these efforts lead to lasting change.

REFERENCES

[1] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2002726&utm_source=chatgpt.com

[2] Hoekstra, A. Y., & Mekonnen, M. M. (n.d.). The water footprint of humanity. https://doi.org/10.1073/pnas.1109936109/-/DCSupplemental

[3] https://www.statista.com/statistics/263156/water-consumption-in-selected-countries

[4] https://nwm.gov.in/bwue

[5] Gichuhi, J., Khakata, E., & Kofi, I. (2023). A Smart Water Management System for Detecting Household Water Wastage. E3S Web of Conferences, 469. https://doi.org/10.1051/e3sconf/202346900017.

[6] Godrejproperties- https://www.godrejproperties.com/blog/water-conservation-in-indian-homes-strategies-for-a-sustainable-future

[7] Gichuhi, J., Khakata, E., & Kofi, I. (2023). A Smart Water Management System for Detecting Household Water Wastage. E3S Web of Conferences, 469. https://doi.org/10.1051/e3sconf/202346900017.

[8] Levidow, L., a, Zaccaria, D., Maia, R., Vivas, E., Todorovic, M., University of California, Universidade do Porto, & CIHEAM—Mediterranean Agronomic Institute of Bari (IAMB). (2014). Improving water-efficient irrigation: Prospects and difficulties of innovative practices. In Agricultural Water Management (Vol. 146, pp. 84–94). http://dx.doi.org/10.1016/j.agwat.2014.07.012Agr5

[9] Erion Bwambale, Felix K. Abagale, Geophrey K. Anornu,

[10] Smart irrigation monitoring and control strategies for improving water use efficiency in precision agriculture: A review, Agricultural Water Management, Volume 260, 2022, 107324, ISSN 0378-3774,https://doi.org/10.1016/j.agwat.2021.107324.

[11] Pavlos V. Pavlou, Stylianos Filippou, Solon Solonos, Stelios G. Vrachimis, Kleanthis Malialis, Demetrios G. Eliades, Theocharis Theocarides, Marios M. Polycarpou; Monitoring domestic water consumption: a comparative study of model-based and data-driven end-use disaggregation methods. Journal of Hydroinformatics 1 April 2024; 26 (4): 709–726. doi: https://doi.org/10.2166/hydro.2024.120

[12] Ivanova, D., Stadler, K., Steen-Olsen, K., Wood, R., Vita, G., Tukker, A. and Hertwich, E.G. (2016), Environmental Impact Assessment of Household Consumption. Journal of Industrial Ecology, 20: 526-536. https://doi.org/10.1111/jiec.12371

Fake news filtering with Supervised Machine Learning for Social Life Digital Sustainability

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Abstract: Fake news is an unethical process done with some malicious intension for social disturbance. Fake news causes big losses in terms of business reputation, social disruptions, affecting mental and social health of person and society. Therefore, to get the social life digital sustainability, we need to work on fake news identification. In this proposed research paper, researchers have worked on filtration of fake news using SML-supervised machine learning. SML algorithms are used for training and test the data. It divides the data as per the ratio chosen into training & test datasets having labelled data based on which training ism to be given using various algorithms like SVM-support vector machines, LR-logistic regression, MNB-multinomial naïve based classification, RFC-random forest classification and based on the correct predictions made on the test data, the accuracy of each model is found. The core objective of this research work is to find the analysis of the given news bulletin as it is real or fake using supervised machine learning. This paper takes the data from Kaggle - news_dataset.csv where two fields are there as label and text to check whether the news is actually fake. Here, training test ratio is 75:25. The authors get 99.0%, 99.0%, 95% and 100% accuracy with RFC, MNB classifier, LR, and SVM respectively.

Keywords: Fake news Filtering, Supervised Machine Learning, logistic regression, multinomial naïve based classification, random forest classification, social sustainability.

I. INTRODUCTION

The internet and digital media have transformed the way people acquire and distribute information, making it more accessible and widely available. However, this rapid growth has also results to the viral of misinformation and false news, also raising significant challenges for individuals, institutions, and society as a whole. Given its influence on public opinion, political decisions, and social harmony, identifying and preventing the spread of false news. The growth of false news has become a significant focus of research. In this landscape, machine learning plays a crucial role in automating the identification of false information, enhancing the accuracy and efficiency of detection methods.

Social sustainability is a practice to sustain the peaceful communities without compromising the future. Digital fake news destroyed the social life through digital social media. Social sustainability can create safe environment where people can live peacefully.

The identification or detection of fake news is a text problem of classification. For that supervised machine learning techniques have shown considerable promise. These algorithms work with labelled datasets, where each data point is assigned a specific label. To enable models to learn patterns and relationships during training and evaluate their performance on unseen data during testing, the dataset is typically distributed into training and test subsets. By employing various algorithms, such as SVM, RFC, MNB, and LR, researchers can assess the correctness of these models in distinguishing between fake and real news.

Global standard motivates the organizations to maintain the social and environment impacts through ISO26000. GRI standards given guidelines for ethical business practices, social responsibility and sustainability. Fake news filtration can give partial social life sustainability.

The proposed research paper addresses the issue of fake news detection using supervised learning techniques. For this study, researchers utilized the news_dataset.csv from Kaggle. This dataset is specifically designed for supervised learning, consisting of two key components: a label that identifies whether a news article is real or fake, and the actual news content in text format.

Our study supervises how effectively different SML algorithms can classify news articles based on these labels. This research paper is planned as follows: Section 2 literature reviews prior studies on machine learning-driven fake news detection. Section 3 details the dataset and its preparation process. Section 4 outlines the classification techniques and algorithms employed. Section 5 presents the experimental results and their relevance. Finally, Section 6 summarizes the study and proposes directions for future advancements in this domain.

II. RESEARCH OBJECTIVE

This study aims to apply supervised learning methods to find fake news. The specific objectives include:

1. Detecting Fake News: Implement and analyse different supervised learning algorithms such as Random Forest model, Support Vector Machines (SVM), Multinomial Naïve Bayes, and Logistic Regression, to determine the authenticity of news articles.
2. Improving Social Stability: Reducing the dissemination of fake news promotes a more reliable information environment, lessens societal upheavals, and stops the propagation of false information.
3. Algorithm Performance Evaluation: Labelled dataset is use to confirm the performance of algorithm and compare the precision and effectiveness of machine learning algorithms.
4. Classification of News Dataset: Dataset source can be a kaggle, which has news stories with labels to assess and train the machine learning model.
5. Optimization of Dataset splitting for Training and Testing: To get the highest accuracy and generalizability, use 75:25 ratio of training and testing data can be used.
6. Assessment of Effectiveness of Model: Evaluate news article on the basis of authenticity using machine learning classification methods.

III. LITERATURE REVIEW

Research study have developed the efficacy to automate the detection of fake news using supervised machine learning methodologies. It helps in controlling the spread of false information on such a digital platform. Natural language Processing expanding the field of machine learning which provides valuable and insightful information to identify false news with enhanced accuracy.

The LSTM – Long Short Term Memory, Random Forest and Naïve Bayes models, Passive Aggressive algorithms are used in fake news identification learned from this research work. It combines the LSTM and Naïve Bayes (NB) methods to form hybrid method.

The outcome shows that Naïve Bayes performance is better in recall. Hybrid NB-LSTM model had 92.34% maximum accuracy rate in finding out errorneous fake information. When using TF-IDF, classification accuracy result is 92.26% whereas LSTM given an accuracy of 92.34% in standalone models.[1]

Random Forest model showed highest prediction accuracy at 94%, while the lowest accuracy given by Neural Network model at 92.1%. This was the overall observations studied.

The research work focused on current fake news identification methods and presents a new approach that uses Twitter. Fake news detection can be affected by the word sentiments, users in degree centrality, total number of tweets and word similarity. The user interactions, content, properties, and network structure in to account considered for analysis.

The ranking of accuracy is started with CART and Neural Network is 94.6% and The Random Forest model accuracy is 94.1%. The results focused on the significance of linguistic and network based features in improvising fake news identification accuracy. Therefore, this study presents the total number of tweets formed by each account of social media. This system is used to detect fake news, it is really a very crucial role in finding out the accuracy.[2]

Experiments employed the LIAR1 and LIAR2 datasets for fake news classification, illustrating the necessity of extracting and analyzing news features for accurate identification [3]. Further research is required in this domain, with deep learning techniques leveraged to address misleading multimedia content [4].
Deep learning and natural language processing serve as key linguistic tools. Governments also encounter cyberwarfare challenges due to fake news, prompting reliance on computational detection methods to mitigate its effects [5].
In this paper, various Machine leaning algorithms like Support Vector Machine (SVM) algorithm, Multinomial Naïve Bayes algorithm and Random Forest Classifier.

Support Vector Machine (SVM):
SVM classifiers utilize support vectors—coordinates representing individual observations. The algorithm establishes a hyperplane that best separates two distinct categories. If a clear linear hyperplane is not feasible, an additional feature is introduced to optimize separation (S. Vanaja, , 2018).

Multinomial Naïve Bayes (MNB):
This algorithm operates based on term frequency (TF), which reflects the occurrence rate of words in a document. It determines not only whether a word appears but also its frequency, contributing to accurate classification (Tyagi, A., 2019).

Random Forest Algorithm (RFC):
Random Forest is a supervised classification algorithm that employs ensemble learning. Multiple decision trees analyze different subsets of data, and the final classification is derived from the majority prediction among all trees (Sarraf, T., 2020).

Logistic Regression (LR):
Although named "regression," logistic regression is a classification technique designed for binary prediction tasks. By applying the sigmoid function, it transforms inputs into probabilities, indicating the likelihood of a given data point belonging to a specific category.

IV. RELATED WORK

Data Collection:
We have used Kaggle dataset 'news_dataset.csv' file for Indian Fake News, for our study, which has 3729 rows and 2 columns – label (Fake / Real) and the text, which contains the actual text data related to the news. The URL for this file is https://www.kaggle.com/datasets/imbikramsaha/fake-real-news. Figure 1 shows the first few lines of the dataset.

```
Dataset Sample:
  label                                               text
0  REAL  Payal has accused filmmaker Anurag Kashyap of ...
1  FAKE  A four-minute-long video of a woman criticisin...
2  FAKE  Republic Poll, a fake Twitter account imitatin...
3  REAL  Delhi teen finds place on UN green list, turns...
4  REAL  Delhi: A high-level meeting underway at reside...
```

Figure 1: 'news_dataset.csv' file for Indian Fake News

B. Data Pre-processing:
We have applied data preprocessing technique – handling missing values by dropping the row for the missing values. The 'x' parameter is taken as the text content of the news itself and the 'y' parameter is the label – real or fake, to be predicted for the text data based on the training data and compare each one against the actual label and to find the accuracy using four various models of supervised machine learning. Figure 2 shows the handling of missing values.

```
Handling missing values...
0       1
1       0
2       0
3       1
4       1
       ..
3724    1
3725    1
3726    0
3727    1
3728    1
Name: label, Length: 3721, dtype: int64
```

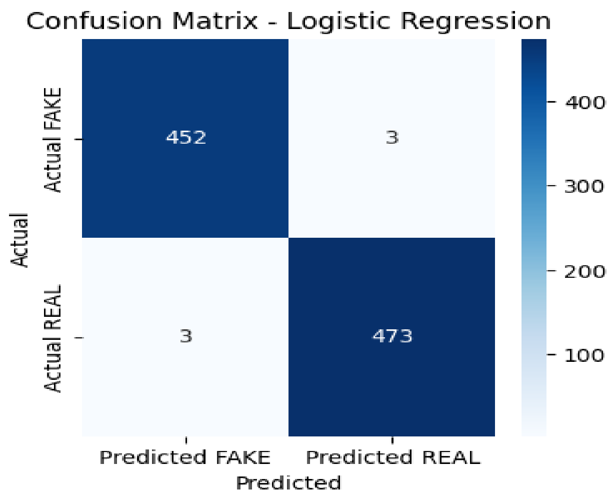
Figure 2: handling missing values

The total rows reduces to 3721 from the original 3729 rows.

C: Applying Supervised Learning Algorithms:

After defining 'x' as the text data and 'y' as the label for the text of 'x', the labels – 'REAL' and 'FAKE' are encoded to 1 and 0 respectively to classify them as per each four supervised machine learning algorithms one by one. The splitting of data executed as training and test data sets split and converted the text data to numerical data using TF-IDF Vectorizer. Each of the four models has been trained one by one by calling the fit() method of python on the model's object. The accuracy score, confusion matrix and the classification report have been found, which are listed in the figure 3, figure 4,figure 5 and figure 6 respectively.

```
Logistic Regression
Accuracy: 0.99
```



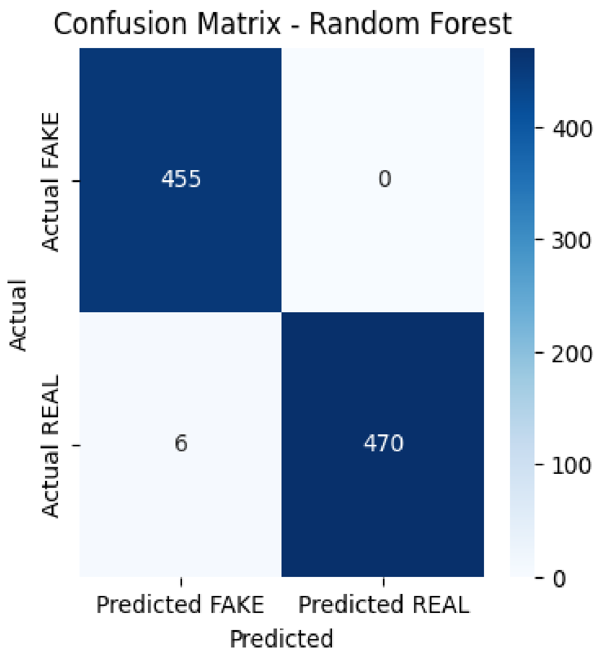

```
Classification Report:
              precision    recall  f1-score   support

           0       0.99      0.99      0.99       455
           1       0.99      0.99      0.99       476

    accuracy                           0.99       931
   macro avg       0.99      0.99      0.99       931
weighted avg       0.99      0.99      0.99       931
```

Figure 3: accuracy score, confusion matrix and classification report for Logistic regression

```
Random Forest
Accuracy: 0.99
```



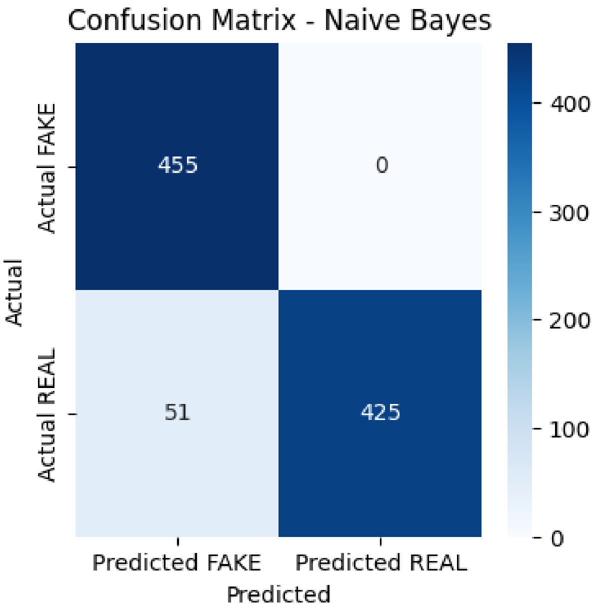

```
Classification Report:
              precision    recall  f1-score   support

           0       0.99      1.00      0.99       455
           1       1.00      0.99      0.99       476

    accuracy                           0.99       931
   macro avg       0.99      0.99      0.99       931
weighted avg       0.99      0.99      0.99       931
```

Figure 4: the accuracy score, the confusion matrix and the classification report for RFC-Random Forest classification

```
Naive Bayes
Accuracy: 0.95
```



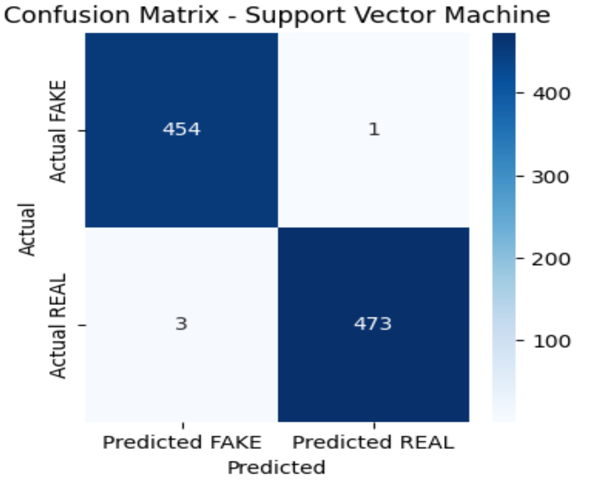

```
Classification Report:
              precision    recall  f1-score   support

           0       0.90      1.00      0.95       455
           1       1.00      0.89      0.94       476

    accuracy                           0.95       931
   macro avg       0.95      0.95      0.95       931
weighted avg       0.95      0.95      0.95       931
```

Figure 5: accuracy score, confusion matrix and classification report for Multinomial Naïve Bayes

```
Support Vector Machine
Accuracy: 1.00
```




```
Classification Report:
              precision    recall  f1-score   support

           0       0.99      1.00      1.00       455
           1       1.00      0.99      1.00       476

    accuracy                           1.00       931
   macro avg       1.00      1.00      1.00       931
weighted avg       1.00      1.00      1.00       931
```

Figure 6: accuracy score, confusion matrix and classification report for support vector machine

V. CONCLUSION AND FUTURE WORK

Our research paper worked on fake news filtration using supervised learning algorithms. In the Table 1, it depicts the accuracy classification for all four supervised machine learning classification.

Algorithm	Accuracy score
Support Vector Machine	1.0
Multinomial Naïve Bayes	0.95
Random Forest	0.99
Logistic Regression	0.99
Hybrid Ensemble Model	0.9937

Table 1: Comparative data of accuracy score for four different supervised machine learning algorithm.

As per the table 1, we have drawn the conclusion that Support Vector Machine has the highest and 100 % accuracy to detect the fake news. So if any software is to be developed to filter the fake news then the support vector classifier can be used for that. Fake news filtering with Supervised Machine Learning helps to bring Digital Sustainability in our social life.

REFERENCES

[1] D. Rohera *et al.*, "A Taxonomy of Fake News Classification Techniques: Survey and Implementation Aspects," *IEEE Access*, vol. 10, pp. 30367–30394, 2022, doi: 10.1109/ACCESS.2022.3159651.

[2] M. Park and S. Chai, "Constructing a User-Centered Fake News Detection Model by Using Classification Algorithms in Machine Learning Techniques," *IEEE Access*, vol. 11, pp. 71517–71527, 2023, doi: 10.1109/ACCESS.2023.3294613.

[3] C. Xu and M.-T. Kechadi, "An Enhanced Fake News Detection System With Fuzzy Deep Learning," *IEEE Access*, vol. 12, pp. 88006–88021, 2024, doi: 10.1109/ACCESS.2024.3418340.

[4] W. Shahid *et al.*, "Detecting and Mitigating the Dissemination of Fake News: Challenges and Future Research Opportunities," *IEEE Trans. Comput. Soc. Syst.*, vol. 11, no. 4, pp. 4649–4662, Aug. 2024, doi: 10.1109/TCSS.2022.3177359.

[5] F. Khan, R. Alturki, G. Srivastava, F. Gazzawe, S. T. U. Shah, and S. Mastorakis, "Explainable Detection of Fake News on Social Media Using Pyramidal Co-Attention Network," *IEEE Trans. Comput. Soc. Syst.*, vol. 11, no. 4, pp. 4574–4583, Aug. 2024, doi: 10.1109/TCSS.2022.3207993.

[6] Singh, S. N., & Sarraf, T. (2020). Sentiment Analysis of a Product based on User Reviews using Random Forests Algorithm. 2020 10th International Conference on Cloud Computing, Data Science & Engineering (Confluence).

[7] Satuluri Vanaja, M. B. (2018). Aspect-Level Sentiment Analysis on E-Commerce Data. Proceedings of the International Conference on Inventive Research in Computing Applications (ICIRCA 2018) (p. 5). Bengaluru: Amrita School of Engineering

[8] Singh, G., Kumar, B., Gaur, L., & Tyagi, A. (2019). Comparison between Multinomial and Bernoulli Naïve Bayes for Text Classification. 2019 International Conference on Automation, Computational and Technology Management (ICACTM).

[9] Singh, S. N., & Sarraf, T. (2020). Sentiment Analysis of a Product based on User Reviews using Random Forests Algorithm. 2020 10th International Conference on Cloud Computing, Data Science & Engineering (Confluence).

Hashmi, E., Yayilgan, S. Y., Yamin, M. M., Ali, S., & Abomhara, M. (2024). Advancing fake news detection: hybrid deep learning with fasttext and explainable AI. IEEE Access.

[10] Dhiman, P., Kaur, A., Hamid, Y., & Ababneh, N. (2023). Fake News Detection Datasets: A Review and Research Opportunities. International Journal of Computing and Digital Systems, 16(1), 39-55.

[11] Akhtar, P., Ghouri, A. M., Khan, H. U. R., Amin ul Haq, M., Awan, U., Zahoor, N., ... & Ashraf, A. (2023). Detecting fake news and disinformation using artificial intelligence and machine learning to avoid supply chain disruptions. Annals of operations research, 327(2), 633-657.

[12] Hashmi, E., Yayilgan, S. Y., Yamin, M. M., Ali, S., & Abomhara, M. (2024). Advancing fake news detection: hybrid deep learning with fasttext and explainable AI. IEEE Access.

[13] Dhiman, P., Kaur, A., Hamid, Y., & Ababneh, N. (2023). Fake News Detection Datasets: A Review and Research Opportunities. International Journal of Computing and Digital Systems, 16(1), 39-55.

14] Akhtar, P., Ghouri, A. M., Khan, H. R., Amin ul Haq, M., Awan, U., Zahoor, N., ... & Ashraf, A. (2023). Detecting fake news and disinformation using artificial intelligence and machine learning to avoid supply chain disruptions. Annals of operations research, 327(2), 633-657.

[15] Allcott, H., & Gentzkow, M. (2017). Social media and fake news in the 2016 election. Journal of Economic Perspectives, 31(2), 211–

[16] Booth, A., Hamilton, B., & Vintiadis, M. (2019). Fake news, real problems: combating social media disinformation. Global Fraud and Risk Report 2019/20 11th annual edition.

[17] Churchill, F. (2018). Unilever says fake news makes digital supply chain unsustainable

[18] Clarke, J., Chen, H., Du, D., & Hu, Y. J. (2020). Fake news, investor attention, and market reaction. Information Systems Research, 32(1), 35–52

[19] Di Domenico, G., & Visentin, M. (2020). Fake news or true lies? Reflections about problematic contents in marketing. International Journal of Market Research, 62(4), 409–417

[20] Di Domenico, G., Sit, J., Ishizaka, A., & Nunan, D. (2021). Fake news, social media and marketing: A systematic review. Journal of Business Research, 124, 329–341

[21] Gupta, A., Li, H., Farnoush, A., & Jiang, K. (2021). W. Understanding Patterns of COVID Infodemic: A Systematic and Pragmatic Approach to Curb Fake News.Journal of Business Research

[22] Jiang, T., Li, J. P., Haq, A. U., Saboor, A., & Ali, A. (2021). A Novel Stacking Approach for Accurate Detection of Fake News. Ieee Access: Practical Innovations, Open Solutions, 9, 22626–22639

[23] Kim, G., & Ko, Y. (2021). Effective fake news detection using graph and summarization techniques. Pattern Recognition Letters, 151, 135–139

Cyber Ecological Anxieties in Squid Game: A Dystopian Reflection

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Abstract–The South Korean drama Squid Game (2021), here in after referred to as k-drama, is making setting social media platforms abuzz with the release of season two in 2024. This paper analyzes the k-drama as a chillingly relevant dystopian reflection of contemporary anxieties, especially those relating to cyber ecology. Owing to its treatment of social inequality and competition, the series is a strong social commentary of the complicated and often-fraught relationships amongst technology, the environment, and human society. Through a close reading of the structure of the game and the inbuilt symbolism, this paper elaborates on how a movie or series can visually translate the fear of illusion of control and the environmental price paid for progress and technology-induced dehumanization. With inspiration drawn from the critical analogies on cyber ecology and sustainability literature, this analysis demonstrates dangers of uncontrolled technological advancement, calls for collective action, and captures the urgent need towards human well-being and the integrity of the natural environment itself amidst increasing ecological pressures.

Keywords–Cyber Ecology, Environment, Social Inequality, Dystopia, Human Nature

I. INTRODUCTION

Squid Game is a show in which the unfortunate circumstances of the participants deep in debt are placed in life-threatening games of chance to win a colossal prize that will enable to live a debt-free, comfortable future. While the games themselves are both physically challenging and emotionally demanding, they index larger social problems metaphorically. The games serve as a metaphor for competition for limited resources and scarcity of available resources. Just as the players meet untimely demise and are eliminated, the earth's resources are being rapidly consumed and depleted from the planet and the remaining resources are being diminished for generations to come. Audiences are given a realistic image of competition, where resources are being done in competition; putting the world's unhealthy usage practices on display in light of some of the games. The bridge is a demonstration of the hazardous circumstances facing the current condition of the environment, where players must either choose a safe or risky path to proceed. Today's decision to support or refuse sustainable practices will determine our Earth and its future.

Squid Game is particularly apt for analyzing cyber ecological anxieties. The cyber ecosystem, juxtaposed with competition between the participants, form a complex web that perpetuates social inequality through systemic manipulation and algorithmic control. The game's rules, while seemingly simple, are routinely controlled, manipulated and altered by the organizers. Thus algorithms and undisclosed rules are seen to manipulate outcomes. This thereby indexes the anxieties that emerge from the increasing dependence on algorithms in various aspects of life such as social media feeds and credit scoring. Additionally, the potential for these algorithms to be biased and detrimental to individuals and society are also evidenced in the series.

II. OBJECTIVE

This paper observes that the k-drama, apart from its evident social commentary on economic disparity and the brutal pursuit of wealth and a better lifestyle, serves as a powerful metaphor for the anxieties characteristic of the cyber-ecological system that we operate in, particularly concerning the loss of sustainability, both in practice and though. By examining the structure of the game and the symbolic significance of the game, interesting conclusions can be derived about the complex interplay between technology, environment, and human life, especially with reference to the need for sustainability. The paper also argues that there exists a problematic relationship between the participants who are the deprived 'have-nots' and their helplessness in the face of technological control overseen by the wealthy and affluent 'haves', the organizers, and indirectly, the viewers who consume the series as entertainment. This paper thus examines Squid Game as a cultural artifact that reflects contemporary anxieties in the cyber ecosystem of the game. The k-drama is seen to depict the complex relationship between technology, the environment, and human society. This research also aims to identify and analyze select cyber ecological themes within the k-drama such as the illusion of control, the loss of trust, the environmental cost of progress, and the dehumanizing impact of technological processes and systems. Additionally, the paper explores the ways in which the series employs visual and narrative elements to convey the said cyber ecological anxieties through colour, setting, and technology. The paper also examines the ethical consequences of unrestrained technological development and the importance of adopting a sustainable and equitable digital future.

III. LITERATURE REVIEW

Cyber ecology explores the intricate interconnectedness between technology, the environment, and human society. It draws upon studies from ecology, environmental science, computer science and social sciences to examine the complex dynamics of said interconnected system.

A. Technological Determinism vs. Social Shaping

The argument is based on a simple question 'Does technology shape society or does society developing technology?' Technological determinists insist on the former; that technology is a key element that drives social change, while social scientists insist on the latter i.e., the role of human agency and social environments in influencing the development and application of technology. Relevant scholars in this regard include Langdon Winner (1977) and Neil Postman (2011).

B. The Environmental Impact of Technology

The ecological consequences of technological development include a study of issues such as climate change, resource depletion, pollution, and biodiversity loss. Relevant scholars in this regard include William Rees, Mathis Wackernagel (Ecological Footprint), Clive Hamilton (Requiem for a Species), Timothy Morton (The Ecological Thought)

C. The Social and Ethical Implications of Technology

This focuses on the impact of technology on social relations, individual autonomy, privacy, and equity. Relevant scholars include Shoshana Zuboff (Surveillance Capitalism), Sherry Turkle (Alone Together), Jacques Ellul (The Technological Society), Michel Foucault (Discipline and Punish)

D. The Dehumanizing Effects of Technology

Scholars such as Turkle and Ellul have raised concerns about the capacity of technology to render individuals as mere objects, thereby reducing empathy, and leading to alienation.

Cyber ecology, in the context of the series, is therefore seen as embedded with anxieties about the future amidst a rapidly digital landscape. The increasing dependence on advanced technological systems generates a sense of vulnerability and also a fear of a potential loss of autonomy. Individuals feel powerless in the face of rapid and complicated technological change and fear consequences. Zuboff's concept of "surveillance capitalism" (2019) notes the potential for technology to be employed by elites to manipulate and control individuals. This reinforces cyber-ecological anxieties. The spread of misinformation, the rise of "filter bubbles" (Pariser, 2011), and the modus operandi of cyber-attacks reduces trust in institutions, technological systems and also other individuals. This loss of trust acts as a barrier for the possibility of collective action on important environmental and social matters. The awareness of climate change, resource depletion, and biodiversity loss generates anxieties about the long-term sustainability of the human civilization. The pursuit of technological advancement, mostly driven by short-term gains and vested interests, can have serious environmental consequences. The potential for technology to dehumanize individuals, weaken empathy, and further loneliness is a source of anxiety.

IV. RESEARCH METHODOLOGY

The research adopted a qualitative research approach to examine the South Korean Netflix series Squid Game (Hwang, 2021) through the domain of cyber ecology.

Primary Data was procured by viewing and analysing the Squid Game series and an observation of visual and narrative elements, such as character development, plot, symbolism, and use of colour.

Secondary Data was obtained through a review of relevant academic literature on cyber ecology, such as works by Shoshana Zuboff, Sherry Turkle, Jacques Ellul, William Rees, Mathis Wackernagel, and others. Articles were studied as were critical analyses of Squid Game, focusing on its social, cultural, and political commentary.

V. RESULTS AND DISCUSSION

Squid Game's game's complex structure enabled by pervasive surveillance systems, automated game mechanisms, and an environment designed with extensive human labour, is indicative of the ever-growing reliance on technology in the lives of humans. Shoshana Zuboff (2019) notes that technology in the hands of mega corporations and businesses, is increasingly employed to influence and direct human behaviour for profitable gains. Individual autonomy is limited. The need to control opposes the principles of sustainability.

The pervasive surveillance within the game aligns with Michel Foucault's conceptualization of the panoptic on in his book, Discipline and Punish (1977). The players are monitored 24x7 by hidden cameras and drones, strategically placed all over to never miss a single action. This is the internalization of the gaze of the, audience, the organizers and the unseen observer. Much like the concept of the panopticon that generates a behaviour out of self-surveillance, this structure of the game also leads to self-surveillance and a constant state of anxiety. Such pervasive scrutiny creates a sense of dread, fear and self-discipline, where players are compelled to comply to the rules of the game and suppress dissent. The organizers of the game, act as the unseen guard in the panopticon and exert power not through coercion or force, but through the constant threat of observation and the psychological pressure that follows through the participants' awareness of being monitored. This system of surveillance effectively controls the players, shaping their behaviour and thereby contributing to their dehumanization.

The all-seeing, omnipresent CCTV cameras, often depicted as cold, metallic eyes, create an overall sense of anxiety and control. The use of CCTV footage and digital interfaces further emphasize the technological control exercised over the players, reminding the viewers the anxieties that surround the increasing surveillance in their own lives and the myth of privacy in the digital age.

The organizers in the game are hidden through anonymity and operate using sophisticated technology. They exploit the players' desperation and vulnerability and lack of trust in traditional systems. This mirrors the skepticism and loss of trust in societal institutions and systems, which is worsened by the spread of misinformation and the emergence of "filter bubbles" (Pariser, 2011) on social media platforms. This has led to increasingly fragmented and polarized social structures. Such breakdown of trust acts as an obstacle to collective action on significant environmental issues, such as climate change and pollution, where global co-operation and shared responsibility are much needed to achieve the sustainable development goals (SDGs) envisioned by the United Nations.

The isolated island setting of the game renders it a desolate and post-apocalyptic landscape. This serves as a chilling reminder of the environmental cost of unrestrained technological progress. This is reflected in the literature on the ecological consequences of technological development, such as the works of William Rees and Mathis Wackernagel (1996). The works of these thinks expound on ecological footprint, and the concept of the 'Anthropocene', highlighting the profound impact of human activities on planet Earth. The series is a loud reminder that the pursuit of wealth and technological advancement, often driven by short-term goals, vested interest and disregard for long-term repercussion, can cause environmental degradation and destruction of natural ecosystems which undermine the foundations of sustainability. Kim Soo Yeon (2023) observes that the representation of games in the series finds a universal and unprecedented appeal to the masses which is derived from a paradoxical human desire for ruthless competition and moral cooperation.

Squid Game has zero marketing budget and zero promotion when it first landed on the platform, Netflix. It also received zero push from the platform in the form of homepage recommendations to viewers. But 111 million viewers crashed Netflix serves in 28 days. In the fourth day of its release, word about the series spread on social media platforms which led to 2.1B views in merely 24 hours. An estimate of 1.2 million TikTok videos were created that spoke about the series. And soon the series was trending in 92 countries. The rise of Squid Game was completely organic and user-generated. Viewers found the universal themes of survival, inequality and anxiety in the cyber world appealing and relevant. Though a Korean language series, it had a universal appeal. Even though the game in the series were cultural specific such as the Red Light, Green Light game or the Dalgona challenge, the series still spoke to everyone.

The competition for survival is depicted in a merciless and unforgiving manner which reflects the dehumanizing nature of technology. The players are commodified and reduced to mere data. The lives of the players are determined by algorithmic logic. Here, algorithm becomes God, deciding if a player advances or dies. Sherry Turkle (2011) notes that technology may connect us but it also isolates us from genuine human interaction. Technological applications have increased over time and this has led to a loss of our ability to empathize. Social media users are exposed to so much content, constantly, rapidly and unchecked. This hyper exposure has led to benumbing and desensitization. Additionally, the creation of a hyper-competitive, individualistic attitude are in opposition to the principles of sustainability i.e., cooperation, shared responsibility, and respect for life and the interconnectedness of life on the plant. The game commodifies death (Beaunoyer, 2023), thereby positioning life as a mere blip in a cyber-powered ecosystem. Death becomes merchandise and human suffering, sport. Even the bodies of the dead are commodified as items for trade in the series. The k-drama thus captures the anxiety of life and death in the cyber ecosystem as technologies advance and dominate every activity.

The colour palette of pink and green which are contrasting colours on the colour wheel creates a jarring and unsettling visual aesthetic. The stark contrast between the guards' shocking pink uniforms and the players' muted greens or teals immediately establishes a power dynamic. Pink is often associated with innocence and childhood but is used in the series as a symbol of authority, violence, and the unforgiving inhuman system. The pink is bright and loud, infusing the aesthetic with shock and horror. The inversion of the symbolism of the colour pink further reinforces the theme of the loss of innocence and trust. The players must lose their humanity to survive. These games are not for fun, they are about life and death. Green which is linked to nature and life, are donned by the players who are vulnerable and struggling against the oppressive system. This visual dichotomy is reflective of the conflict between humanity and the dehumanizing and commodifying nature of technology.

The game is thus a metaphor for the cyber ecosystem of social life. This is exemplified by its complex rules, hidden dangers, and the pressure to compete for survival. Players in the series are constantly attacked with information, faced with challenges without warning, and forced to adapt quickly to changing circumstances. This is indicative of the cyber ecosystem, where new technologies and social media trends emerge constantly, demanding constant adaptation.

VI. CONCLUSION

Squid Game is a work of fiction. But it serves as a mirror for the anxieties of the cyber ecological age. The k-drama depicts how rampant technological advancement for selfish gains can have damage life and the environment. It is thus important to create awareness about developing a sense of collective responsibility that prioritize human well-being and environmental integrity. Technological development must happen with careful consideration of its social, ethical and environmental impact.

REFERENCES

[1] Beaunoyer, E. (2023). "Commodified Death as the Ultimate Outcome of Social Inequalities: An Analysis of the Squid Game Discourse". Leisure Sciences, 46(6), 883–899.

[2] Ellul, J. (1964). The Technological Society. Alfred A. Knopf.

[3] Foucault, M. (1977). Discipline and Punish: The Birth of the Prison. Vintage Books.

[4] Hamilton, C. (2010). Requiem for a Species: Why We Resist the Truth about Climate Change. Routledge

[5] Hwang, D.H. (2021). Squid Game [Television series]. Netflix.

[6] Kim, S. Y., & Park, S. (2023). "What's in a game? Adialectic of competition and cooperation in Squid Game". International Review for the Sociology of Sport, 58(3), 455-468.

[7] Morton, T. (2010). The Ecological Thought. Harvard University Press eBooks.

[8] Pariser, E. (2011). The Filter Bubble: What the Internet Is Hiding from You. Penguin Press.

[9] Postman, N. (2011). Technopoly: The Surrender of Culture to Technology. Random House US.

[10] Rees, W. E., & Wackernagel, M. (1996). Our Ecological Footprint: Reducing Human Impact on the Earth. New Society Publishers.

[11]Turkle, S. (2011). Alone Together: Why We Expect More from Technology and Less from Each Other. Basic Books.

[12]Wackernagel, M., & Rees, W. (2017). Our Ecological Footprint. Macat Library eBooks.

[13] Winner, L. (1977). Autonomous Technology: Technics-out-of-control as a theme in political thought. MIT Press.

Zuboff, S. (2019). The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power

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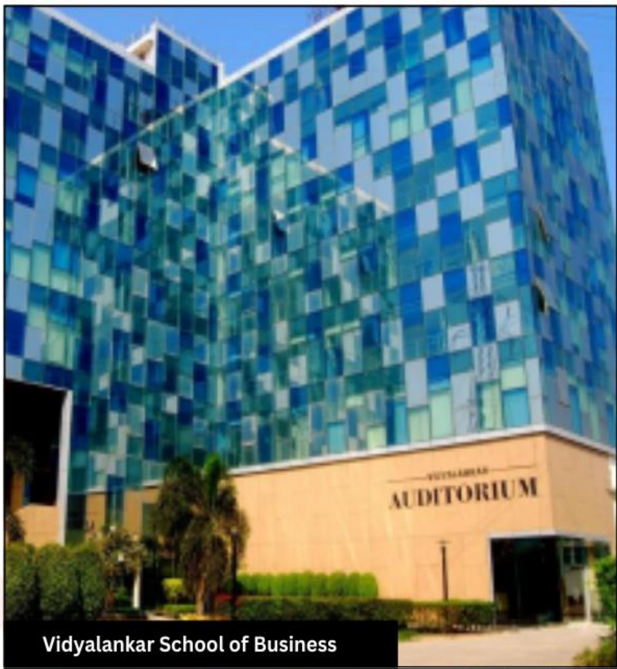

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