Principal's Message

It is my honor to address the readers in this journal, emphasizing our unwavering commitment to fostering a culture of innovation and research within our academic community. As we strive for academic excellence, we stand at the convergence of transformative changes driven by the synergy between research and innovation in higher education. Recognizing the intrinsic link between cutting-edge research and the advancement of our educational landscape is essential as we navigate the complex web of knowledge creation and dissemination.

Innovation and research are the lifeblood of our educational institution. In the words of Steve Jobs, "Innovation distinguishes between a leader and a follower." Our collective efforts in embracing innovative practices and interdisciplinary research initiatives serve as catalysts for nurturing a dynamic learning environment. This environment equips our students to become trailblazers and thought leaders in their respective fields.

As stewards of higher education, we acknowledge that embracing innovation and research is not just an option, but a moral imperative. It is our responsibility to provide our students with an environment where they can explore, question, and create without being confined by convention. As Albert Einstein famously stated, "We cannot solve our problems with the same thinking we used when we created them." This highlights the importance of fostering a culture of transformative research and interdisciplinary collaborations that transcend traditional boundaries and pave the way for groundbreaking discoveries and solutions to the complex challenges of our time.

By nurturing a culture of innovation and research, we empower our academic community to address the most pressing challenges, envision solutions yet to be conceived, and contribute meaningfully to the broader body of knowledge. This edition of our journal testifies to the resilience and intellectual curiosity that define our institution's commitment to pushing the frontiers of knowledge and fostering a culture of continuous learning and growth.

I extend my heartfelt appreciation to the authors, reviewers, and editorial team for their unwavering dedication and scholarly rigor in bringing this publication to fruition.

Rev. Dr. Praveen Martis S J
Principal, St Aloysius College(Autonomous), Mangaluru.

Editorial

In the heart of a centuries-old university, a professor with an unwavering belief in research and innovation fostered an environment where students were encouraged to explore, question, and seek knowledge with unbridled enthusiasm. A young, inquisitive student joined this institution, and under the professor's mentorship, they embarked on a research journey into a mysterious native plant species. Their work led to a groundbreaking discovery: the plant possessed medicinal properties with the potential to cure a devastating disease that had plagued their community for generations. This revelation transformed the university into a hub of innovation, capturing the attention of the global scientific community and philanthropists. The story of the professor and the student serves as a touching reminder that the pursuit of knowledge is a collective journey, uniting us in our quest to create a better world through continuous discovery and innovation. It emphasizes that these endeavors are not merely about workforce preparation but are about nurturing future leaders, thinkers, and dreamers. By fostering an environment that encourages students to think critically, challenge norms, and collaborate on pioneering research, higher education institutions become the architects of a brighter, more prosperous, and just world.

The current edition features six dynamic research papers spanning various disciplines. The paper titled 'Variation of Pressure in Sound Waves due to Interaction with Gravitational Waves,' authored by Sneha M, Sreehari M P, and Dr. Nilakanthan V K, addresses the challenging exploration of gravitational waves, which has become increasingly significant in recent times due to its applications in understanding the structure and composition of the early universe. The recent discovery of gravitational waves by LIGO has heightened the importance of this field. In this study, the authors re-examine the interaction between gravitational waves and sound waves.

Ms. Ruqaya S. ALGed's paper, 'The Role of Memory in the Formation of Social Identity Theory among Iraqi Diaspora Communities: A Study of Inaam Kachachi's The American Granddaughter,' investigates the influence of memory on social identity theory within Iraqi diaspora communities. Through an analysis of Inaam Kachachi's novel, the study supports the idea that memory significantly impacts the identity formation of Iraqi diasporic individuals. Beginning with an overview of social identity theory, the paper explores how individuals' perceptions of identity are shaped by membership in social groups. It then delves into the role of memory, suggesting that collective recollections contribute to the formation of a shared identity among a particular group. Focusing on Kachachi's work, the study argues that her novels illustrate how memory can be employed to establish and sustain a shared Iraqi identity despite the challenges of exile.

In their paper, 'Impact of Silicon Valley Bank Collapse on Indian Stock Market,' authors Sanath Kumar K, Deepak K V, and Apeksha Bhandary assess the fallout of the Silicon Valley Bank collapse on the NSE Nifty 50 Index. The bank's failure on March 10, 2023, marked the most significant U.S. financial institution collapse since the 2008 crisis. Using event research methodology with 10-day pre-event and post-event periods, the study finds negative and atypical returns in the NSE Nifty 50 Index, highlighting the adverse impact of Silicon Valley Bank's crisis on the Indian Stock Market. This empirical evidence aligns with the belief that Indian markets tend to follow U.S. market trends.

In their work, "Adaptation and Translation of Psychological Instruments Into Kannada," Ms. Wilma Neetha Vaz, Dr. I Shalini Aiyappa, and Dr. V. Premanand tackle the issue of assessing self-concept, emotional competence, psychological well-being, and identity orientation among Kannada-speaking adolescents using instruments originally developed in English. The absence of culturally relevant tools prompted the researchers to translate and adapt established scales into Kannada, including Children's Self Concept Scale, Emotional Competence Scale, Psychological Well-being Scale, and Identity Orientation Scale. Following Brislin's Model and Campbell's cross-cultural research techniques, the study employed one-way translation, translation by committee, and back translation to ensure content, semantic, and conceptual equivalence. Using a methodological design involving 204 adolescents aged 14 to 20, the research established reliability and validity in both English and Kannada. The Cronbach alpha values, ranging from 0.874 to 0.930, demonstrate robust internal consistency, and validity is confirmed through item-scale correlations as per Kerlinger's recommendations.

'Review Article on Hypergraphs,' Ms. Dhanya D and Apoorva Shetty explore the realm of Hypergraph theory, a mathematical extension of Graph theory that allows hyperedges to connect more than two vertices. The review outlines the intricate relationships within diverse fields like computer science, genetics, and social networks that Hypergraph theory encapsulates. The article systematically delves into the foundational concepts, properties, and applications of hypergraph theory, emphasizing its significance in addressing real-world connectivity and relationship challenges.

In the tribute titled "Father of the Green Revolution in India" by Dr. P. P. Sajimon, the spotlight is on the remarkable legacy of Dr. M. S. Swaminathan. Known as a visionary and often hailed as the "Father of the Green Revolution in India," Dr. Swaminathan's profound contributions have left an enduring impact on agriculture and food security. The tribute emphasizes his unwavering dedication to improving the lives of farmers and ensuring food security for all. Driven by his vision, he played a pivotal role in transforming India from a food-deficit to a self-sufficient nation. Beyond his accomplishments, Dr. Swaminathan stood as a fervent advocate for sustainable agriculture and rural development. His legacy extends far beyond national borders, inspiring millions globally to strive for a more just and equitable food system. The tribute reveres him as a true champion of the poor and marginalized, highlighting the indelible mark he has left on the world.

I express my heartfelt gratitude to the Principal of St. Aloysius College (Autonomous), Rev Dr. Praveen Martis SJ, for his unwavering and consistent support throughout the entire process. I extend my thanks to all the contributors, reviewers, and esteemed members of the editorial board for their invaluable cooperation in making the publication of this issue possible. Their collective efforts, expertise, and dedication have significantly enriched the content and quality of this publication. This collaborative spirit has played a crucial role in ensuring the success of this endeavor, and I am sincerely appreciative of the contributions from each individual involved.

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Dr P P Sajimon
Editor-in-Chief

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VARIATION OF PRESSURE IN SOUND WAVES DUE TO INTERACTION WITH GRAVITATIONAL WAVES

Sneha M, Sreehari M P, Nilakanthan V K

Abstract

Study of gravitational waves has been a formidable challenge in recent times because of its applications like structure and composition of the early universe. Recent discovery of gravitational waves by LIGO has only increased its importance. By considering interaction of gravitational waves with sound waves, a new experimental method has been introduced to detect the gravitational waves. In this work, we re-examine the interaction of gravitational waves with sound waves. The gravitational waves from rotating neutron stars are used in this study. The effect of gravitational waves on sound waves in a fluid is that gravitational waves vary the pressure of the fluid while crossing it. Gradient of pressure is taken to be proportional to the variation of polarization of the gravitational waves. The variation of pressure in air at different altitudes is studied in this work. It is observed that as we go to higher altitudes the variation in pressure increases.

Keywords: Gravitational waves, General relativity, sound waves, pressure variation, linearized field equations.

Introduction

The discovery of gravitational waves has lately transformed astronomy and created a new door for gravitational wave astronomy. The Laser Interferometer Gravitational Wave Observatory (LIGO) and the Virgo team observed gravitational wave ripples in 2015 (https://www.ligo.caltech.edu/(2015)). Following this discovery, the advanced LIGO-Virgo-KAGRA cooperation discovered many additional gravitational waves. LIGO is made up of two vacuum facilities, one in Hanford, Washington, and the other in Livingston, Louisiana, each with 4 km long arms. VIRGO situated in Europe is a 3 km laser interferometer. Waves of a frequency range of 10 Hz to 10 kHz can be detected by both LIGO and VIRGO. The first gravitational wave observatory in Asia is the Kamioka Gravitational Wave Detector (KAGRA). It has two 3 km long arms. Due to gravity-gradient noise, gravitational waves from celestial objects with frequencies less than 1 Hz cannot be detected

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by Earth-based detectors. Here the Laser Interferometer Space Antenna (LISA) detector comes into play because it will be stationed in orbit and will be operated by the European Space Agency and NASA. The first proposed mission to fly is the LISA.

Thus, today's massive experimental efforts to detect gravitational waves, ranging from bar detectors to laser interferometers on Earth (GEO-600, LIGO, VIRGO, and so on) and interferometers in space (LISA) to interplanetary spacecraft Doppler tracking, are aimed at increasing the chances of future detections.

Until the detection of gravitational waves, the cosmos was examined on the basis of electromagnetic waves. So the detection of gravitational waves will assist us to explore the universe from a different point of view. The information about the universe's origin is carried by gravitational waves that travel through space-time without being significantly scattered. Thus detecting the gravitational waves will assist us to explore into the history and origin of the cosmos. We will be able to study the universe in a new way by detecting and analysing them.

Newtonian gravitation has been effectively for more than three decades. It is still being used for non-relativistic applications. With the advent of special relativity (Hartle (2021)), Newton's law will cease to be exact. The concept of simultaneity in special relativity differs depending on the frame of reference. Newton's law, on the other hand, could only be true in one frame.

The General relativity generalizes special relativity and modifies Newton's law of universal gravitation, and explains the gravity as a geometric property of space and time or four-dimensional spacetime(Weinberg(1972)). Also, spacetime curvature is related to energy and momentum of matter. Einstein's field equations explains this relation.

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -\frac{8\pi G}{c^4} T_{\mu\nu} (1)$$

1.1 Gravitational Waves

Gravity is a universal, unscreened, long-range and the weakest of four fundamental forces (Hartle (2021)). Even though it is the weakest force, gravity is the

foundation of cosmology and astrophysics. According to the general relativity theory, the gravitational force of attraction between any two masses is caused by the warping of spacetime. Therefore, mass bends spacetime. Spacetime ripples are caused by the bulk motion of large, energetic objects. Gravitational waves are the name for these rippling effects, and they move through spacetime at the speed of light. According to Einstein's hypothesis, gravitational radiation is generated in incredibly small quantities in ordinary atomic process and the transition between two atomic state is proceeded by the emission of gravitational radiation rather than the electromagnetic radiation (Weinberg(1972)).

Einstein first predicted gravitational waves in 1916, gravitational wave detection has started in the same century. The discovery of the Hulse-Taylor binary pulsar (PSR 1913+16) provided the first inference that gravitational waves exist. After 100 years, gravitational waves from the merger of two black holes have finally been discovered in 2016 by the Laser Interferometer Gravitational Wave Observatory (LIGO).

1.2 Types of Gravitational waves

LIGO scientists have classified gravitational waves into four based on their origin (https://www.ligo.caltech.edu/(2015)):

1. Continuous gravitational waves: These particular waves come from sources with well specified frequencies. Black holes in orbit around one another and binary stars are examples of such sources. As they evolve over long periods, it is assumed that the gravitational waves they produce would be quite faint.

2. Compact In-spiral gravitational waves: These wave kinds are created when two objects merge into one at the final stage of a binary system. These sources include a pair of black holes, a pair of neutron stars, and a pair of black holes plus a neutron star.

3. Stochastic gravitational waves: It is expected that the processes in the early cosmos will produce these radiations. The big bang would create the most fascinating background. It is anticipated that the information

regarding the universe's beginning and development will be carried by these radiations.

4. Burst gravitational waves: LIGO is yet to detect these types of waves. They are expected to be produced from the unknown sources.

2 Literature Survey

Akash Patel et. al. (2021) have examined the interaction of electromagnetic waves with gravitational waves in the de-sitter space and flat space. It is observed that the electromagnetic waves are perturbed by the gravitational waves and observed perturbation is weak compared to the initial waves. This result will be useful in studying inhomogeneities in Cosmic Microwave Background.

Basem Ghayour et. al. (2021) proposed a new experiment for gravitational wave detection using effect of gravitational waves on sound waves in a fluid. It is observed that the gravitational waves vary the pressure of the fluid by crossing it. It is also emphasised that the proposed method may be difficult in practical experiment due to the presence of noise.

A Cetoli et. al. (2012) have developed a framework for analysing the interaction of gravitational waves with matter. It derives an expression for dispersion of gravitational waves in matter. It is found that the self-energy of gravitational waves has contribution which is similar to the paramagnetic and diamagnetic contribution to the self- energy of an electromagnetic wave in matter.

The interaction of magnetic and electric fields with gravitational waves has been researched by C. Barrabes et. al. (2010). Consideration of gravitational waves as impulsive waves allows researchers to examine three different physical scenarios: 1) a cylindrical impulsive gravitational wave propagating in a universe with a magnetic field, 2) an axially symmetric impulsive gravitational wave propagating in a universe with an electric field, and 3) a spherically impulsive gravitational wave propagating in a universe with a small magnetic field. It is observed that electromagnetic radiation is produced in the first two circumstances behind gravitational waves and in the third case after the wave unless a current is established behind the wave-breaking Maxwell vacuum.

Morales et. al. (2020) have explored the interaction of scalar and Fermion field with a gravitational wave. It discusses the effect of gravitational wave on a massive scalar field and neutrino wave. It focusses mainly on the perturbation caused by gravitational wave on massless scalar and chiral fermions. The results obtained has implications for cosmology and ground-based detector observations.

Gravitational waves' interactions with charged particles have been investigated by Wickramasinghe et. al. (2015). Charged particles may absorb energy from gravitational waves that strike them, weakening the waves in the process. Even if the charges are not in a magnetic field, attenuation still occurs. More attenuation is discovered to occur close to the source.

The interplay between multipolar nuclear transitions and gravitational waves has been the subject of theoretical research by Cheang et.al.(2008). They illustrate their findings using long-lived Mossbauer nuclides of multipolar transitions. A nuclear quadrupole deformation occurs as a result of gravitational waves. Similar to NMR, the nuclear spin is flipped by gravitational waves through resonant helicity-rotation coupling. The multipolar transitions can be accelerated by the quadrupole deformation, which will aid in the detection of gravitational waves, especially in the low frequency band between 100nHz and 1Hz.

Fryer et. al. (2011) have studies about the gravitational waves originating from the gravitational collapse. It discusses about the entire range of stellar collapse source of gravitational waves which includes the collapse of white dwarf, black holes, and supermassive stars, etc. it is found that the gravitational waves from such sources have more potential to be detected by the ground-based and space-based detectors.

The continuous gravitational wave emission from individual spinning neutron stars, whose spin down is solely caused by gravitational wave emission, has been studied by Sieniawska et. al. (2022). It is demonstrated that, while continuous gravitational wave emission from rotating neutron stars does not allow for precise measurements of compact binary coalescence, it is nevertheless possible to gain knowledge from such gravitational wave detection.

Ezquiaga et. al. (2020) have investigated the cosmic propagation of gravitational waves across homogeneous and isotropic backdrops beyond general relativity. It examines four different classes of derivative and non-derivative interactions: mass, friction, velocity, and chiral. It also takes into account the gravitational wave interaction with an additional tensor field. These answers to this came from the formation of WKB. Depending on the kind of tensor interaction, it is shown that the gravitational wave signal may show amplitude and phase distortion with regard to a gravitational wave waveform in general relativity.

Abbott et. al. (2016) have studied the of detection of a transient gravitational wave signal by LIGO. The observation from LIGO matches with the predictions of general relativity for the inspiral and merger of a pair of black holes. It confirms the existence of binary stellar axis black hole system.

Kamionkowski et. al. (1986) have examined the stochastic background gravitational waves produced by first-order cosmological phase transitions from colliding bubbles and hydrodynamic turbulence. It is observed that the gravitational waves from such first-order phase transitions have a better possibility for detection.

The characterisation of the detectors in the ground-based gravitational wave interferometers has been reviewed by Davis et. al.(2022). It examines several elements of interferometer characterisation for gravitational wave detection, such as the evaluation of instrument performance, the assessment of data quality, and the discovery and admonition of data quality problems that impede detection. It anticipates modifying new detector characterisation techniques to accommodate the evolving requirements of gravitational wave astronomy.

Based on the concept of the electromagnetic wave polarizations in a waveguide, Tong et al. (2008) have suggested a technique for gravitational wave detection. It is claimed that in a gravitational wave-affected region of spacetime, the electromagnetic wave polarisation vector will rotate. Additionally, it reevaluates the same technique for finding remnant gravitational waves. It is discovered that the relic gravitational wave's amplitude is too small for currently operational waveguide detectors to pick up on.

Dimopoulos et al. (2009) have proposed a method for gravitational wave detection with atom interferometry. It uses one terrestrial based and another satellite-based interferometer. It is observed that the use of ballistic atoms as inertial test masses improves systematics coming from vibrations and acceleration noise, and reduces spacecraft control requirements.

Klimenko et al. (2016) have proposed a method for detection and reconstruction of gravitational wave transients with network of advanced detectors. It uses analytic method using algorithms for detection of transient gravitational wave sources. It is found that the polarization measurements enable rapid reconstruction of the gravitational waveforms, sky localization and also helps in identifying the origin of the source.

Renzini et al. (2022) has studied about the stochastic gravitational-wave background. It characterizes the stochastic gravitational-wave signals based on their source and properties. It also discusses about the current detection methods for stochastic GW signals. It gives an outlook on third generation detectors, space-based interferometers, and non-interferometric detection methods that are proposed.

The Decoherence of gravitational wave oscillations in bigravity has been researched by Max et.al.(2018). It results in the gravitational wave echo events that result from coalescence events. It offers bigravity in the coherent regime an apparent signature.

The opacity of gauge field dark energy in gravitational waves has been discussed by Caldwell et. al. (2019). It looks into a specific gauge field dark energy scenario where the gauge field absorbs gravitational waves and then emits them again. It demonstrates that when gravitational waves travel across cosmic gauge fields, they are modulated.

A gravitational wave's effect on laser interferometers has been investigated by Adrian Melissinos et.al.(2010). The TT gauge was used to conduct the study. It is discovered that the electromagnetic plane wave propagation in the curled space-time caused by gravitational waves can achieve the same outcome. It is

concluded that a sideband at the gravitational wave frequency is created when gravitational waves interact with a plane wave carrier.

In order to study the gravitational wave events GW170817 and GW190521 and their electromagnetic counterparts, S Mastrogiovanni et al(2021). They consider three scenarios: a time-varying Planck mass, large extra dimensions, and a phenomenological parametrisation that encompassed several theories beyond general relativity. A friction term comes upin the gravitational wave propagation equation in each of the three scenarios effectively modifying the GW luminosity distance.

3 Linearized Gravitational Waves and effect of Gravitational waves on sound waves

Einstein's Gravitational Field Equation is highly non-linear in nature;therefore, it is highly difficult to arrive at a general solution for an arbitrary matter distribution. Assume thatthe field is weak. The weak gravitational field correspond to region where space-time isslightly curved. Consider a coordinate system x^{μ} where the space-time metric is given by,

$$g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} \quad (2)$$

for which we get the linearized form of the Einstein's equation (eq: 1) as

$$h_{\mu\nu} = -\frac{16\pi G}{c^4} T_{\mu\nu} \qquad (3)$$

This equation under a source less case ($T^{\mu\nu} = 0$) gives us the wave equation for which we get the polarization states as,

$$h_{\mu\nu} = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & h_+ & h_\times & 0 \\ 0 & h_\times & -h_+ & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \exp[i(kz - \omega t)] \, (4)$$

h_+ and h_x are the two polarization states of gravitational waves. When gravitational waves pass through matter, the particles oscillate due to the variation in spacetime. polarized waves make the particles to oscillate in vertical and

horizontal direction and polarized waves make the particles to oscillate in oblique direction.

The interaction of gravitational waves with sound waves has been studied by BasemGhayouretal (2021). The change in pressure of a fluid caused by the perturbation of gravitational waves is considered. The proposed experiment will pave the way for a potential gravitational wave detection. The effect of gravitational waves on sound waves in fluid is studied in this work. The perturbation of gravitational waves on sound waves changes the shape of the sound waves. This induces a variation of pressure in the fluid. This pressure variation is measured and hence gravitational waves can be detected.

The sound waves are longitudinal waves which requires a material medium to propagate. A fluid is considered as the material medium for the propagation. A particle here is considered as a small volume of the fluid. The following assumptions are made for calculating the variations in pressure Basem Ghayour et al. (2021)

- The fluid is homogeneous, isotropic and elastic;
- The amplitude of sound waves is small;
- The variation of density is small with respect to its value in equilibrium state.

$dp = p - p_0$ is the variation of the pressure, $\tilde{a}$ is the speed of propagation, w is variation of particle with respect to x, ρ_0 is the density of fluid in equilibrium, p is the instantaneous pressure at each point of fluid and p_0 is thepressure of fluid in equilibrium. From Newton's second law of motion, one can obtain the wave equations as

$$\frac{\partial^2 w}{\partial t^2} = \gamma^2 \frac{\partial^2 w}{\partial x^2} \ (5)$$

$$\frac{\partial^2 p}{\partial t^2} = \gamma^2 \frac{\partial^2 p}{\partial x^2} \ (6)$$

Solving equation (6), we get the variation of pressure in sound waves as

$$dp = p_+ - p = \frac{1}{2} \rho_0 \gamma^2 h_{0+} [1 - (\cos(kz) + \omega t \sin(kz))] (7)$$

4 Results and Discussions

Here the interaction of gravitational waves on sound waves has been studied to examine the sensitivity of detection of gravitational waves on different altitudes. There are different sources of continuous gravitational waves like binary systems of stars and black holes from which the frequency of continuous gravitational waves from the rotating neutron stars is considered. The rotating Neutron stars are currently known to rotate at an order of hundreds of Hz. Hence we choose the frequency (ù) as 100 Hz. An estimated upper bound of h_{0+} is 10^{-24} (Basem Ghayour et. al. (2021)). The limit of integration over time (t) is taken from 0 to 10^5 years. In (7), $-1 \leq \omega t \sin(kz) \leq 1$ is considered here for calculation. Pressure variations observed in Pascals (Pa) at different altitudes of the Indian subcontinent thus calculated is listed in table 1.

Table 1: Variation of pressure in sound waves due to gravitational waves.

Altitude	Atmospheric pressure (Pa)	dp (Pa)
Sea level	101.3×10^3	-50.6×10^{-9}
1600 ft above sea level	54.3×10^3	-27.39×10^{-9}
29028 ft above sea level	30.8×10^3	-15.39×10^{-9}

5 Conclusion and scope for future work

The interaction of gravitational waves with sound waves has been studied using gravitational waves from rotating neutron stars. The effect of gravitational waves on sound waves in a fluid is that gravitational waves vary pressure of the fluid by crossing it. Gradient of pressure is taken to be proportional to the variation of polarization of the gravitational waves. The variation of pressure in air at different altitudes is studied in this work. When altitude is twice the previous one, the pressure calculated is also twice the previous one. Therefore, it is observed that as we go to higher altitudes the variation in pressure increases. Recent development in gravitational wave cosmology makes it inevitable to study the interaction of gravitational waves with matter. There are potential sensitive gravitational wave detectors to detect and measure the radiation from various astrophysical sources. In this report we have examined the interaction of gravitational waves with sound waves. Further the interaction of gravitational

waves can be studied with charged particles, electric and magnetic field, multipolar nuclear transitions.

References

Abbot B. P. et al.(LIGO Scientific Collaboration). (2016).Observation of gravitational wave from binary black hole merger. *Physical Review Letters 116* (061102), doi.org/10.1103/PhysRevLett.116.061102.

C. Barrabès and P. A. Hogan (2010). On the interaction of Gravitational waves with magnetic and electric fields. *Physical Reviews D* 81(064024), doi.org/ 10.1103/PhysRevD.81.064024.

Caldwell R. R., and Devulder C. (2019), Gravitational wave opacity gauge field dark energy. *Physical Reviews D 100* (103510), doi.org/10.1103/ PhysRevD.100.103510.

Cettoli A. and Pethick C. J (2012). Interaction of gravitational waves matter. *Physical Reviews D 85*(064036), doi.org/10.1103/PhysRevD.85.064036.

Cheang Y., Jian Qi Schen J. Q. (2008). *Interaction between multipolar nuclear transitions and gravitational waves*" arXiv:gr-qc/0703066.

Davis D., and Walker M., (2022) Detector characterization and mitigation of noise in ground based gravitational wave interferometer. *Galaxies*, *10*(1), 12, https://doi.org/10.3390/galaxies10010012.

Dimopoulos S., Graham P. W., Hogan J. M., Kasevich M. A., Rajendran S. (2009), Gravitational wave detection with atom interferometry. *Physics Letters B, 678* (1), 37-40, https://doi.org/10.1016/j.physletb.2009.06.011.

Ezquiaga J. M.,Jimenez J. B.and Heisenberg L. (2020). Probing cosmological fields with gravitational wave oscillations. *Journal of Cosmology and Astrophysics*. 2020 (04), **doi.org/**10.1088/1475-7516/2020/04/027.

Ghayour B., Khodagholizadeh J., Corda C., Ming-Lei Tong M. L., &Ali Ghayour A (2021). A new experiment for the gravitational waves detection. *Canadian Journal of Physics*, 99 (11), doi.org/10.1139/cjp-2021-0077.

Hartle J. B. (2021), *Gravity: An Introduction to Einstein's General Relativity*. Cambridge University Press.

https://www.ligo.caltech.edu/

Kamionkowski M., Kosowsky A., and Turner M. S. (1986), Gravitational radiation from first order phase transition". *Monthly Notices of the Royal Astronomical Society*, 218 (4), 629–636, https://doi.org/10.1093/mnras/218.4.629.

Klimanko S. et al. (2016),Method for detection and reconstruction of gravitational wave transients with networks of advanced detectors. *Physical Reviews D 93* (042004), doi.org/10.1103/PhysRevD.93.042004.

L. Fryer C. L., New K. C. B. (2011). Gravitational waves from gravitational collapse. *Living Reviews in Relativity*.14 (1), https://doi.org/10.12942/lrr-2011-1.

Mastrogiovanni S., et al., (2021). Gravitational wave friction in light of GW170817 & GW190521. *Journal of Cosmology and Astrophysics*, 2020 (02), **doi.org/**10.1088/1475-7516/2021/02/043.

Max K., Platseher M., and Smirnov J. (2018), Decoherence of gravitational wave oscillations in bigravity. *Physical Reviews D* 97 (064009), https://doi.org/10.1103/PhysRevD.97.064009.

Melissinos A., and Das A., (2010). The response of laser interferometers to a gravitational wave.*American Journal of Physics* 78, 1160–1164, https://doi.org/10.1119/1.3443566.

Morales S., Dasgupta A. (2020), *Scalar and fermion field interaction with a gravitational waves, Classical and Quantum Gravity*, 37 (10), **doi.org/**10.1088/1361-6382/ab79d6.

Patel A. and Dasgupta A. (2021). *Interaction electromagnetic field with a gravitational wave in Minkowski and de-sitter space-time*. arxiv:2108.01788.

Renzini A. I., et al. (2022). Stochastic gravitational wave backgrounds: current detection efforts and future prospects.*Galaxies* 2022, *10*(1), 34; https://doi.org/10.3390/galaxies10010034.

Sieniawska M., and David Ian Jones D. I. (2022) Gravitational waves from spinning neutron stars as not-quite-standard sirens.*Monthly Notices of the Royal Astronomical Society.* 509 (4),February 2022, 5179–5187, https://doi.org/10.1093/mnras/stab3315.

Tong M. L., Zhanj Y., and Li F. Y., (2008). Detecting very high frequency relic gravitational waves by a waveguide. Chinese Journal of Astronomy and Astrophysics, 8 (3), 314, **doi.org/**10.1088/1009-9271/8/3/08.

Weinberg S. (1972), Gravitation and Cosmology: Principle and Applications of the General Theory of Relativity", John Wiley and Sons.

Wickramasinghe, T., Rhodes, W., Revalski, M. (2015). Interaction of Gravitational Waves with Charged Particles. In: Sopuerta, C. (eds) Gravitational Wave Astrophysics. Astrophysics and Space Science Proceedings, vol 40. Springer, Cham. https://doi.org/10.1007/978-3-319-10488-1_26.

THE ROLE OF MEMORY IN THE FORMATION OF SOCIAL IDENTITY THEORY AMONG IRAQI DIASPORA COMMUNITIES: A STUDY OF INAAM KACHACHI'S THE AMERICAN GRANDDAUGHTER

Ruqaya S. ALGed

Abstract

This study deals with the impact of memory on the evolution of social identity theory within Iraqi diaspora communities. The analysis of Inaam Kachachi's novel The American Granddaughter supports the idea that memory has a significant effect on the identity formation of Iraqi diasporic individuals. The study begins with an overview of the social identity theory, which posits that individuals' perceptions of their own identity are influenced by their membership in various social groups. The subsequent section of the study investigates the role of memory in the formation of social identity, proposing that recollections of collective events may contribute to the formation of a shared sense of identity among members of a particular group. Furthermore, the study focuses on an analysis of Kachachi's work, arguing that her novels explore how memory can be used to establish and maintain a shared sense of Iraqi identity despite the challenges of exile.

Keywords: *diaspora, identity theory, social identity theory, memory, Inaam Kachachi, The American Granddaughter, Dispersal.*

Introduction

It is commonly acknowledged that diasporic groups can maintain their social identity and sense of belonging by relying on their shared memories. The correlation between identity and memory has attracted significant scholarly interest, particularly when examining the diaspora community. The primary aim of this study is to elucidate the significance of memory in shaping the identity of individuals within the Iraqi diaspora. The objective of this study is to conduct a meticulous analysis of the literary works of Inaam Kachachi "The American Granddaughter" and explore the role of memory in shaping the identity of the characters.

The Iraqi diaspora encompasses a substantial and heterogeneous population that has been compelled to depart from their own nation due to violence, oppression,

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economic hardship, and political instability. The extensive expanse of the Iraqi diaspora, encompassing significant centers such as Europe and London, North America, and Australia, perhaps contributes to a deeper understanding of the complexities inherent in the diasporic experience. (Kadhum,2021)

Based on an extensive body of scholarly literature, it is evident that the Iraqi diaspora frequently encounters difficulties in preserving their cultural identity and cultivating a feeling of affiliation within their respective countries of origin. The task of reconciling the maintenance of a distinct cultural identity with the process of integrating into foreign surroundings can provide considerable difficulties. Furthermore, diaspora communities may experience feelings of social isolation and discrimination due to their displaced status. (Saleh, 2015).

Memory's role in facilitating individuals' adaptation to the challenges associated with migration and relocation. In the discipline of diaspora studies, the concepts of nostalgia and homeland sentiment have been the subject of extensive research. Nostalgia, as a potent emotion, has the ability to evoke memories associated with one's native country, thereby providing a sense of continuity and stability throughout the chaotic experience of migration.(Bucerius, S et al., 2022). The significance of memory is of greatest significance in the preservation of cultural identity and the facilitation of ties among people of the diaspora who have shared experiences. Researchers have conducted investigations on the impact of diaspora tourism on the identity of migrants and their emotional connection to their country. These investigations have focused on many aspects, such as place attachment, cultural identity, well-being, and cultural connectivity. The experience of nostalgia has the potential to serve as a catalyst for diaspora tourism, safeguard their cultural inheritance, and facilitate the opportunity for individuals to reestablish connections with their place of origin. (Zeng & Xu, 2021)

This study aims to examine the fundamental principles of social identity theory, the influence of collective memory on the development of identity, and an in-depth analysis of Kachachi's work. By doing so, it seeks to provide insight into the role of memory as a resilient factor that unites individuals within the Iraqi diaspora. Through an examination of the tales and viewpoints shown in these literary works, a more

profound comprehension can be attained about the role of memory as a mechanism for the establishment and preservation of collective Iraqi identity within the diasporic context.

Review of Literature

Extensive research has been conducted in the field of social psychology regarding the complicated interplay between individual cognition and group dynamics. Social Identity Theory (SIT) is a significant theoretical framework that provides insight into the interconnectedness being discussed. The Social Identity Theory (SIT), which emerged from the influential research conducted by Tajfel and Turner throughout the 1970s, proposes that individuals develop a significant aspect of their self-concept by associating themselves with particular social groupings. The fundamental elements of social identity comprise the concepts of in-groups, out-groups, social categorization, and social comparison. These characteristics are of crucial significance in enabling a comprehensive comprehension of the process by which individuals classify themselves and others into distinct social groups. (Tajfel &Turner 1979)

The concepts of in-group and out-group are to social categorizations employed by individuals to differentiate between those who belong to their own group and those who do not. In-group formations refer to the social groupings with which individuals associate and have a sense of affiliation, whereas out-groups denote social groups that individuals do not associate with and may even harbour negative sentiments towards. (Tajfel &Turner 1979)

In addition, Social categorization refers to the cognitive process through which individuals classify people into distinct groups based on common features, such as race, gender, religion, or connection with particular sports teams. This phenomenon has the potential to result in the manifestation of in-group bias, characterised by the inclination to have a more positive perception of individuals belonging to one's own group in comparison to those belonging to other groups.

Social comparison is the evaluation of oneself through comparison to others. This is possible with both in-group and out-group members. When people compare

themselves to members of their in-group, it can boost their self-esteem because they see themselves as similar to those they revere. However, comparing oneself to members of an out-group can contribute to feelings of inferiority, as individuals perceive themselves to be less successful than others. (Tajfel &Turner 1979)

Memory's role within the complex interaction between one's social identity and cognitive abilities. The concept of memory, which serves as a complex reservoir of shared experiences and collective history, plays a significant role in shaping and maintaining social identity. This phenomenon is particularly conspicuous within the framework of diasporic societies because memory functions as a powerful instrument for the preservation of cultural heritage and communal narratives. The analysis effectively illustrates the intricate relationship between memory and social identity, elucidating how the remembrance of historical events, cultural customs, and collective hardships fosters a stronger feeling of affiliation between diasporic communities. (Fivush & Graci,2017)

Memories are not only cognitive constructions; rather, they include emotional elements that have a significant influence on a person's self-perception within their social environment. The recollections connected to cultural practices, customs, and historical events elicit emotional responses that establish a connection between individuals and their cultural heritage. The enhancement of an individual's social identity may be primarily attributed to the development of a personal affiliation with their cultural upbringing. (Esposito, 2008)

The notion of collective memory assumes a vital role in comprehending the ways in which memories contribute to the construction of identity, especially for diaspora societies or those experiencing exile. The concept of collective memory pertains to the communal remembrance of past events and encounters that shape the collective identity of a particular community. The aforementioned entity functions as a cohesive element that brings together individuals through the provision of a collective narrative and a shared comprehension of their past. Despite the experience of relocation, the phenomenon of collective memory serves as an essential link that connects individuals to their cultural history and fosters a sense of connection among members of the same group.(Barclay & Koefoed,2021)

The exploration of memory and identity is a central focus in Innam Kachachi's literary work, with special prominence found in her novel titled, 'The American Granddaughter.' The protagonist, Zeina, encounters challenges in reconciling her Iraqi experience with her American citizenship, adopting the use of recollections as a tactic for navigating the complexities inherent in these distinct aspects of her identity. Kachachi employs the mechanism of memory as a means for Zeina to maintain her connection to her Iraqi heritage while residing in the United States. Laila is able to relive memories from her youth in Iraq through the occurrence of frequent flashbacks (Kachachi, 2010).

The recollections in question serve to establish a sense of coherence with her cultural heritage, mitigating sentiments of detachment resulting from her immersion in American society. The process of recalling memories is crucial for the establishment and maintenance of a unified individual identity that encompasses both temporal and spatial aspects (Assman,2011). Zeina utilizes memories as a means of navigating her dual Iraqi and American identities, so employing them as a "method of negotiating identity" (Al-Ali,2007).

Nevertheless, the extensive dependence on recollection serves to emphasize the fractured aspect of Zein's identity. Memories exhibit inherent incompleteness and undergo temporal modifications analogous to the dynamic evolution of an individual's identity (Olick et al., 2011). This occurrence becomes evident when Zeina recalls past occurrences in a manner that departs from the recollections of her Iraqi relatives (Kachachi,2010). The inherent imperfections and flexibility of memory imply that Zeina's complete restoration of her "original" Iraqi identity is unattainable only via the process of remembrance.

Furthermore, The emigrant resides in a transitional space, spanning the boundaries of two distinct worlds, experiencing a profound lack of affiliation with either their country of origin or their adopted homeland. Zeina consistently remains on the periphery, undergoing continuous development while never attaining her full capabilities. The state of liminality possesses the capacity to stimulate novel concepts and advancements; however, it also harbors the ability to induce emotional turmoil and create social isolation. This phenomenon is called "in-betweenness,"

when Zeina's identity is characterized by a state of being neither entirely Iraqi nor American. (Boym,2001)

The objective of this study is to further investigate the significant impact of memory in defining the social identity of Iraqi diaspora populations. The methodology employed in this study will mostly be theoretical, utilizing careful textual analysis approaches to thoroughly examine the novel entitled "The American Granddaughter." The objective of this study is to conduct a comprehensive analysis of the novel, with the intention of identifying the fundamental themes, storylines, characters, and events that are centered on the notions of memory, identity, and exile. The main focus of the study will be to examine the strategies employed by the authors in using memory as a means to strengthen the sense of connection to Iraqi identity and culture among those who have resettled outside of Iraq. Through this project, the aim is to illuminate the complex dynamics that exist between memory and the maintenance of cultural connections among diaspora groups.

All in all, the interconnection between personal and collective memory is exemplified by Kachachi's distinctive amalgamation of the two. The narrative of Zenia's personal quest to establish a connection with her family's historical roots bears a striking resemblance to Iraq's collective effort to recreate its own historical narrative in the aftermath of conflict. The story emphasizes the role of memory as a reservoir of cultural legacy, facilitating the preservation of identity despite experiences of exile and hardship.

Memory's role in shaping identity

Kachachi explores Zeina's journey in a comprehensive manner, providing a detailed examination of her experiences as a woman of Iraqi-American descent. This narrative emphasizes the multifaceted nature of cultural heritage, displacement, and personal history. In her capacity as the protagonist, Zeina confronts the various obstacles encountered by individuals who inhabit multiple domains and whose identities become entangled. The recollections that Zeina retains from her formative years in Iraq function as emotive elements that interconnect her own sense of self with her family lineage. A vital aspect of Zeina's narrative is around the memories she preserves from her developmental period in Iraq. These memories function as

affective components that establish a connection between her own identity and her family heritage. The metaphorical connection they establish between her past historical encounters and her present situation serves to facilitate a more profound comprehension of her own identity and her position within the Iraqi diaspora community. Within a global context characterized by displacement and fragmentation, the novel emphasizes the significance of valuing and safeguarding our memories as a mechanism for cultivating comprehension, empathy, and a deep-rooted feeling of affiliation. She depicts:

> "I'd seen them at weddings in Detroit and Chicago and San Diego, the immigrants who still hung by an umbilical cord to their motherland, ready to sway their heads and shed a tear with the first tune of a patriotic song. 'If you lose a homeland, where will you find another?' They seemed to secretly enjoy this heartache. 'Oh birds in the sky, fly to my people.' Why had they come to America then? Why had they come with Iraq smuggled in their pockets like a drug that they couldn't quit?" (Kachach, 2010).

Zeina undertakes a reflective examination of the tricky balance between assimilating into her American upbringing and maintaining her connections to her Iraqi heritage and her ties to her Iraqi ancestry inspired by these memories. In the following lines, Zeina provides an illustrative description of her recollection of her grandmother, Rehma.

> "I rested my head in her lap and let her tell me her stories that were steeped in the scent of Iraq. She delved deep into her memory for anecdotes and other means of explanation. She told me of my family's history that was manifest everywhere around us. The print of my blood and the bones of my ancestors. I drank her stories in, but they didn't quench my thirst. There was a missing link somewhere, and it wasn't my grandmother's job to find it, but mine." (Kachachi,2010)

The novel prominently explores the concept of memory and the importance of memory in shaping both individual and social identities, hence delving into its relevance. Zeina's recollections serve a dual purpose, not only enhancing her own identity as an Iraqi-American woman but also establishing her connection within

the wider context of the diaspora. The memories of the individual are imbued with resonance, emphasizing the collective identity that unifies the diaspora via the common experiences, values, and traditions of their group. Zeina confesses :

> "all the while the old rhymes that engraved their message forever upon my still-soft memory. Rhymes inherited from the days of Mosul and the old stone house that sits on a cliff overlooking the river. The house of Girgis Saour, my great-grandfather whose surname Saour – The churchwarden – he acquired from taking care of Al-Tahira Church, together with its saints' icons and its candlesticks that every Saturday had to be cleaned of the wax that had hardened on the shafts and polished with a slice of lemon. They took me to Mosul one day when I was little. It was the Easter holidays, early April, and the valleys were ablaze with camomile flowers. The sprawling yellow vastness bewitched me, the scent of nature made me dizzy." (Kachachi,2010).

Furthermore, the novel highlights the inherent contradiction of memory, which serves as both a catalyst for resilience and a cause of suffering. Zeina's recollections of Iraq stimulate a diverse array of emotions, often leading to sad and distressing contemplations. Kachachi perfectly illustrates feeling:

> "Yet, I like this sorrow of mine. I feel the softness of its gravel as I wade with bared soul into its fountain, and I have no desire to shake off its burden. My beautiful sorrow, which makes me feel that I am no longer an ordinary American but a woman from a faraway and ancient place, her hand clutching the burning coal of a story like no other."

She also describes Zeina's childhood as :

> "The scenes of my childhood poured over me like hot rain, burning instead of cooling." (Kachachi, 2010).

Nevertheless, these experiences also afford her a deep-seated feeling of inclusion, allowing Zeina to reestablish her cultural heritage and discover comfort in her sense of self. The novel highlights the significance of recognizing and honoring our history despite the inherent complexities and obstacles involved in recollecting a chaotic

past. By recognizing and acknowledging the importance of this concept, individuals may gather the necessary resilience to address the current circumstances and actively contribute to the development of a future characterized by inclusivity and empathy. Zeina illustrates that, in essence, her expedition stands as a testament to the profound impact of memory in effecting personal transformation. This statement underscores the capacity of people to demonstrate resilience and adaptation in navigating the intricate dynamics of cultural hybridity. This is so clear in the case of Zeina's mother weeping, begging for her father's repentance while performing the U.S. national anthem upon being handed American citizenship. Zeina describes the situation:

> "The voice of my mother, the Iraqi woman Batoul Fatouhy Saour, was the only one out of tune, as she wailed in Arabic, "Forgive me, Father. Yaabaa, forgive me"." (Kachachi,2010)

Remarkably, the novel underlines the value of the memory of the diaspora community in conserving the cultural legacy. The characters' memories of Iraq function as a hyperlink to their cultural heritage, allowing them to retain and preserve their rituals, words, and principles through the decades. The act of recalling provides a tactic to prevent the breakdown of one's cultural heritage in the context of integration and displacement. Zeina portrays how memory preserves her own Iraqi accent when American troops visit Almosul city. She comments :

> "I wanted to jump off the truck, shout something like 'Allah yusa'edhum!' and make small talk with them. Maybe ask about the wheat season or about the nearest store to buy a loofah for the bath, or simply invite myself in for a glass of cold water in one of their houses. I wanted to flaunt my kinship in front of them, show them that I was a daughter of the same part of the country, that I spoke their language with the same accent, I wanted to tell them that Colonel Youssef Fatouhy, assistant to the chief of army recruitment in Mosul in the 1940s, was my grandfather."(Kachachi , 2010).

The literary work delves into the intricate dynamics of memory and identity as they undergo transformation through successive generations. The elderly individuals depicted in the narrative possess strong recollections of Iraq and the formative events that prompted their decision to immigrate. On the contrary, the younger

cohort, who were raised and grown up in the United States, frequently possess a fractured or idealised perception of their native country. The presence of generational disparities in memory serves as a contributing factor to the emergence of conflicts among both the family unit and the broader diaspora group. Zeina's grandmother, Rahma, provides an unbroken description of life in Iraq that persists until Zeina manages to establish a personal connection to her own former experiences in that country, unrestricted by the influence of exile. Zeina's grandmother possesses the ability to provide a comprehensive and consistent narrative pertaining to the remote past, which is intricately linked to the contemporary context that Zeina is going to encounter throughout her time.

> "my grandmother took pride in saying, when I was a little girl sitting on her lap, by way of explanation for her natural steadfastness, telling the story of my great-grandfather, the pistachio trader who moved between the Kurdish villages and roamed the borders of Turkey and Iran." (Kachachi,2010)

Zeina adds :

> "As we hugged, I cried tears of love and nostalgia, and she cried tears of love and frustration, and maybe shame." (Kachach,2010).

So Rahma deliberately and actively adopts an approach wherein she emphasises a history of relationship and a culturally diverse background, with the intention of embedding her own principles in Zeina and fostering a sense of optimism for their future resurrection.

In a nutshell, Rahma's sense of separation inside the country presents Zeina with yet another intricate issue that requires resolution. The origins of this issue may be traced back to the sadness experienced by Zeina's grandmother upon coming back as an American. Zeina encounters a significant challenge in her endeavor to redefine her personal narrative with the aid of Rahma. The rationale for this is that Zeina's grandmother evidently holds biased views towards Zeina's supposed compromised identity, which she feels can alone be rectified via drowning herself in recollections associated with Iraq. Zeina provides insight into her grandmother's response upon witnessing wearing the uniform of Ameican Army. Zeina states

"She started to beat her thighs with her hands like women only do at funerals and catastrophes. The sad look in her eyes as she looked at me said it all. I felt vulnerable and exposed and sat there waiting for the sermon of reproach. I knew what I'd done wrong and had no intention of defending myself." (Kachachi ,2010)

To sum up Rahma explores the dynamic relationship between memory and identity over several generations within the context of the work. This phenomenon highlights the challenges faced by immigrant communities in preserving their cultural heritage while also adjusting to unfamiliar environments. The contrasting viewpoints of Rahma and Zeina exemplify the intergenerational disparities among diaspora communities, hence raising crucial questions pertaining to cultural heritage and individual identity within a context of globalisation.

Conclusion

Innam Kachachi's novel 'The American Granddaughter' masterfully weaves together themes of memory and social identity to show how much the past can affect one's sense of who they are and their place in the world. Memory impacts and shapes one's sense of self in a wide variety of ways, as demonstrated by research into diaspora, transgenerational memory, narrative reconstruction, heritage preservation, and emotional connectedness. There is a rising trend in contemporary literature to probe the entangled nature of personal history and identity. Kachachi's writings in this regard are an expressive testimony to the lasting power of memory in defining the richness of the human experience.

References

Al-Ali, N. (2007). *Talk: Iraqi Women-Untold Stories from 1948 to the Present*.

Assmann, J. (2011). *Communicative and cultural memory. In Cultural memories: The geographical point of view* (pp. 15-27). Dordrecht: Springer Netherlands.

Barclay, K., & Koefoed, N. J. (2021). *Family, memory, and identity: An introduction*. Journal of Family History, 46(1), 3-12.

Boym, S. (2008). *The future of nostalgia*. Basic books.

Bucerius, S. M., Thompson, S. K., & Dunford, D. T. (2022). *Collective Memory and Collective Forgetting: A Comparative Analysis of Second-Generation Somali and Tamil Immigrants and Their Stance on Homeland Politics and Conflict*. Qualitative Sociology, 45(4), 533-556.

Esposito, E. (2008). *Social forgetting: A systems-theory approach. Cultural memory studies: An international and interdisciplinary Handbook*, 8, 181.

Fivush, R., & Graci, M. (2017). *Memory and social identity*. The Routledge handbook of philosophy of memory, 268-280.

Haimed, S., & Pradhan, V. (2023). *A disoriented homecoming: the scattered identity in Inaam Kachachi's The American Granddaughter.* Journal of Translation and Language Studies, 4(2), 79-85.

Kachachi, I. (2010). *The American Granddaughter*. Simon and Schuster.

Kadhum, O. (2021). *Iraqi diaspora mobilization and the future development of Iraq*.

Olick, J. K., Vinitzky-Seroussi, V., & Levy, D. (Eds.). (2011). *The collective memory reader*. Oxford University Press.

Saleh, Z. (2015). *Learning from the Diaspora: Toward an Anthropology of Iraqi Exile*.

Tajfel, H., Turner, J. C., Austin, W. G., & Worchel, S. (1979). *An integrative theory of intergroup conflict. Organizational identity*: A reader, 56(65), 9780203505984-16.

Zeng, Y., & Xu, R. (2021). *An exploration of the relationships between nostalgia, involvement, and behavioral intention in diaspora tourism*. Sustainability, 13(21), 12273.

IMPACT OF SILICON VALLEY BANK COLLAPSE ON INDIAN STOCK MARKET - AN EVENT STUDY WITH REFERENCE TO NSE NIFTY 50 INDEX

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Abstract

After the 2008 financial crisis, the number of bank failures in the United States considerably rose. The most bank failures since the savings and loan crisis in the 1980s and early 1990s occurred in 2010, when 157 banks failed. A bank run, one of the oldest problems in banking, caused Silicon Valley Bank to fail on March 10 2023, causing the financial institution best known for its relationships with high-flying tech start-ups and venture capital firms to collapse. Since Washington Mutual failed at the height of the financial crisis more than ten years prior, its fall is the largest financial institution failure in the US. This study intends to reveal the effect and severity of the crisis of Silicon Valley Bank on Indian stock market by considering Nifty 50. Since the crises of US is reflected in the Indian stock market in the past and most of the investors believe that Indian stock market follow the trend in US market, this study tries to show the same empirically by using event research methodology, which examines the changes in Index prices to indicate how the event affected the market returns beyond expectations, has been used to clarify the impact of the collapse of Silicon Valley Bank. The pre-event and post-event periods of 10 days each were used to conduct the event study. The collapse of Silicon Valley Bank had an influence on the NSE Nifty 50 Index of the Indian stock market, producing atypical returns that are negative and indicative of the event's negative consequences on the Indian Stock Market.

Keywords: Event Study, NSE Nifty 50 Index, Silicon Valley Bank Collapse, Abnormal Returns.

Introduction

In a crisis that occurred between March 8 and March 10, 2023, over the course of just a few hours it had a significant impact on both the US and other global financial systems, Silicon Valley Bank (SVB), an iconic institution serving the technology sector in the innovation hub for which it was named, collapsed.(Ciuriak, 2023)

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The number of bank failures in the United States increased significantly after the 2008 financial crisis. The number of bank failures in 2010 was 157, the most since the savings and loan crisis in the 1980s and early 1990s. Nonetheless, since that time, there has been fewer bank collapses on a consistent basis. The regulatory changes made following the financial crisis, which attempted to strengthen the banking industry and avert failure in the future, might have been one factor contributing to this reduction. For instance, the Dodd-Frank Wall Street Reform and Consumer Protection Act added additional laws to raise the capital and liquidity demands on banks as well as to improve risk management procedures. By strengthening the banking industry's stability and resilience, these steps have decreased the chance of bank collapses. (Vo & Le, 2023)

The failure of Silicon Valley Bank (SVB) in March 2023 shook the world's financial markets. The SVB disaster resembled a traditional bank run in many ways, with elements that seem more appropriate for the 19th than the 21st century. The usual tools of the Federal Reserve and FDIC were unable to preserve SVB since its deposit base was more than 90% uninsured and its balance sheet had been severely harmed by a combination of bad luck and bad strategy. As a result, the FDIC was compelled to undertake the rare action of a takeover during regular business hours, with many elements of this resolution not being made public until the following weekend. These incidents marked the start of a string of bank interventions that have continued to this day on both sides of the Atlantic. (Metrick & Schmelzing, 2023)

Start-ups, private equity, venture capital, and well-established technology enterprises are among SVB's clients. The bank provides a variety of financial services, including standard banking services like loans and deposit accounts as well as more specialized ones like venture debt, project finance, and mergers and acquisitions advice services. Understanding the demands of the tech business is one of SVB's strongest suits. (Ali, Aysan, Yousef, et al., 2023)

This study intends to reveal the effect and severity of the crisis of Silicon Valley Bank on Indian stock market by considering Nifty 50. Since the crises of US is reflected in the Indian stock market in the past and most of the investors believe

that Indian stock market follow the trend in US market, this study tries to show the same empirically.

Literature Review

(Ali, Aysan, & Associate, 2023)explained that the collapse of SVB as a result of a contemporary digital bank run raises significant concerns about the oversight of the Federal Reserve and the necessity of changing policies. By allowing regulators to intervene when necessary and enabling real-time monitoring, the implementation of CBDCs may be able to prevent market panic and bank failures. By ensuring investors, depositors, and borrowers that authorities are actively monitoring their banks and will act quickly in cases of turbulence and irregularities, CBDCs may help boost their confidence in banks, even small and mid-sized ones. Additionally, CBDCs have the potential to improve the implementation of monetary policy and advance financial stability. Therefore, in order to improve monetary policy and advance global economic growth, central banks should keep researching and developing CBDCs.

Vuillemey, (2023)According to this study's empirical findings, US banks that are more exposed to the core causes of the saving glut—such as the growth in the wealth share of the richest people or the rising savings of businesses that use intangibles—are likewise more vulnerable. Over the years, US banks have relied more on deposits overall, including uninsured deposits. While the percentage of uninsured deposits over total bank liabilities has been growing over the past 20 years, the economy as a whole is seeing its highest level of deposits-to-GDP since World War II (and likely an all-time high). I utilise the unanticipated failure of SVB in March 2023 as a quasi-natural experiment to determine causally how this "deposit glut" affects financial stability.

Kim & Franke, (2023)elucidated that the failure of Silicon Valley Bank serves as a warning about the necessity for further scholarly investigation of the complex practice of interest rate risk hedging. As market rates decline, bank clients will increasingly use swaps and forwards to lower interest rate risk on loans and mortgage originations, complicating the practice of hedging. Banks may use interest rate derivatives due to mismatched maturities on their balance sheets.

SVB did, however, highlight the need for further study into bank hedging strategies involving held-to-maturity and available-for-sale securities when market rates increase, particularly in institutions that face financing concerns like uninsured deposits.

(Hauf & Posth, 2023)The study found that there should be forward-looking regulations to provide regulatory monitoring and market discipline. Currently, despite the expanding regulatory reporting requirements, the regulator is constantly in "response mode," attempting to solve factors that have caused crises in the past but infrequently foreseeing brand-new problems. Even if the regulator deals with urgent issues like liquidity provision, lobbying pressure and improper or insufficient formulation may reduce the regulation's effectiveness. Furthermore, it is debatable whether installing peer-to-peer control mechanisms in banks would be advantageous given the collapse of SVB and the collateral harm incurred by other institutions. Despite its bad connotation, it could be a good idea to take into account the installation of anything akin to an institutionalised "whistle-blower"-process by the supervisory authorities for eligible institutions.

(Bales et al., 2023)The study analysed the interaction between media coverage and stock activity surrounding Silicon Valley Bank's default on March 10, 2023. The study showed that the public's attention significantly drove the crash dynamics and caused SVB's market excess returns to decline based on tweets and Google searches. Thus, this study highlights the value of social media for maintaining financial stability and offers concrete proof of media-driven bank runs. Since many Twitter users deleted their messages right after after the crash, the actual effects may be far more severe than anticipated. The attention measurement may therefore be too low for actual attention. Last but not least, it must be emphasised that the default resulted from an asset-liability mismatch brought on by poor risk management and the particular purpose.

(Pandey et al., 2023)The study found that the demise of SVB had a considerable impact on global, regional, and national stock markets using a complete ESM approach. Global markets experienced negative returns from the event day to

t+4, with established markets being more susceptible than emerging markets. The effect on the various regions varied, with the short-term returns in the Americas, Middle East, and Africa being significantly negative, while the impact on the European markets was felt over a longer period of time. Additionally, on t+3 and t+5, Asian markets saw two sizable positive returns. Additionally, the impact varied across nations, with some being more negatively impacted than others. This incident emphasises how crucial it is for the financial sector to have strict regulatory monitoring and risk management procedures.

(Azmi et al., 2023)The study presented three major findings. First off, all other assets do not respond to the event in any notable way, with the exception of Gold and US T-Bills. Second, Gold's excellent performance on the event day demonstrates the safe-haven qualities of the metal. Additionally, the fact that US T-Bills react negatively to the event suggests that fixed income government securities were viewed as risky around the time of the event. Third, according to CARs of specific asset classes, US T-Bills experienced negative reaction not just on the event day but also on post-event days (t+1 to t+5). This implies that the US T-Bills were still viewed as a risky occurrence after the incident. This is an intriguing discovery because people often consider government securities to be safe havens during times of financial instability.

Ivanov, (2014)In comparison to Hollywood banks, we find that Silicon Valley banks had consistently better ROE over the course of the study period, which includes two periods during and after the recession. Hollywood banks, on the other hand, only had higher ROA in the latter two quarters of the studied period. Banks in Silicon Valley routinely have greater ROA. Additionally, we discover that the amount of deposits, the leverage ratio, and the total amount of loan charge-offs all consistently affect how well banks perform. We contend that Silicon Valley banks' superior performance may be explained by the fact that they recognised their error before the Great Recession by accepting larger loan charge-offs earlier than Hollywood.

Danielsson et al., (2023)Rising interest rates rather than default was the threat SVB faced. It purchased its bonds during a period of prolonged, extremely low

interest rates. With the best of intentions to boost the economy and help the world recover from the 2008 financial crisis, the US Federal Reserve set these low interest rate levels. It wasn't the only one doing it. Global central banks, including those in the UK, followed suit. Unfortunately, the low interest rate strategy resulted in new categories of risk that the central banks did not fully recognise during the process. Companies gradually became dependent on the low borrowing rates as they adapted to them, which made them vulnerable to serious problems when the rates rose.

Objective of the study

This study by taking NSE Nifty50 as a reference tries to understand and evaluate the impact of the collapse of Silicon Valley Bank on the Index to demonstrate the comprehensive movements of the index prices.

Research Methodology

Kumar et al., (2022)For elucidating the impact of the collapse of Silicon Valley Bank on Nifty index returns the event study methodology has been used this study analyses the change in the index prices which in turn will reflect how the event affected the market returns beyond expectations.

The event study is conducted by taking the pre-event period of 10 days from February 24th, 2023 to March 9th, 2023 prior to the event date of March 10th, 2023. The post-event period is also 10 days from March 11th, 2023 to March 24th, 2023. NSE Nifty 50 index is collected from the official website of the National Stock Exchange of India. A pre-event period is a period preceding the event date which is February 24th, 2023 in which we believe nothing of significance has occurred in the market and the performance is normal as a result of which we take that period as a base for comparison. The post-event period is the period in which we suspect the influence of the event. Event day or day 0 is a day in which a particular event took place here, the date on which the collapse of a Silicon Valley Bank took place.

Event Study Timeline:
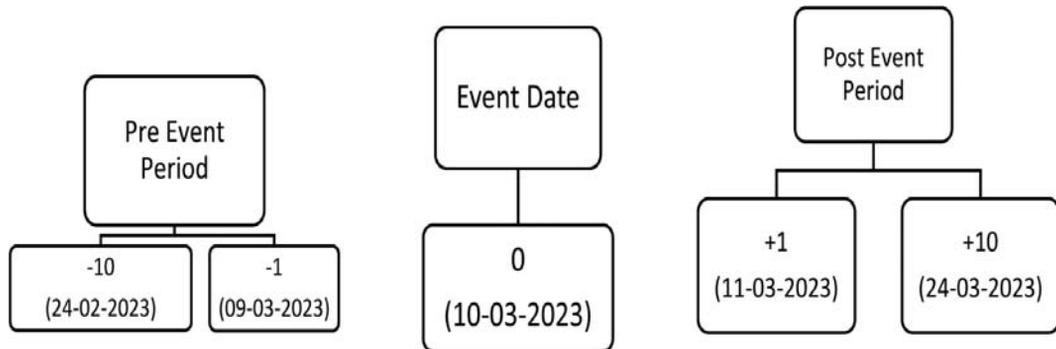
According to EMH,(Fama, 1970)it is not possible for any participant in the market, to outperform the market by earning abnormal returns as the stock prices quickly adjust to all the publicly available information. To empirically test the market efficiency, especially the semi-strong form of market efficiency during the event of Collapse of Silicon Valley Bank. Event study methodology is adopted by taking an event window of 20 days.

Calculation of Abnormal Returns:

The values in the Table 1 are calculated as follows:

1. % Daily Returns:

   $R_t = (P_t - P_{t-1}) * 100 / P_{t-1}$

   Where, P_t = Closing NSE Nifty 50 Indexvalue of the current day

   P_{t-1} = Closing NSE Nifty 50 Indexvalue of the previous day

2. % Average Abnormal Returns:

   AAR= Actual Return-Expected Returns *100/ Actual Return

   *Expected Returns is the average or mean returns of the 10 days prior to the study period, i.e.,24th February 2023 to 9th March 2023 Cumulative Average Abnormal Returns:

   CAAR is the summation of all the % AARs calculated to know the total abnormal returns made before and after the event. CAAR by giving a clear

picture of the cumulative abnormal returns, in case the influence is not completely reflected on the date of the event, acts as an effective tool of analysis in addition to the % AAR.

3. t-value:

Statistical significance of the test is empirically by applying t-test and the by calculating t-values.

i. t-value (AAR) = AAR/Standard Deviation of AAR

ii. t-value (CAAR) = CAAR/Standard Deviation of CAAR

The above values have been calculated by using MS Excel.

Hypothesis:

For the statistical test conducted the hypothesis are stated as specified below:

H_0: There is no significant difference between the Average Abnormal Returns before and after the Collapse of Silicon Valley Bank on NSE Nifty 50 Index.

H_1: There is a significant difference between the Average Abnormal Returns before and after the Collapse of Silicon Valley Bank on NSE Nifty 50 Index.

The hypothesis testing is done using paired sample T-test to understand if there is a significant difference between Average Abnormal Returns before and after the Collapse of Silicon Valley Bank on NSE Nifty 50 Index.

Data Analysis and Interpretation:

Table No 1. Shows the Average Daily Returns of NSE Nifty 50 Index In % along with the percentage Daily Average Abnormal Return, Cumulative average Abnormal Return, and also t-value calculated on AAR and CAAR on a day-to-day basis to check the significance of the event.

Table 1: Average Abnormal Return and Cumulative Average Abnormal Return for S&P BSE Metal Index.

DAY	%Daily Return (1)	% AAR (2)	CAAR (3)	t-value (ARR) (4 i)	t-value (CAAR) (4 ii)
+10	0.200168	-9.90768	181.801	-0.11106	1.413069
+9	-0.23989	191.7087	263.2148	2.149046	2.045868
+8	0.772096	71.50613	121.1939	0.801581	0.941994
+7	0.437269	49.68772	234.4531	0.556997	1.822314
+6	-0.25954	184.7654	316.146	2.071212	2.457282
+5	-0.70107	131.3806	197.6859	1.472771	1.536537
+4	0.652922	66.30532	198.9555	0.74328	1.546405
+3	-0.67381	132.6502	510.2527	1.487003	3.965999
+2	-0.07925	377.6025	424.9036	4.232907	3.302613
+1	0.417466	47.3011	47.3011	0.530243	0.367653
0	0.647068	66.00048		0.739862	
-1	-0.77	128.5714	282.2299	1.44128	2.193665
-2	-0.41	153.6585	345.3252	1.722505	2.68408
-3	-0.24	191.6667	325	2.148575	2.5261
-4	-0.66	133.3333	328.9855	1.49466	2.557078
-5	-0.23	195.6522	383.6522	2.193252	2.981982
-6	-0.25	188	372.6154	2.107472	2.896197
-7	-0.26	184.6154	529.0598	2.06953	4.112179
-8	-0.09	344.4444	511.1111	3.861206	3.972671
-9	-0.33	166.6667	320.3252	1.868326	2.489765
-10	-0.41	153.6585	153.6585	1.722505	1.194329

The aforementioned table displays the NSE Nifty 50 index average daily returns in percent along with the cumulative average abnormal return (CAAR) and daily AAR and CAAR t-values, which are used to determine the significance of an event. The idea behind calculating abnormal returns is that there shouldn't be any post-event abnormal returns if the event had no influence. The influence of the incident, though, may occasionally show up in the prices a few days later. In these circumstances, cumulative average abnormal return is a statistically significant indication. Results of statistical analysis to determine the effect of the collapse of a Silicon Valley Bank.

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Preevent-	249.5908	10	137.75339	43.56145
Post event	355.1963	10	107.75741	34.07589

Paired Samples Correlations

	N	Correlation	Sig.
Pre-event &Post event	10	.573	.083

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Preevent-Post event	-105.60552	116.50067	36.84075	-188.94508	-22.26596	-2.867	9	.019

The paired sample T-test is used to test the null hypothesis, which states that there is no discernible difference between the average abnormal returns on the NSE Nifty 50 Index before and after Silicon Valley Bank collapsed. The t value for this test is.019, meaning that the null hypothesis is rejected at the 5% level of significance. This suggests that the failure of Silicon Valley Bank had an effect on the NSE Nifty 50 Index, resulting in unusual returns that are statistically significant.

Chat 1: Shows AAR &CAAR NSE Nifty 50 Index during Pre & Post Event period
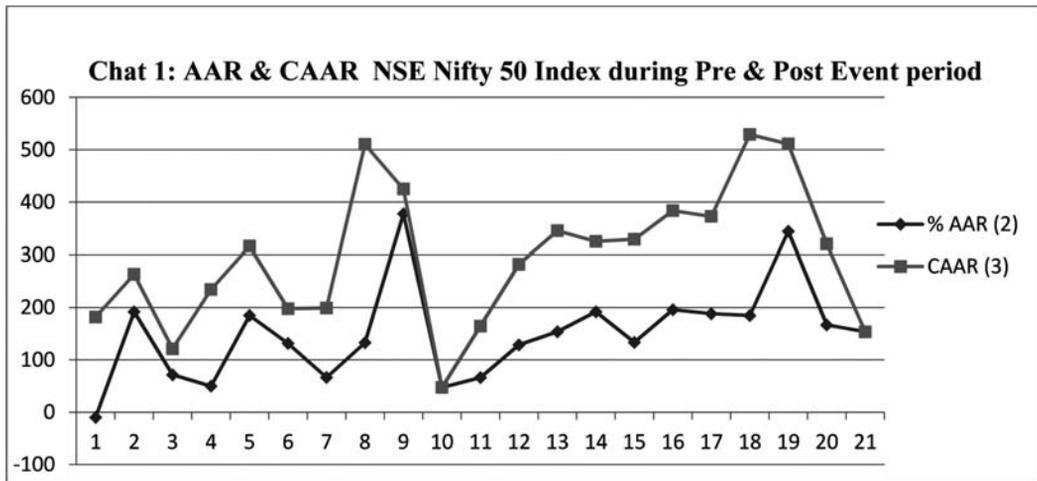
As mentioned earlier, CAAR is a helpful statistical analysis in addition to AAR because it aids in understanding the cumulative impact of abnormal returns, particularly if the influence of the event during the event window is not entirely reflected on the event date itself. The null hypothesis in this case is that CAAR is zero. At a 5% level of significance, the null hypothesis is rejected, indicating that CAAR is not equal to zero and that the collapse of Silicon Valley Bank had a statistically significant negative influence on the NSE Nifty 50 Index.

Conclusion:

Silicon Valley Bank (SVB) went under on March 10, 2023, following a bank run, making it the third-largest bank failure in American history and the biggest since the 2007–2008 financial crises. Along with Silver gate Bank and Signature Bank, it was one of three American banks that failed in March 2023.Start-up businesses in the United States and internationally suffered serious repercussions from SVB's demise, as many were temporarily unable to withdraw funds from the bank. Stock Market is an important indicator of how the economy is performing. Due to the Collapse of Silicon Valley Bank stock markets across the globe underwent serious downturns and the stock market of India is no exception. The NSE Nifty 50 saw a drastic decrease after the event of Collapse of Silicon Valley Bank which is quite evident from the decreasing AAR during the Post Event

period which is after the Collapse Of Silicon Valley Bank, the third largest bank of the US economy. The study also reveals that the Collapse of Silicon Valley Bank had a saying impact on the Indian Stock Market and the impact is statistically significant.

References

Ali, H., Aysan, A. F., & Associate, R. (2023). *From Tech Hub to Banking Failure: Exploring the Implications of CBDCs on the Destiny of Silicon Valley Bank Foundation Non-Resident Fellow Middle East Council on Global Affairs (ME Council) Tarik M. Yousef Middle East Council on Global Affairs (ME Council) Senior Fellow and Director*. https://ssrn.com/abstract=4411360

Ali, H., Aysan, A. F., Yousef, T. M., & Associate, R. (2023). *CC-BY 4.0 · Article*. https://doi.org/10.32388/DQGGO7

Azmi, W., Anwer, Z., Naeem, S., Nobanee, A. C.-H., & Azmi, S. N. (2023). *On the impact of Silicon Valley Bank failure: Evidence on the reaction of major global asset classes*. https://ssrn.com/abstract=4410761

Bales, S., Burghof, H.-P., & De (B.-H. (2023). *Public attention, sentiment and the default of Silicon Valley Bank*. https://nancialservices.house.gov/news/.

Ciuriak, D. (2023). *Policy Commentary The Silicon Valley Bank Failure: Historical Perspectives and Knock-on Risks The Silicon Valley Bank Failure: Historical Perspectives and Knock-on Risks*. https://ssrn.com/abstract=4392931

Danielsson, J., Macrae, R., & Tchouparov, N. (2023). *Lessons from the collapse of Silicon Valley Bank*. https://blogs.lse.ac.uk/businessreview/2023/03/15/lessons-from-the-collapse-of-silicon-valley-bank/1/8

Fama, E. F. (1970). American Finance Association Efficient Capital Markets: A Review of Theory and Empirical Work. In *Source: The Journal of Finance* (Vol. 25, Issue 2).

Hauf, P., & Posth, J.-A. (2023). *Silicon Valley Bank-(Why) did regulation and risk management fail to uncover substantial risks?*

Ivanov, S. I. (2014). *PERFORMANCE ANALYSIS OF BANKS HEADQUARTERED IN HOLLYWOOD VERSUS SILICON VALLEY* (Vol. 8). www.census.gov.

Kim, R., & Franke, W. A. (2023). *Interest Rate Hedging and Silicon Valley Bank Idiosyncrasies **. https://ssrn.com/abstract=4413099

Kumar, S. K., V, D. K., & Professor, A. (2022). *IMPACT OF RUSSIA UKRAINE WAR ON METAL INDEX-AN EVENT STUDY WITH REFERENCE TO S&P BSE METAL INDEX*.

Metrick, A., & Schmelzing, P. (2023). *The March 2023 bank interventions in long-run context-Silicon Valley Bank and beyond*. http://www.nber.org/papers/w31066

Pandey, D. K., Hassan, M. K., Kumari, V., & Hasan, R. (2023). *Repercussions of the Silicon Valley Bank collapse on global stock markets*. https://ssrn.com/abstract=4404745

Vo, L. Van, & Le, H. T. T. (2023). *From Hero to Zero-The Case of Silicon Valley Bank*.

Vuillemey, G. (2023). *From the Saving Glut to Financial Instability: Evidence from the Silicon Valley Bank Failure **. https://ssrn.com/abstract=4413287

ADAPTATION AND TRANSLATION OF PSYCHOLOGICAL INSTRUMENTS INTO KANNADA

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Abstract

Psychological instruments developed and standardised in English to assess the level of self-concept, emotional competence, psychological well-being, and identity orientation among adolescents does not allow for use with population that is linguistically different. Lack of culturally and contextually relevant psychologicalinstruments has prompted the researchers to translate and adapt the existing Instrument in English language to Kannada to enable the assessment of the same constructs among Kannada speaking population.For the purpose of measuring the constructs of self-concept, psychological well-being, emotional competence, identity orientation of adolescents, the researchers undertook the task of adapting and translating Children's Self Concept Scale, Emotional Competence Scale, Psychological well-being scale, and Identity Orientation Scale into Kannada. Following the guidelines suggested by Brislin's Model of back translation of cross-cultural research and Campbell's techniques to overcome problems of translation, the procedures of one way translation, translation by committee, back translation was carried out. Methodological study design was adopted to achieve content, semantic and conceptual equivalence. Data was collected from a sample of 204 adolescents in the age group of 14 to 20 years to establish the reliability and validity of the tools in the source language and the target language. The obtained Cronbach alpha values of 0.874 for Children's Self Concept Scale, 0.884 Emotional Competency Scale,0.893 for psychological wellbeing scale and 0.930 for identity orientation scale indicates very good internal consistency. By correlating items of the scales with total scores as suggested by Kerlinger validity is established.

Keywords: translation, reliability, validity, Kannada, psychological instruments

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Introduction

Psychologists are developing hundreds of Psychological Tests everyday all over the world to measure and compare the human behaviour and draw conclusions about behavioural aspects of the individuals. According to Kaplan and Saccuzzo(2018), "a testis a measurement device or technique used to quantify behavior or aid in the understanding and prediction of behavior" and " a psychological testor educational test is a set of items that are designed to measure characteristics of human beings that pertain to behavior".

Though most of the tests measure the observable behaviour, covert behaviour like thoughts and feelings can also be assessed using certain standardised psychological tests. Some tests may measure the present behaviour where as some help us to predict the occurrence of future behaviour (Kaplan and Saccuzzo, 2018).

There are numerous standardised tests available that measure diverse attributes or constructs in the individuals and such tests can be distinguished from one another depending on the purpose and classified under different categories as achievement, aptitude, intelligence, personality tests, etc. Some of the psychological tests can be administered to the group of individuals where as some can be used only with a single individual at a time(Miller, et al., 2016).

Psychological tests are used by psychologists as well as by other professionals in order to make decisions in the educational, health, corporate and clinical setting about people of different age groupsacross countries and cultures.(Miller, et al., 2016). Such tests are developed in several languages and validated to provide valuable information thatfacilitate comparisons across groups of respondentson certain attributes systematically.

Though initially standardised psychological tests were developed and validated among Western population, today they have been expanded all over the world. Since developing and validating a standardised tools is complex,laborious,time consuming process and involves huge cost, translating and adapting the existing standardised psychological instruments into culturally relevant and appropriate tools,is a better option available to the professionals.

Cross-cultural adaptation of existing psychological scales helps us to assess people in their own cultural context and establishing psychometric properties for

such tools permits us to compare different cultural populations on same construct or attribute.

The ITC Guidelines for Translating and Adapting Tests were published by van de Vijver and Hambleton (1996), Hambleton (2003), and Hambleton, Merenda and Spielberger (2005). Though many advances have been made, such as new paradigms for test adaptations, and new methodologies are suggested, there is no complete consensus among the experts in the field about the definite steps involved in the cross-cultural adaptation of tools. The different authors have suggested different methods and techniques for translation and adaptation of cross cultural test(Brislin 1970;Campbell, 1970;) and combination of methods are adopted for the translation and adaptation of psychological tools in the present research.

The aim of the present research is to translate and adapt four psychological tools into Kannada, a south Indian language viz., the Childrens Self Concept Scale, Emotional Competence Scale, Psychological wellbeing scale and Aspects of Identity questionnaire. Thus the present research has the following objectives:

1. To translate and adapt the standardized psychological scales - Children's Self Concept Scale, Emotional Competence Scale, Psychological Well-being Scale and Identity Orientation Questionnaire- into Kannada

2. To verify the meaning, relevance and appropriateness of items in the translated questionnaires.

3. To establish the reliability of the scales – internal consistency of the questionnaires

4. To establish the validity of the translated tools

Method:

A quantitative approach is followed and Methodological study design is adopted.For the purpose of translation four standardised psychological tools are selected.

Tools:

●   Children's Self-concept Scale by Ahluwalia & Singh (2001). It contains 80 items and measure self-concept in six areas such as behavior, intellectual and school status, physical appearance and attributes, anxiety, popularity,

happiness and satisfaction. The test -retest reliability of 0.88 and spilt half reliability of 0.74 and 0.79 with male and female participants respectively have been derived for the original tool .The concurrent validity determined by finding intercorrelations among the subscales of the test ranges from 0.384 to 0.621.

- Emotional competence scale by Bharadwaj & Sharma revised (2007) contains 30 items and measure five emotional competencies such as depth of feeling, adequate expression and control of emotions, ability to function with emotions, ability to cope with problem of emotions and enhancement of positive emotions separately as well as a whole. The coefficient of reliability derived by test retest method ranges from 0.71 to 0.90 for different dimensions and total score. The validity determined by correlating with Factor A and C of 16 PF questionnaire is found to be 0.64 and 0.69 respectively.

- Aspects of identity questionnaire by Cheek & Briggs (2013) is a 35 item questionnaire which measures four identity orientations like personal identity, relational identity, social identity and collective identity. The internal consistency of the subscales of tool varies between 0.72 and 0.94. The intercorrelations among subscales of the questionnaires rangefrom 0.1 to 0.45.

- Psychological well- being scale by Sisodia & Choudhary (2012). It is a 50-item scale which measures five areas such as satisfaction, efficiency, sociability, mental health and interpersonal relation. The testclaims to have the internal consistency value of 0.90 and coefficientof 0.94 for validity.

Participants:

- A sample of 31 bilinguals (10 males and 21 females), in the age range of 14 to 55 years were selected using convenient sampling method and both English and Kannada questionnaires were administered to them.

- For the purpose of establishing reliability of the tool, using convenient sampling method a sample of 100 adolescents (55 boys and 45 girls) , aged between 13 to 17 years , was selected and 104 were selected for establishing the concurrent validity of the tools.

Procedure:

The present research has adopted methodological study design to translate and validate the psychological tools. Following the guidelines suggested by Campbell

et. al (1970) for translation and adaptation of the culturally appropriate tests and Brislin's model of back translation for cross cultural research,   combination of methods wereused for the purpose of translation and adaptationof the standardized questionnaires . These methods are explained in the sequence below.
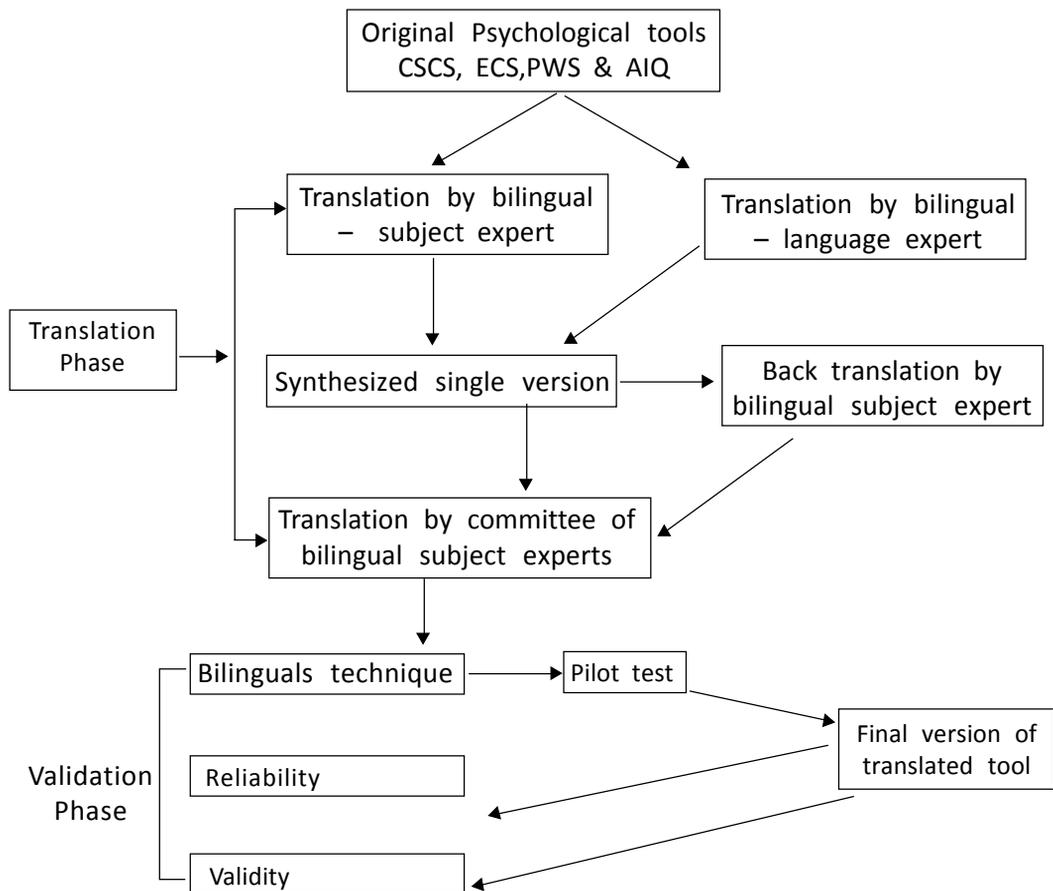
1. Translation steps

a. Independent translation of four psychological tools from source language into target language was done by twobilinguals, one being the subject expert and other being the language expert.

b. A single version of the translated tools are createdby synthesizing the two independently translated tools considering the semantic, conceptual , linguistic and contextual factors.

c. Back Translation : The translated version of the tools are translated back into source language from the target language using decentering method in order to identify the inconsistencies in expression, conceptual error in final version and words that are not clear.

d. Committee approach : Using the synthesized translated tools and back translated versions of psychological tools,   the committee of three members who are bilingualsubject experts modified and corrected the items to have semantic, conceptual, linguistic equivalence between questionnaires in source and target language.

e. Bilinguals' technique: the finalized tools by the experts committee is administered to a group of 31 bilinguals aged between 14 to 55 years to identify the discrepancies in the responses. The translated tools along with the original English tools were administered to 31 bilinguals, 15 of them had responded to English tools first followed by Kannada tools within the gap of 7 to 15 days and another 16 were asked to respond to Kannada tools first followed by English tools. Statistical analysis of the responses in target and source language is done using Pearson Product Moment correlation method.

f. Pilot test : in order to test the appropriateness of items with regard to meaning and difficulty of the items, the translated tools were administered to a small group of adolescents who were either   bilinguals i.e. had the

knowledge of both Kannada and English or those who knew only Kannada. Thus, the final version of the translated tool was developed.

2. **Reliability:** after the process of translation, the translated scales' reliability was established using internal consistency method .

3. **Validity:** concurrent validity of the translated scales was established by correlating the total and dimension score on the scales as suggested by Kerlinger

The figure 1.1 below shows the methodology outline of translation and validation of the tools from source language to target language.

```
                    ┌──────────────────────────┐
                    │ Original Psychological tools │
                    │   CSCS, ECS,PWS & AIQ     │
                    └──────────────────────────┘
                        ↙              ↘
        ┌──────────────────────┐   ┌──────────────────────┐
        │ Translation by bilingual │   │ Translation by bilingual │
        │  – subject expert      │   │  – language expert     │
        └──────────────────────┘   └──────────────────────┘
                    │                      ↙
  ┌────────────┐    ↓
  │ Translation │  ┌──────────────────────┐   ┌──────────────────────┐
  │   Phase    │→ │ Synthesized single version │→ │ Back translation by    │
  └────────────┘  └──────────────────────┘   │ bilingual subject expert │
                        │                      └──────────────────────┘
                        ↓                          ↙
            ┌──────────────────────────┐
            │ Translation by committee of │
            │   bilingual subject experts │
            └──────────────────────────┘
                        │
                        ↓
        ┌──────────────────┐    ┌──────────┐
        │ Bilinguals technique │→ │ Pilot test │
        └──────────────────┘    └──────────┘
                                      ↘  ┌──────────────────┐
  ┌────────────┐                         │ Final version of   │
  │ Validation │  ┌──────────────┐       │ translated tool    │
  │   Phase    │  │ Reliability   │←──────└──────────────────┘
  └────────────┘  └──────────────┘
                  ┌──────────────┐←──────────┘
                  │ Validity      │
                  └──────────────┘
```

RESULTS AND DISCUSSION

The translation and adaptation of the tools from English to Kannada is done in two phases. In the translation phase, translated and back translated items of four psychological tools were verified by a committee of three experts and examined if the items had maintained conceptual, semantic equivalence in the target language compared to the tools in source language. Thus, following the four technique suggested by Brislin (1970) back-translation method, bilingual technique, committee approach and pretest procedure the equivalence between the original and translated measures was maintained. This is statistically indicated by the mean and SD of the tools both in English and Kannada versions of the tools in table 1 given below.

Table 1 showing the Total, Mean, SD for English and Kannada translated scores of Bilinguals

	PWB e	PWB K	EC e	EC K	CSCS e	CSCS K	AIQ e	AIQ K
TOTAL	6159	6206	3353	3319	1971	1978	4973	4930
MEAN	186.64	188.06	101.61	100.58	59.73	59.94	150.7	149.40
SD	24.06	21.72	13.76	14.13	10.03	9.74	27.80	24.90

In order to find out if the items of translated tools have semantic similarity, conceptual and functional equivalence compared to the items of original tools, correlation coefficient between the total scores of Kannada and English versions of toolswas calculated using Pearson Product moment correlation method. The obtained correlation in given in the table 2. The obtained correlation coefficient 0.944 for Psychological Wellbeing Scale, 0.972 for Emotional Competence Scale,0.934 for Childrens Self Concept Scale and .904 for Aspects of Identity Questionnaire are high and significant at 0.01 level of significance.

Table 2 showing the correlation coefficient between English and Kannada translated scores of Bilinguals

	PWK	ECK	CSCSK	AIQK
PW(e)	.944**			
EC e		.972**		
CSCS (e)			.934**	
AIQ (e)				.904**
N	31			

Note: **. Correlation is significant at the 0.01 level (two tailed).

Table 3 showing the Cronbach alpha for the translated scales (internal consistency reliability)

Name of test	Cronbach alpha	No. of items
Childrens' Self Concept Scale	.874	80 items
Emotional Competence Scale	. 884	30 items
Psychological Wellbeing scale	.893	50 items
Aspects of Identity Questionnaire	.930	45 items

If the translated tools are to be used, it is essential to provide evidence for the reliability and validity of such tools. Cronbach alpha was calculated to find out the internal consistency reliability of all the four translated Kannada tools. The Cronbach Alpha of 0.874 obtained for Children Self Concept scale with 80 items, .884 for Emotional Competence Scale with 30 items, 0.893 for Psychological Wellbeing Scale with 50 items and 0.930 for Aspects of Identity Questionnaire with 45 items as given in the table 3. The Cronbach alpha above 0.8 indicates high internal consistency among the items of the Translated tools.

The significant moderate to high range of correlations have been found between the dimensions and total scores of Emotional competence scales. The values range from 0.337 between Ability to Function with Emotions (AFE) and Ability to Enhance Positive Emotions (AEPE) to 0.852 between Ability to Cope with Problem Emotions (ACPE) and Total emotional competence scale, which are significant at 0.01 level of significance as shown in table 4.

Table 4 showing the correlation between dimensions and total score of emotional competence scale.

	ECAECE	ECAFE	ECACPE	ECAEPE	ECTOTAL
ECADF	.622**	.604**	.637**	.342**	.817**
ECAECE		.585**	.605**	.402**	.796**
ECAFE			.594**	.337**	.783**
ECACPE				.514**	.852**
ECAEPE					.684**

Note: ** Correlation is significant at the 0.01 level (two tailed).

The inter correlation values between the dimensions and total scores of Children Self Concept Scale (CSCS) are significant at 0.05 level of significance and range from 0.406 to 0.812 as given in table 5. The correlation coefficient between Behaviour dimension of Children Self Concept Scale (CSCSB) and Intellectual and school status dimension of Children Self Concept Scale (CSCI) is 0.406 whereas between Intellectual and school status dimension of Children Self Concept Scale (CSCI) and total score has been found to be 0.812, indicating the significant concurrent validity of items of translated tools. The intercorrelation between various elements of Self concept dimensions of original Children Self Concept Scale (CSCS) and with the total scores are also found to be within the range of 0.397 to 0.621.

Table 5 showing the correlation between dimensions and total score Children's Self Concept Scale

	CSCSI	CSCSAT	CSCSAN	CSCSP	CSCSH	total
CSCSB.	406**	.414**	.525**	.478**	.515**	.721**
CSCSI		.694**	.503**	.644**	.504**	.812**
CSCSAT			.507**	.555**	.563**	.789**
CSCSAN				.509**	.566**	.780**
CSCSP					.597**	.803**

**. ** *   **Correlation is significant at the 0.01 level (2-tailed).

Table 6 showing the correlation between dimensions and total score of Psychological Wellbeing scale

	PWBII	PWBIII	PWBIV	PWBV	TOTAL
PWBI	.607**	.439**	.501**	.444**	.761**
PWBII		.600**	.508**	.612**	.846**
PWBIII			.466**	.610**	.791 **
PWBIV				.413**	.728**
PWBV					.798**

**. Correlation is significant at the 0.01 level (2-tailed).

The scores of different dimensions and total of Psychological Wellbeing Scale were inter correlated in order to ascertain the concurrent validity of the scale are given in table 6. The values range from 0.413 to 0.846 which are found to be significant at 0.01 level of confidence indicating moderate to high level of significant relationship among the dimensions and overall scores of Psychological Wellbeing Scale. The original tool claims to have validity coefficient of 0.94.

Table 7 showing the correlation between dimensions and total score of Aspects of Identity questionnaire

	AIQRI	AIQSI	AIQCI
AIQPI	.661**	.583**	.619**
AIQRI		.519**	.577**
AIQSI			.661**

**. Correlation is significant at the 0.01 level (2-tailed).

The significant moderate level of correlation coefficient values have been found at 0.01 level of significance among the different identity orientations of Aspects of Identity Questionnaire that range from 0.519 to 0.661. The inter correlation between the different identity orientations as shown in table 7 indicate the concurrent validity of the tool.

Conclusions

- Items of the translated questionnaires are relevant, appropriate and have semantic and conceptual equivalence

- The translated questionnaires have high internal consistency making it reliable tools

- The concurrent validity of the tools ranges from moderate to high level and it is significant at 0.01 level of significance. Thus the translated tools are valid.

Limitations & Future recommendations

- Exploratory factor analysis and confirmatory factor analysis can be further performed to enhance the psychometric properties of the tools

- Additional measures of reliability like test-retest reliability can be performed as only internal consistency of the tools is established.

- Since only concurrent validity has been found for the tools, other types of validity can also be established.

References

Ahluwalia, S. P. (2001). Manual for children's self concept scale. National Psychological corporation, Kacheri Ghat, Agra.

Borsa, J. C., Damasio, B. F., & Bandeira, D. R. (2012). Cross-Cultural Adaptation and Validation of Psychological Instruments: Some Considerations. *Paidéia*, *Vol 22*(53). https://doi.org/10.1590/1982-43272253201314

Brislin. R. W. (1970), Back Translation for cultural research, Journal of Cross Cultural Psychology, 1(2) 1.85-216.

Campbell, D.T. & Werner, O., (1970). Translating, working through interpreters, and the problem of decentering. *In A hand book of cultural anthropology, edited by Naroll, R., Cohen, R., 398-419.*

Cha E. S, Kim H.K & Erlen A. J (2007). *Translation of scales in cross-cultural research: issues and techniques*, Journal of Advanced Nursing 58(4), 386–395,https://doi.org/10.1111/j.1365-2648.2007.04242.x

Cheek, J.M., & Briggs, S.R.(2013). Aspects of identity questionnaire (AIQ-IV). Measurement instrument Database for the Social Science. Retrieved from www.midss.ie.

Gregoire, J. (2018). ITC guidelines for translating and adapting tests (second edition). *International Journal of Testing, 18*(2), 101–134. https://doi.org/10.1080/15305058.2017.1398166

Hambleton, R. K., & De Jong, J. H. (2003). Advances in translating and adapting educational and psychological tests. *Language testing*, *20*(2), 127-134.https://www.researchgate.net/publication/249870059

Hambleton, R.K., Merenda, P.F., & Spielberger, C.D., (2005). Adapting educational and psychological tests for cross-cultural assessment. *72(4)* 649-651. http://10.1007/s11336-007-9014-3

Jones P S., Lee J. W., Philips L R., Zhang Z E., &Jaceldo K B (2001) Nursing Research, 50 (5)

Kaplan, R. M., &Saccuzzo, D. P. (2017). *Psychological Testing: Principles, Applications, and Issues,* (9th ed.). Cengage Learning.

Kim A & Lim E Y (2003). Effects of Different types of Practice in Cross Cultural Test adaptation of Affective Measures, Korean Journal of Psychology,22(1) , 89-113.

Maneesriwongul, W., & Dixon, J. K. (2004). Instrument translation process: a methods review. *Journal of Advanced Nursing ,48*(2), 175–186.

Miller, L. A., &Loveler, R. L. (2016). *Foundations of Psychological Testing, A Practical Approach* (5th ed.). Sage Publications.

Musa, R., Fadzil, M. A., & Zain, Z. (2007). Translation, validation and psychometric properties of Bahasa Malaysia version of the Depression Anxiety and Stress Scales (DASS). *ASEAN Journal of Psychiatry*, *8*(2), 82–89.

Sharma, H.C., & Bhardwaj, R.L (2007). Manual for the scale of Emotional Competence, Bal Niwas, Taj Basai Agra

Sidheek F. K.P., Satyanarayana, V. A., Sowmya, H.R., Chandra, P. S., (2017). Using the Kannada version of the Connor Davidson Resilience Scale to assess

resilience and its relationship with psychological distress among adolescent girls in Bangalore, India.*Asian Journal of Psychiatry*, https://doi.org/10.1016/ j.ajp.2017.10.015

Sisodia, D. S., & Choudhary, P. (2012). Manual for Psychological well-being scale. Agra: National Psychological Corporation

Thammaiah, S., Manchaiah, V., Easwar, V., Krishna ,& McPherson, B. (2016). Psychometric properties of the hearing handicap questionnaire: a Kannada (South-Indian) translation. *International Journal of Audiology*.http://dx.doi.org/ 10.1080/14992027.2016.1247500

Van de Vijver, F., & Hambleton, R. K. (1996). Translating tests. *European psychologist*, *1*(2), 89-99.

REVIEW ARTICLE ON HYPERGRAPHS

Dhanya D
Apoorva Shetty

Abstract

Hypergraph theory is a branch of Mathematics that extends the concept of Graph theory by allowing the hyperedges to connect more than two vertices. This review captures complex relationship in various fields including computer science, Genetics and social networks. This article explores fundamental concepts, properties and applications of hypergraph theory, emphasizing its role in addressing real world connectivity and relationship challenges.

Keywords: Hypergraphs, subhypergraph, vertices, edges, conformal, dual, Helly property.

Introduction

Graph theory is a branch of Mathematics that deals with the study of graphs, which are mathematical structures that model pair wise relations between objects. A graph consists of a set of vertices (nodes or points) and a set of edges that connect pairs of vertices [6]. It is an important area of contemporary Mathematics with numerous applications in diverse fields such as Computer Science, Genetics, Chemistry, Engineering, industry, business and in social sciences [7].

Hypergraphs are the system of finite sets and form the most general concept in discrete Mathematics. Hypergraph theory is an extension of Graphtheory, where sets are considered as generalized edges. Hypergraphs have applications in various areas, such as database design, VLSI circuit design, and machine learning. This theory emerged as a branch of Mathematics in the latter part of the 20th century due to the influence of Computer Science. It became an independent theory in the early 1960s and was developed by Claude Berge. Hypergraph theory has gained significant interest in recent decades due to its applications in solving real-world problems.

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This article aims to give a basic introduction to hypergraphs and its applications in various scientific fields including computer science, social sciences, operations research, and many more.

Definitions:[1]

A Hypergraph H = (V, E = (ei)$_{i \in I}$) is a pair (I is a finite set of indexes) where V is a finite set called vertex set, denoted by V (H) and E is the subset of V called hyperedges, denoted by E(H).

Let *H=(V, E =(ei)$_{i \in I}$)* be a hypergraph. A hypergraph *H'=(V', E')* is said to be a *subhypergraph* if V is a subset of V and each edge in E' exists in E, i.e., *V '⊆V* and *E' ⊆ E.* We denote it by, H' ⊆ H.

A *partial subhypergraph H' = (V, E')* is a subhypergraph that contain every vertex of the original graph *H = (V, E).*

A subhypergraph whose edge family consists of those edges in the original graph *H = (V, E)* that are completely between the vertices in *V'*, where *V'* is a subset of *V*, is called an *induced subhypergraph.*

For a hypergraph *H = (V, E),* the bipartite representation of *H* is defined as the bipartite graph *B(H) = (V, E; D)* whose vertex set is *V ∪ E* where, *V* and *E* are the left and right part respectively and *D* is the edge set. A vertex *v* ∈ *V* is adjacent to a vertex *v* ∈ *E* if and only if *v* is incident to edge *e in H.*

H
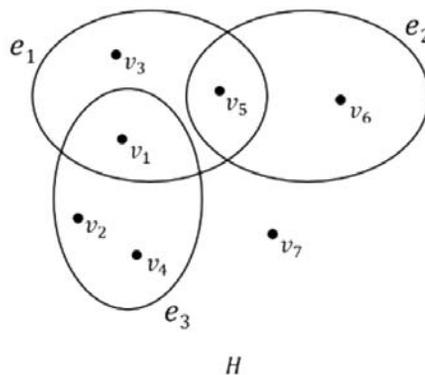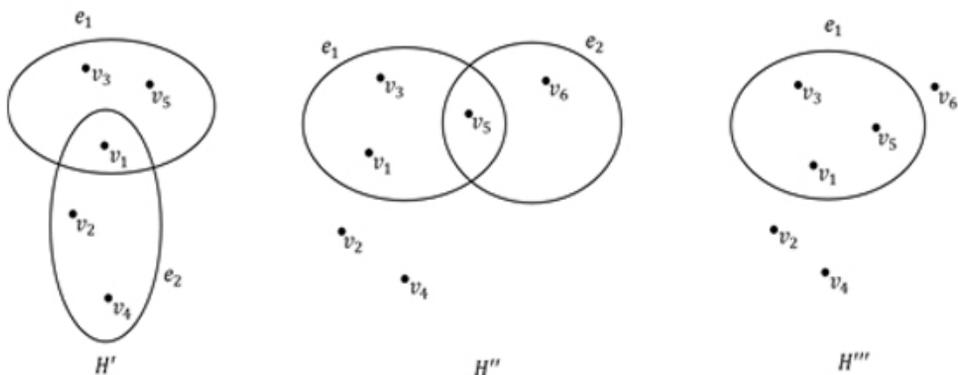
Fig 1: Hypergraph

Fig 2: The below figures are the subhypergraph ' , partial subhypergraph H" and induced subhypergraph H''' of the hypergraph H in the figure 1.
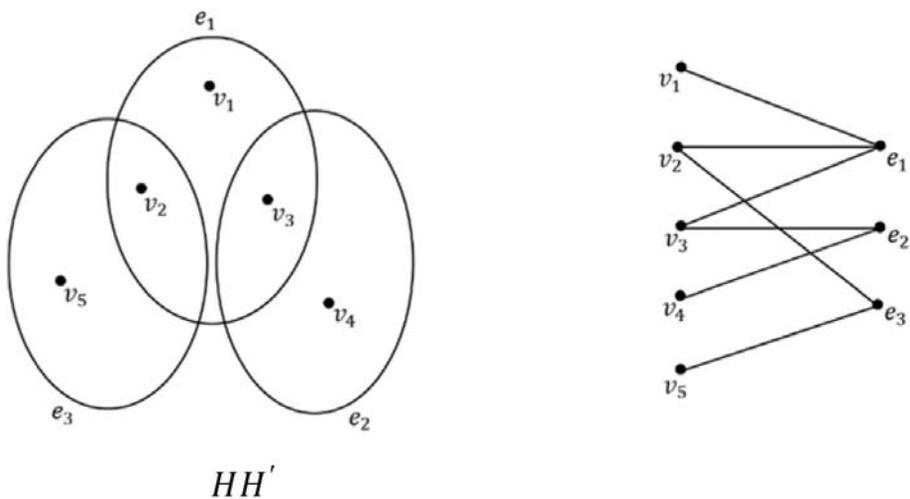
Fig 3: Hypergraph *H* and its bipartite representation *H'*

Path and connectedness: [1]

Let $H = (V,E)$ be a hypergraph without isolated vertex. A *path P* in H from x to y is a vertex-hyperedge alternative sequence,

i) $x = x_1, e_1, x_2, e_2, x_3, e_3, ..., x_s, e_s, x_{s+1} = y$

such that

i) $x_1, x_2, x_3, ..., x_s, x_{s+1}$ are distinct vertices with possibility that $x_1 = x_{s+1}$

ii) $e_1, e_2, e_3, ..., e_s$ are distinct hyperedges

iii) $x_i, x_{i+1} \in e_i (i = 1, 2, ..., s)$

If $x = x_1 = x_{s+1} = y$ then the path is called as a *cycle*. The integer S is the length of path P. If there is a path from x to y then there is a path from y to x too. In this case we say that P connects x to y. If the cycle's length is odd or even then it is referred as odd or even cycle respectively.

A hypergraph H is said to be *connected* if for any pair of vertices there is a path between them. Otherwise,the hypergraph is said to be *disconnected*.
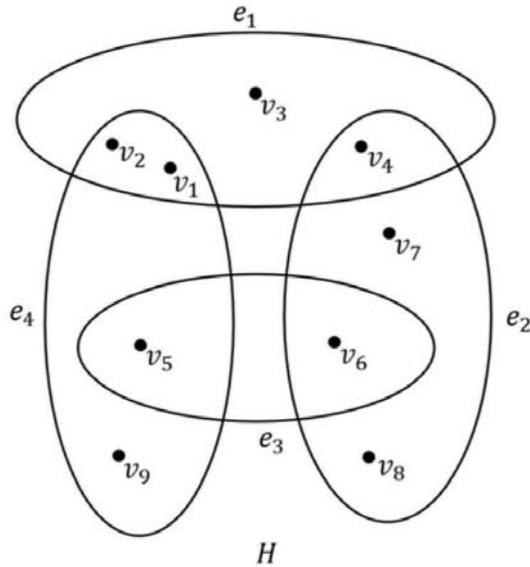
Fig 4: In the below hypergraph, P = $v_9, e_4, v_5, e_3, v_6, e_2, v_4, e_1, v_3$ is a path of length 4 and P' = $v_1, e_4, v_5, e_3, v_6, e_2, v_4, e_1, v_1$ is a cycle of length of 4.

Duality:[1]

Let $H = (V, E)$ be a hypergraph without isolated vertex. Let V = $\{x_1, x_2, x_3, \dots \dots, x_m\}$ and E = $\{e_1, e_2, e_3, \dots \dots, e_n\}$. A *dual H* = (V*,E*)* of a hypergraph H is a hypergraph obtained by interchanging vertices and edges, so that the vertices and edges are given by $V^* = E$ and $E^* = \{X_1, X_2, X_3, \dots \dots, X_m\}$, where, $X_j = \{e_i : x_j \in e_i\}$, $1 \le i \le n$, $1 \le j \le m$, respectively.

The dual of H can be written as $H^* = (V^* = E, E^* = (H(x))_{x \in V^*}$.
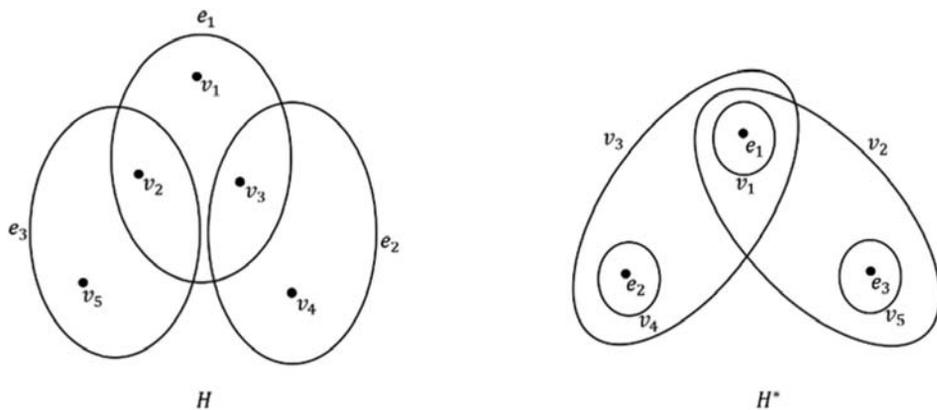
Fig 5: A hypergraph H and its dual $H*$

Some particular hypergraphs:

Balanced hypergraph:[8] If every odd cycle of length ≥ 3 has an edge that contains three vertices of the cycle then the hypergraph H is said to be *balanced* and if every cycle of length ≥ 3 has an edge that contains three vertices of the cycle then the hypergraph H is said to be *totally balanced*.
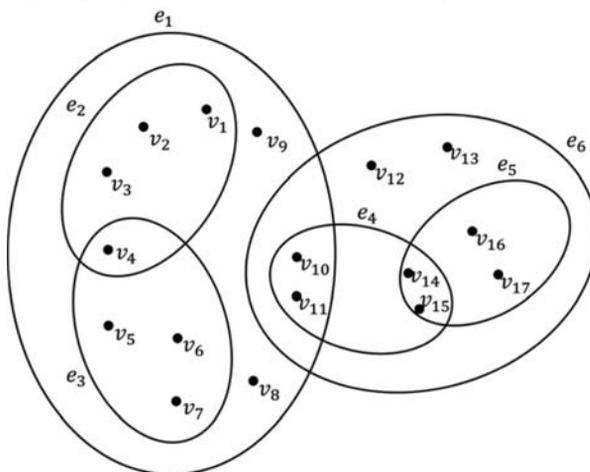
Fig 6: Balanced hypergraph

Theorem:[8] The dual of a totally balanced hypergraph is totally balanced.

Proof. Let H be a totally balanced hypergraph. To prove that the dual of H is totally balanced. Since H is totally balanced, then if an edge contains three

vertices of the cycle, it means that one vertex is contained in three vertices of the cycle. When we take the dual of H, cycles become the cycles of same length with one vertex contained in three edges of the cycle i.e., an edge containing three vertices of the cycle implies that the dual of H is totally balanced.

Unimodular hypergraph:

A m x n matrix A is said to be *totally unimodular* if the determinant of every square submatrix of A is equal to -1, 1 or 0 and if the incidence matrix of a hypergraph H = (V, E) is totally unimodular then the hypergraph H = (V, E) is called a *unimodular hypergraph.*
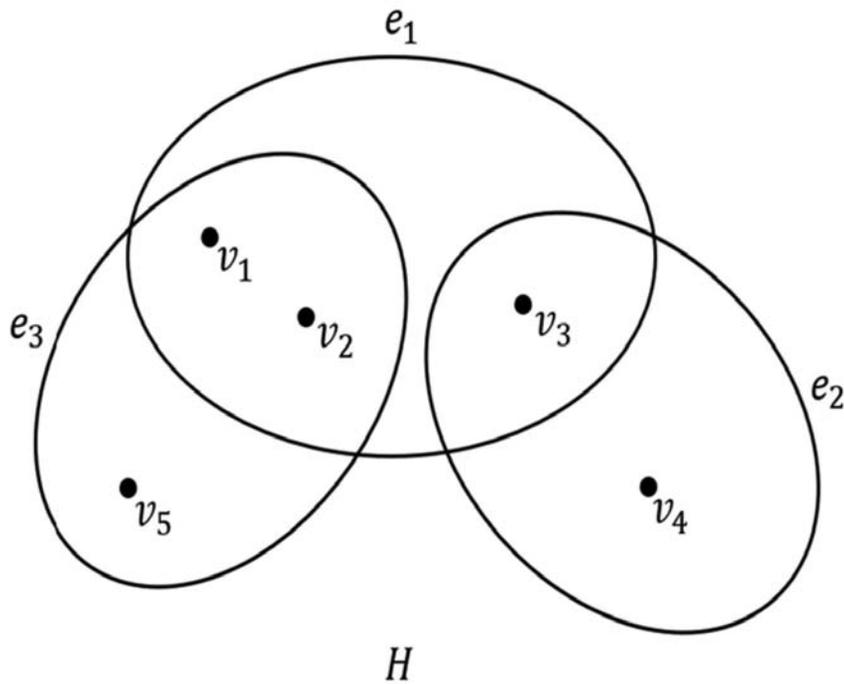
Fig 7: Unimodular hypergraph

Planar hypergraphs:

A hypergraph H = (V, E) is called a *planar hypergraph* if the bipartite representation of H defined as the bipartite graph B(H) is a planar graph.
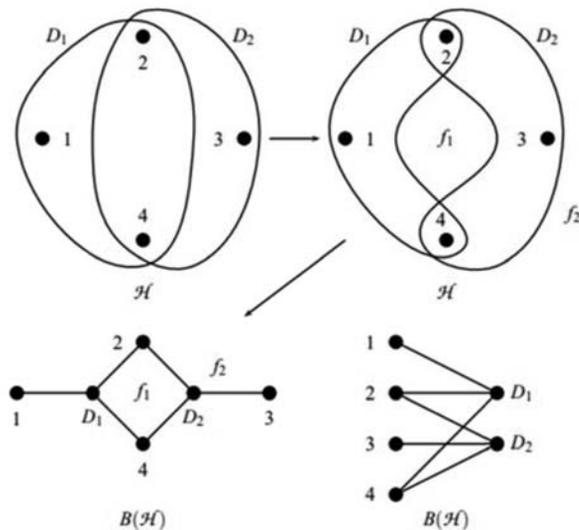
Fig 8: Planar hypergraph

Theorem: (Euler's formula) Let $H(V,E)$ be a planar hypergraph with n vertices and m edges embedded in the plane with f faces. Then

$$n - \sum_{i=1}^{m}(|E_i| - 1) + f = m - \sum_{j=1}^{n}(|E(x_j)| - 1) + f = 2$$

Proof. First, construct the planar embedding of the bipartite graph B(H). It has $n' = n + m$ vertices, $m' = \sum_{i=1}^{m}|E_i| = \sum_{j=1}^{n}|E(x_j)|$ edges and $f' = f$ faces. Since $B(H)$ is a planar graph, we get,

$$n' - m' + f' = 2$$

Substituting $n' = n + m$ and $m' = \sum_{i=1}^{m}|E_i|$ we get,

$$n + m - \sum_{i=1}^{m}|E_i| + f = 2$$

$$\Rightarrow n - \sum_{i=1}^{m}(|E_i| - 1) + f = 2$$

and taking $n' = n + m$ and $m' = \sum_{j=1}^{n}|E(x_j)|$ we get,

$$n + m - \sum_{j=1}^{n}|E(x_j)| + f = 2$$

$$\Rightarrow n - \sum_{j=1}^{n} (|E(x_j)| - 1) + f = 2$$

which is the required result.

Properties of Hypergraphs:

The 2- *section* of a hypergraph $H = (V, E)$ is a graph denoted by $[H]_2$ consisting of a vertex set V and edge set E' where $v_n v_m \in E'$ when v_n and v_m share an incident edge in the hypergraph.

Let $H = (V, E = (e_i)_{i \in I})$ be a hypergraph. A subfamily of hyperedges $(e_j)_{j \in J}$ where $J \subseteq I$ is an *intersecting family*[5] if every pair of hyperedges has a non-empty intersection.

A star H(x) centered in x is the family of hyperedge $(e_j)_{j \in J}$ containing x.

A hypergraph has *Helly Property*[5], if each intersecting family has nonempty intersection.

Conformal hypergraphs:

If any maximal clique of the 2 - section graph of a hypergraph H is a hyperedge in H, then that hypergraph is said to be *conformal*.

Proposition:[9] A hypergraph is conformal if and only if its dual has the Helly property.

Proof. Let $H = (V, E)$ be a hypergraph.

Assume that H is conformal. Let H* denote the dual hypergraph of H.

Let X = {X_1*, X_2*, ..., X_k*} be a maximal intersecting family of H*. Then it implies that

$X_i^* \cap X_j^* \neq \emptyset, \forall i \neq j; 1 \leq i,j \leq k.$. Hence there exists a hyperedge e in H such that the vertices v_i, v_j are contained in it. Thus, the intersecting family H denotes a collection of vertices in the maximal clique K_k of $[H]_2$. Since, H is conformal, this clique K_k is contained in the hyperedge e which corresponds to the vertex of H*. As a result, $e \in \cap X_j^*, \forall 1 \leq j \leq k$. Thus, X forms a star in H*. Therefore, we get the helly property in the dual of H.
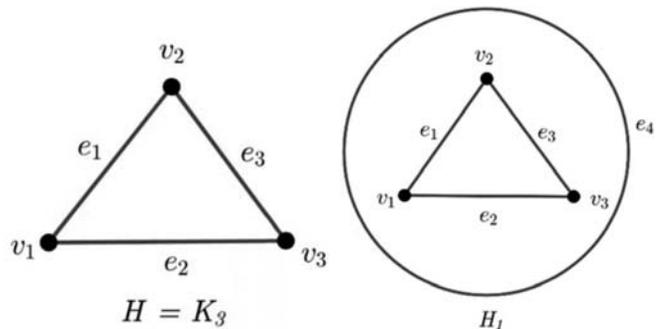
(a) not conformal, not helly   (b) conformal, not helly
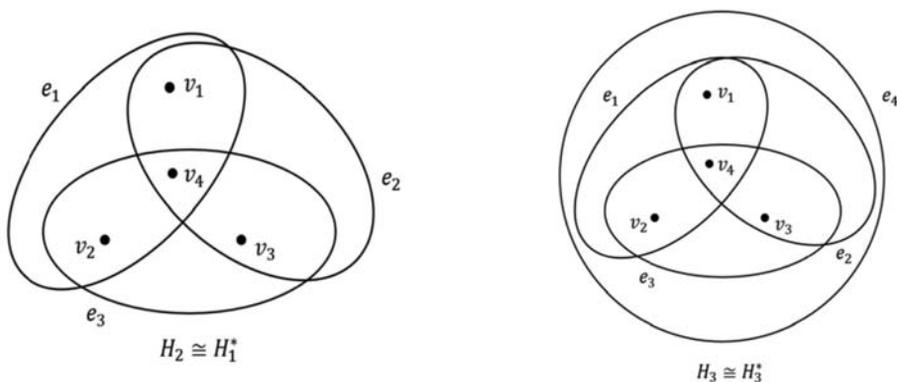
(c) Helly, not conformal(d) Helly, conformal

Fig 9: Conformality and Helly property

Conversely assume that H^* has the helly property.

Let K_k denote the maximal clique of $[H]_2$. Using the definition of 2- section $[H]_2$ of H, for all "v_i, $v_j \in K_k$, there exits a hyperedge containing these vertices. Since, H^* possesses the helly property, the set of vertices of the clique K_k stands for an intersecting family X of H^* is incorporated into a star, it follows that any element of X has vertex of H^* in common. But, this vertex of H^* is a hyperedge of H which contains any vertex of the clique K_k. So, H is conformal.

Lemma: [9]A hypergraph $H = (V, E)$ is conformal if and only if for any $Y \subseteq X$ inducing a clique in $[H]_2$ there is an edge $D \in E$ such that $Y \subseteq D$.

Proof. Let $H = (V, E)$ be a conformal hypergraph.

Let G = [H]$_2$. Let *Y* be any set of vertices of *X* such that G_y is a clique. Since, clique is a subgraph of atleast one maximal clique, there exists a set Z ⊆ X such that Y ⊆ X and G_z is a clique. Then, we get Z = D for some D ∈ E as *H* is conformal. Hence, $Y ⊆ D$.

Conversely assume that for any $Y ⊆ X$ inducing a clique in [H]$_2$ there is an edge $D ∈ E$ such that $Y ⊆ D$. In order to show *H=(V,E)* is conformal, we need to prove that the family *E'* of maximal edges of *H* and the family *C* of maximal cliques of *G* coincide, i.e.,. *E' = C*. First, we shall show that $E' ⊆ C$. Let ∈ E'. Then by the definition of *G* we note that all vertices of *E* are pairwise adjacent. Hence, G$_E$ is a clique and is contained in the maximal clique M∈ C. Therefore, we get. D ⊆ M. Now, by our assumption, for *M* there is an edge *E'* such that ⊆ D'. So we get, D ⊆ M ⊆ D'. But, both *D* and *D'* are maximal which implies that *D = M = D'* and D ∈ C. Consequently, we get, $E' ⊆ C$.

Now, we shall prove that ⊆ E'. Let *M ∈ C* be an arbitrary maximal clique in *G* and we note that the vertices of *M* are pairwise disjoint. By our assumption, there exists an edge *D' ∈ E'* with M ⊆ D. In succession, there exists an edge *D'E'* such that D ⊆ E'. Since vertices of *D'* are pairwise adjacent in *G*, there exists a maximal clique *M'* such that $D' ⊆ M'$. Since both *M* and *M'* are maximal, and ⊆ D' ⊆ M', it implies that *M = D = M'* and *M ∈ E'*. As a result, we get C ⊆ E'.

Hypertrees and chordal hypergraphs:[2]

If every hyperedge of a connected hypergraph *H* produces a connected subgraph in a connected graph *G*, then *G* is the *host graph* for that connected hypergraph. If there is a bijection between the connected components of *G* and of *H*, then G is a host graph for the unconnected hypergraph *H*, with each connected component *G'* of *G* serving as a host for the corresponding H'.

A hypergraph *H = (V, E)* is referred to as a *hypertree* if a host tree *T = (V, D)* exists and every edge *D ∈ E* induces a subtree in *T*.

Every cycle of length ≥ 4 in a hypergraph *H* is said to be *chordal* if it has two non-consecutive vertices being adjacent. We note that H is a chordal hypergraph if and only if its 2 - section

[H]$_2$ is a chordal graph.

If $V(x) \subseteq V(y)$, we say that the vertex x is *pendant* to a vertex y in the hypergraph $H = (V, E)$. Occasionally, hyper-pendant is used to describe pendant vertex.

The hype

rgraph with vertex set $V(G)$ and edge set is the family of vertex sets of maximal cliques in graph G is known as a *clique hypergraph.*

Applications of Hypergraphs:
Chemical Hypergraph Theory:

In chemistry, graph theory is quite helpful. Graphs are frequently used to model chemical structures in computational chemistry. But the main drawback of the graph theory is the lack of convenient tools to represent organometallic compounds, benzenoid systems and so on.

If $H = (V, E)$ denotes molecular structure, where $x \in V$ represents a single atom and hyperedge with degree 2 corresponds to simple covalent bonds while degrees greater than 2 corresponds to polycentric bonds.

Hypergraph Theory for Telecommunications:

It is possible to model cellular mobile communication systems using the hypergraph theory. In a cellular system, two cells can share a channel if their distance is at least a certain predetermined value D. This circumstance can be pictured by graph in which each vertex represent a cell and, a connection between two vertices is only present if the distance between the corresponding cells is shorter than a specific distance, known as the reuse distance and represented by the symbol D.

Hypergraph Theory and Parallel Data Structures:

Hypergraph offer a useful method for simulating parallel data structures. Several processors and memory modules make up a shared memory multiprocessor system. We define a template as a group of data pieces that must be processed concurrently. Hence the data components of a template should be stored in various memory modules. Thus we define a hypergraph where data is represented by a vertex and hyperedge are the templates.

Mathematics:

Natural numbers from 1 to 100 makes up the vertices. The subset of integers with a common divisor greater than 1 that is known as the hyperedges has a subset for each common divisor.

Genetics:

The edges are the subsets of elements representing genes,with one edge for each gene. The vertices are the elements (A,T,G and C) of a specific DNA sequence.

Sociology:

The edges represent subgroups of individuals that share some similar interests, one subset for each interest, while the vertices are employees in a corporation.

Healthcare:

The edges are subsets of illnesses that can be treated by specific medications, one hyperedge for each medication. The vertices are all illnesses.

Conclusion:

In this review, we explored various concepts that are associated with graphs and hypergraphs. While some of these concepts can be generalized in a straightforward and consistent manner, others exhibit similar behavior in hypergraphs as they do in graphs. One important property of hypergraphs is their ability to capture higher-order interactions between vertices, which cannot be represented by simple graphs. This allows us to analyze and understand complex relationships between entities in a more accurate and nuanced way. Overall, hypergraph theory and hypertrees offer a rich set of tools for understanding and modeling complex systems, and their applications are likely to continue growing in the future as researchers explore new ways to apply these powerful concepts.

References

Adler, I., Gottlob, G., Grohe, M. (2007). *Hypertree width and related hypergraph invariants*.

European Journal of Combinatorics, 28(8), 2167-2181.[1]

Berge, C. (1984). *Hypergraphs: combinatorics of finite sets* (Vol. 45). Elsevier.[2]

Berge, C. (1989). *Hypergraphs North Holland Mathematical Library*.[3]

Bollob ìas, B. (1998). *Modern graph theory* (Vol. 184). Springer Science and Business Media.[4]

Bretto, A. (2013). *Hypergraph theory. An introduction. MathematicalEngineering*. Cham: Springer.[5]

Bretto, A., Ub´eda, S. Zerovnik, J. (2002). *A polynomial algorithm for the strong Helly property*.

Information Processing Letters, 81(1), 55-57.[6]

Diestel, R. (2006). *Graph Theory*. Springer-Verlag Berlin Heidelberg.[7]

Harary, F. (2018). *Graph Theory*. Narosa Publishing House.[8]

Hodkinson, I., Otto, M. (2003). *Finite conformal hypergraph covers and Gaifman cliques in finite structures*. Bulletin of Symbolic Logic, 9(3), 387-405.[9]

Klamt, S., Haus, U. U., Theis, F. (2009). *Hypergraphs and cellular networks*. PLoS computational biology, 5(5), e1000385.[10]

Konstantinova, E. V., Skorobogatov, V. A. (2001). *Application of hypergraph theory in chemistry.*

Discrete Mathematics, 235(1-3), 365-383.[11]

Kratsch, D. (Ed.).(2005). *Graph-Theoretic Concepts in Computer Science: 31st International Workshop*, WG 2005, Metz, France, June 23-25, 2005, Revised Selected Papers (Vol. 3787). Springer[12]

Lehel, J. (1985). *A characterization of totally balanced hypergraphs*. Discrete mathematics, 57(1-2), 59-65.[13]

Slater, P. J. (1978). *A characterization of SOFT hypergraphs*. Canadian Mathematical Bulletin, 21(3), 335-337.[14]

Voloshin, V. I. (2009). *Introduction to graph and hypergraph theory*.[15]

Zhang, P., Chartrand, G. (2006). *Introduction to graph theory*. Tata McGraw-Hill.[16]

Zykov, A. A. (1974). *Hypergraphs*. Russian Mathematical Surveys, 29(6), 89.[17]

"FATHER OF THE GREEN REVOLUTION IN INDIA" - DR. M S SWAMINATHAN, A TRIBUTE

P P Sajimon

"Science and technology can play a vital role in solving the world's hunger problem. But we must use these technologies in a way that benefits all people, not just a few." (Swaminathan, M. S. (1982))

Abstract

In the archives of history, there are individuals whose contributions to society are so profound that they leave an indelible mark on the world. Dr. M. S. Swaminathan, often referred to as the "Father of the Green Revolution in India," is undeniably one of these remarkable figures. His life and work have been a source of inspiration for countless individuals, and his legacy continues to shine brightly in the realm of agriculture and food security. Dr. MS Swaminathan was a true visionary. He dedicated his life to improving the lives of farmers and ensuring food security for all. His work on the Green Revolution transformed India from a food-deficit country to a self-sufficient one. He was also a strong advocate for sustainable agriculture and rural development. Swaminathan's legacy is immense. He has inspired millions of people around the world to work towards a more just and equitable food system. He was a true champion of the poor and marginalized.

Keywords: *Green Revolution, sustainable agriculture, food security, marginalised farmers, HYVS, scientific agriculture.*

Introduction

Dr. Mankombu Sambasivan Swaminathan, popularly known as Dr. M. S. Swaminathan, is a distinguished scientist plant geneticist, administrator, agricultural leader and humanitarian whose contributions to humanity, particularly in the realm of agriculture and food security, have left an indelible mark. Born on August 7, 1925, in a small village in Tamil Nadu, India and died on September 28, 2023, in Chennai, Tamil Nadu, India. Dr. Swaminathan's journey began in humble surroundings. However, his voracious inquisitiveness, obstinate perseverance, and untiring obsession for agriculture propelled him on a path that would transform the lives of millions.

Dr P P Sajimon, Dean, PG Studies, St Aloysious College (Autonomous), Mangaluru.

Dr. M. S. Swaminathan was born into a family deeply rooted in academia and public service. His father, Dr. Sambasivan Swaminathan, was a well-respected surgeon, and his mother, Parvati Thangammal Swaminathan, was an ardent supporter of women's education. This familial backdrop instilled in him a strong sense of intellectual curiosity and a commitment to making a positive impact on society. Swaminathan's early education took place in the tranquil backdrop of rural Tamil Nadu. He attended local schools where he displayed an aptitude for academics from a young age. His teachers recognized his potential and encouraged his pursuit of knowledge. This early exposure to rural life and agriculture would later become the foundation for his lifelong dedication to improving farming practices and food security. After completing his schooling, Swaminathan pursued higher education in agricultural science. He enrolled at the College of Agriculture in Coimbatore, Tamil Nadu, where he studied agricultural sciences. This marked the beginning of his formal education in the field that would become his life's work.

He received his Bachelor's degree in Agriculture from the University of Madras in 1948 and his Ph.D. in Cytogenetics from the University of Cambridge in 1952. After returning to India in 1953, Swaminathan worked as a research scientist at the Indian Agricultural Research Institute (IARI). In 1966, he was appointed Director of the IARI Wheat Research Station in Pusa, Bihar. It was at Pusa that Swaminathan developed the high-yielding wheat variety Sonalika, which played a major role in the Green Revolution in India.Swaminathan was appointed Director General of IARI in 1972. He served in this position until 1979, during which time he oversaw the development and introduction of high-yielding varieties of rice, wheat, and other crops. He also played a key role in the establishment of the National Seed Corporation of India and the National Bank for Agriculture and Rural Development. In 1982, Swaminathan was appointed Director General of the International Rice Research Institute (IRRI) in the Philippines. He served in this position until 1988. At IRRI, Swaminathan led the development of new rice varieties that were resistant to pests and diseases. He also promoted sustainable rice production practices. After leaving IRRI, Swaminathan returned to India and founded the MS Swaminathan Research Foundation, a non-profit organization dedicated to promoting sustainable agriculture and rural development. He also served as a member of the Rajya Sabha, the upper house of the Indian Parliament, from 2007 to 2013. He received numerous awards and honors for his work on the Green Revolution and sustainable agriculture. He

was awarded the Ramon Magsaysay Award for Community Leadership in 1971, the World Food Prize in 1987, and the Padma Bhushan in 1967. Swaminathan passed away on 28 September 2023 at the age of 98. He is survived by his three daughters. He was a visionary leader who paved the way for a more sustainable and equitable food system.

1. The Green Revolution Pioneer

> "We need to move from a green revolution to an evergreen revolution. This means developing agricultural practices that are sustainable and equitable."(1987)

Dr. Swaminathan was greatly influenced by the teachings of Mahatma Gandhi, who advocated for self-reliance and the upliftment of rural India. Gandhi's philosophy of serving the poorest of the poor resonated deeply with Swaminathan and became a driving force behind his commitment to improving the lives of farmers. Before Dr. Swaminathan's active involvement, India faced severe agricultural challenges. The nation struggled with food shortages and a precarious food security situation. The inadequacy of traditional farming methods, coupled with a rapidly growing population, made the situation even more critical. His involvement in the Green Revolution began in the 1960s when he collaborated with other eminent scientists, most notably Dr. Norman Borlaug, an American agronomist. The Green Revolution aimed to address India's food crisis by introducing high-yielding crop varieties, improved agricultural practices, and modern technologies. He played a crucial role in testing and disseminating these high-yielding wheat and rice varieties, which were resistant to diseases and pests and could significantly increase crop yields. One of the landmark achievements of Dr. Swaminathan was the successful implementation of high-yielding wheat varieties in India. He was instrumental in promoting the adoption of Mexican dwarf wheat varieties, including Sonalika and Lerma Rojo, which proved to be highly productive. These varieties revolutionized wheat cultivation in India, leading to bumper harvests and eventually making the country self-sufficient in wheat production. He also made significant contributions to rice production. His collaboration with the International Rice Research Institute (IRRI) in the Philippines led to the development and promotion of high-yielding rice varieties, notably IR8, which had a remarkable impact on rice cultivation in India

and other parts of Asia. Beyond introducing new crop varieties, Dr. Swaminathan emphasized the importance of farmer-centric approaches. He recognized that small-scale farmers were at the heart of India's agricultural landscape and that their empowerment was essential for the success of the Green Revolution. His efforts included initiatives to provide farmers with improved seeds, access to credit, and agricultural education. The dramatic increase in crop yields not only ensured food security for the burgeoning population but also reduced the country's dependence on food imports. His work and leadership had a global impact, influencing agricultural practices in many countries facing similar challenges. He also served as the Director General of IRRI, where he continued to promote agricultural research and innovation on a global scale.

2. Agricultural Innovation and Research

"Agriculture is the only profession that creates its own raw material."(1998)

Dr. M. S. Swaminathan's contributions to agricultural innovation and research have had a profound and lasting impact on the field of agriculture. Throughout his distinguished career, he consistently pushed the boundaries of scientific knowledge to improve crop yields, promote sustainable farming practices, and address food security challenges. After completing his Ph.D. at the University of Cambridge, Dr. Swaminathan returned to India and joined the Indian Agricultural Research Institute (IARI) in Delhi. Here, he embarked on his journey of agricultural research, focusing on crop improvement and genetics. His early work laid the foundation for his later innovations. Dr. Swaminathan is best known for his pivotal role in the development and promotion of high-yielding crop varieties, particularly wheat and rice. Collaborating with scientists like Dr. Norman Borlaug, he worked on creating HYVs that were not only high-yielding but also disease-resistant and well-suited to modern farming practices. These new varieties played a crucial role in the Green Revolution, transforming India's agricultural landscape. Beyond wheat and rice, Dr. Swaminathan continued his research in various other crops. He promoted crop diversification to reduce the risk of monoculture and crop diseases. His research contributed to the development of numerous improved crop varieties, ensuring that farmers had access to a wide range of options for different agroclimatic conditions. In the later stages of his career, Dr. Swaminathan was at the forefront of biotechnology research in

agriculture. He recognized the potential of genetic modification to enhance crop traits and increase resistance to pests and diseases. His work paved the way for the development of genetically modified crops, which have played a vital role in global agriculture. Dr. Swaminathan's research also focused on promoting sustainable farming practices. He advocated for organic farming, conservation agriculture, and the responsible use of natural resources. His emphasis on sustainable agriculture helped protect the environment while ensuring long-term food security. Recognizing the challenges posed by climate change, Dr. Swaminathan's research explored strategies for climate-resilient agriculture. He emphasized the importance of drought-resistant and heat-tolerant crop varieties, as well as water-saving irrigation techniques. In addition to his research, Dr. Swaminathan played a significant role in educating and training the next generation of agricultural scientists. He worked on establishing agricultural extension services and training programs to disseminate knowledge and best practices to farmers across India. Dr. Swaminathan's impact extended beyond India. He collaborated with international organizations, research institutions, and governments to share knowledge and expertise in agricultural research. His collaborative efforts contributed to advancements in global food production and security. Dr. M. S. Swaminathan's tireless dedication to agricultural innovation and research earned him numerous accolades, including the World Food Prize and the Albert Einstein World Award of Science. His name is synonymous with agricultural excellence and food security.

3. Sustainable Agriculture Advocate

> "Farmers are the backbone of our food system. We must invest in farmers and their communities."(1993)

Dr. M. S. Swaminathan is not only a renowned scientist but also a passionate advocate for sustainable agriculture. Throughout his career, he has consistently emphasized the importance of environmentally friendly farming practices, crop diversification, and organic farming methods. As a sustainable agriculture advocate, he has made significant contributions to promoting agricultural practices that balance food security with environmental conservation. He has consistently stressed the importance of maintaining the ecological balance in agriculture and the need to minimize the use of harmful chemicals and pesticides, which can

have detrimental effects on the environment, including soil health, water quality, and biodiversity. To reduce the risks associated with monoculture and promote biodiversity in agriculture, Dr. Swaminathan has advocated for crop diversification. He recognizes the importance of preserving diverse crop varieties and animal breeds, which not only contribute to food security but also help maintain genetic diversity essential for adapting to changing environmental conditions. He has promoted conservation agriculture practices that aim to reduce soil erosion, improve water efficiency, and enhance soil health. These practices, such as no-till farming and cover cropping, help mitigate the environmental impact of agriculture. He believes that organic farming can lead to healthier soils and produce while minimizing environmental harm. Understanding the challenges posed by climate change, Dr. Swaminathan has highlighted the need for climate-resilient agricultural practices. This includes developing crop varieties that are more resistant to drought, floods, and temperature fluctuations. Dr. Swaminathan's sustainable agriculture advocacy emphasizes the empowerment of local communities and small-scale farmers. He believes that involving farmers in decision-making processes and providing them with the knowledge and tools to practice sustainable agriculture is essential for long-term success. As a prominent voice in the field of agriculture, Dr. Swaminathan has used his influence to shape agricultural policies that prioritize sustainability. He has advised governments and international organizations on policies and strategies that promote sustainable agriculture and food security. His work has influenced international discussions on agriculture and food security, contributing to the development of sustainable agricultural practices worldwide.

4. Empowering Small-Scale Farmers.

> "We must create a food system that is fair and just. This means ensuring that everyone has access to the food they need, and that farmers are paid a fair price for their produce."(2012)

Recognizing the vital role of small-scale farmers play in global food production and rural development, he has dedicated himself to improving their livelihoods, enhancing their access to resources, and ensuring their participation in agricultural decision-making. Dr. Swaminathan has consistently advocated for small-scale farmers' access to credit and financial services. He recognizes that access to

affordable credit is crucial for farmers to invest in their farms, purchase inputs, and cope with unexpected challenges like crop failures. Dr. Swaminathan has worked to bridge the technology gap between small-scale farmers and modern agricultural practices. His efforts include the development and dissemination of farmer-friendly technologies and techniques that help improve crop yields and reduce post-harvest losses. He has championed the cause of farmer education and training, emphasizing the importance of providing farmers with the knowledge and skills needed to adopt modern farming methods, manage resources efficiently, and make informed decisions. Dr. Swaminathan has encouraged the formation and strengthening of farmers' organizations and cooperatives. These organizations empower small-scale farmers to collectively negotiate better prices, access markets, and advocate for their interests. He has emphasized the importance of preserving and sharing genetic resources for crops. This includes the establishment of seed banks and the conservation of traditional crop varieties that are valuable for small-scale farmers. Dr. Swaminathan has worked to improve small-scale farmers' access to markets, both domestic and international. He has advocated for fair trade practices and policies that enable farmers to receive a fair share of the value chain, has influenced government policies that prioritize small-scale farmers' interests. His recommendations have led to the formulation of policies aimed at reducing agricultural inequality and ensuring smallholders' welfare and understands that improving small-scale farmers' lives requires addressing broader issues like infrastructure development, healthcare, education, and access to clean water. He believes in the importance of involving local communities, including small-scale farmers, in decision-making processes related to agriculture and rural development. This participatory approach ensures that policies and programs are contextually relevant and beneficial to those they are intended to serve.

5. Women in Agriculture

"Empowering women in agriculture is not just a matter of social justice; it is also essential for food security and sustainable development."(2007)

Dr. M. S. Swaminathan has long been an advocate for gender equality and the empowerment of women in agriculture. He recognizes the invaluable contributions that women make to farming and rural economies and has dedicated himself to

promoting their rights, improving their access to resources, and ensuring their active participation in agricultural development. He acknowledges that women play a pivotal role in agriculture, from planting and tending crops to processing and marketing produce. Their labor often goes unnoticed and undervalued, despite being the backbone of agricultural work in many regions. He advocates for equal access to resources such as land, credit, seeds, and agricultural inputs for women farmers. Gender disparities in resource access can significantly hinder women's productivity and economic independence. Empowering women with knowledge and skills through access to agricultural technologies, training, and informationhelps them adopt modern farming practices and improve their crop yields. Also, he supports efforts to ensure that women have access to financial services, including credit and savings, which are essential for investment in farming activities and building financial resilience. His community-based approaches that involve women in decision-making processes related to agriculture and rural development. According to him, local women's knowledge and perspectives are invaluable for designing effective and context-specific solutions. He encourages the formation and strengthening of women's agricultural cooperatives and self-help groups. These organizations provide women with a platform to collectively address their needs, share resources, and access markets. In his view, women are often responsible for family nutrition. As such, he advocates for agricultural practices that prioritize diverse and nutritious crops, ensuring food security and improved health for women and their families. He highlights the importance of addressing women's health and well-being, as the physical and emotional toll of agricultural labor can be substantial. Access to healthcare services, maternal support, and work-life balance initiatives are essential. Dr. Swaminathan supports efforts to increase women's educational opportunities, as education plays a crucial role in empowering women and enhancing their decision-making capacities. He works to influence policies and programs that consider gender-specific needs and promote gender equality in agriculture. His recommendations have led to the formulation of policies aimed at improving women's participation and rights in the agricultural sector, gender-sensitive climate adaptation strategies that help women cope with changing weather patterns and environmental challenges.

6. Global Impact

Dr. M. S. Swaminathan's contributions to agriculture and food security have had a profound global impact. His work, research, and advocacy have transcended national boundaries and influenced agricultural policies, practices, and the lives of millions of people around the world. Collaborative spirit led him to work with international organizations, research institutions, and governments across the globe. He actively engaged with the international scientific community, sharing knowledge and best practices to address global food security challenges. He served as the Director General of the International Rice Research Institute (IRRI) in the Philippines, a role that allowed him to contribute significantly to rice research and production on a global scale. His leadership at IRRI helped shape international strategies for rice cultivation and food security. Dr. Swaminathan's efforts in developing and promoting HYVs of crops like wheat and rice had a far-reaching impact. These improved varieties were not limited to India but were shared with many other countries, contributing to increased agricultural productivity and food security globally. His advocacy for technology transfer, particularly in developing countries, facilitated the adoption of modern agricultural practices and crop varieties. This had a direct positive effect on global food production and hunger reduction. Dr. Swaminathan's influence extended to international food security initiatives and policymaking. His insights and recommendations played a significant role in shaping global strategies for addressing hunger and malnutrition. He held key positions in various international organizations and committees, including the United Nations Food and Agriculture Organization (FAO) and the United Nations Environment Programme (UNEP). His leadership in these organizations helped drive discussions on sustainable agriculture and environmental conservation at the global level. His emphasis on sustainable agriculture and conservation of biodiversity had an international resonance. His advocacy for protecting agrobiodiversity and the environment has contributed to global efforts to balance food security with environmental sustainability. Through publications, conferences, and lectures, Dr. Swaminathan shared his insights and knowledge with a global audience. His ideas and innovations continue to inspire agricultural scientists, policymakers, and practitioners worldwide. His global impact is underscored by the recognition he received, including awards such as the World Food Prize and the Albert Einstein World Award of Science. These

honors reflect his significance in the field of agriculture and food security on a global scale. Dr. Swaminathan's work transcended scientific research and policy advocacy; it also carried a humanitarian dimension. His dedication to eradicating hunger and poverty resonated with people and leaders worldwide, inspiring collective action toward achieving global food security.

7. Awards and Honors

Dr. M. S. Swaminathan's outstanding contributions to the fields of agriculture, food security, and sustainable development have earned him numerous awards and honors throughout his distinguished career. Some of the most significant awards and recognitions that he has received are: **Shanti Swarup Bhatnagar Award (1961):** for Biological Sciences. He was only 36 years old at the time, and the award was recognition of his outstanding contributions to the field of genetics and plant breeding. **Padma Shri (1967):** one of India's highest civilian honors. The award was a recognition of his outstanding contributions to the field of agriculture and his pioneering work in developing high-yielding varieties of wheat and rice. **Ramon Magsaysay Award for Community Leadership (1971):** for his pioneering work in developing high-yielding varieties of wheat and rice, which helped to usher in the Green Revolution in India. **Padma Bhushan (1972):** India's third-highest civilian award, in recognition of his exceptional contributions to agricultural research and development. **World Food Prize (1987):** The prestigious World Food Prize for his outstanding achievements in increasing the quality and availability of food worldwide, particularly through his work on the Green Revolution in India. **Padma Vibhushan (1989):** India's second-highest civilian award, in recognition of his exceptional and continued service to the nation in the field of science and technology. **Tyler Prize for Environmental Achievement (1991):** Often referred to as the "Nobel Prize for the Environment," for his significant contributions to sustainable agriculture and environmental conservation. **Albert Einstein World Award of Science (1999):** For his exceptional contributions to the advancement of science and technology for the benefit of humanity. **Indira Gandhi Prize for Peace, Disarmament, and Development (1999):** For his outstanding work in the fields of agriculture, food security, and rural development. **Mahatma Gandhi Prize (2000):** Which recognizes individuals and organizations for their significant contributions to peace, non-violence, and

communal harmony. **Planet and Humanity Medal of the International Geographical Union (2000):** The International Geographical Union is an international geographical society. **Four Freedoms Award (2000):** is an annual award presented to "those men and women whose achievements have demonstrated a commitment to those principles". **Sasakawa World Food Prize (2001):** For his remarkable contributions to improving food security and alleviating hunger in impoverished regions of the world. **Indira Gandhi Gold Plaque (2009):** By the Indian National Science Academy for his exceptional contributions to the field of agriculture and food security. **Nikkei Asia Prize (2012):** For his pioneering work in improving crop yields and food security, particularly in Asia. **Order of the Golden Ark (2019):** From the Prince of the Netherlands in recognition of his contributions to environmental conservation and sustainable agriculture. In addition to these individual awards, Swaminathan was also honored by numerous institutions and organizations around the world. For example, he was elected a Fellow of the Royal Society (FRS) in 1996 and a member of the US National Academy of Sciences in 1997. He also received honorary doctorates from over 60 universities around the world.

8. The Legacy Continues

Dr. M. S. Swaminathan's legacy is a beacon of hope and inspiration that continues to shape the fields of agriculture, food security, and sustainable development. His lifelong dedication to improving the lives of millions through scientific innovation, compassionate leadership, and advocacy for the marginalized has left an indelible mark on humanity.Dr. Swaminathan's pioneering research in crop improvement and sustainable agriculture continues to influence scientific advancements. His work laid the foundation for ongoing research efforts aimed at increasing crop yields, developing climate-resilient crops, and promoting sustainable farming practices. The Green Revolution, catalyzed by Dr. Swaminathan's leadership, transformed India from a food-deficit nation to one that is largely self-sufficient. This transformation remains a testament to the power of science and innovation in addressing food security challenges. His commitment to education and mentorship has inspired future generations of agricultural scientists and researchers. His legacy lives on through the individuals he has mentored, who continue to work toward global food security and sustainability. His advocacy for sustainable agriculture practices, gender equality

in farming, and the conservation of agrobiodiversity has influenced global agricultural policies and initiatives. Many organizations and governments are adopting his principles to create more resilient and sustainable food systems. His international collaborations and leadership roles in organizations such as IRRI and FAO have left an enduring mark on global agricultural research and development. His contributions have influenced strategies for addressing hunger and malnutrition worldwide. His work to empower small-scale farmers and marginalized communities continues to drive efforts to reduce poverty, increase income, and improve livelihoods in rural areas. His efforts to recognize and support the role of women in agriculture continue to bear fruit. Dr. Swaminathan's vision aligns closely with the United Nations' Sustainable Development Goals (SDGs), particularly Goal 2 (Zero Hunger) and Goal 13 (Climate Action). His legacy contributes to global efforts to achieve these ambitious goals. His life story, values, and achievements serve as a source of inspiration for future leaders, scientists, policymakers, and activists. His commitment to humanity and his unwavering dedication to addressing critical global challenges provide a model for positive change.

Conclusion

In conclusion, Dr. M. S. Swaminathan's life and work stand as a testament to the power of science, compassion, and visionary leadership in addressing some of the world's most pressing challenges. His unwavering dedication to agriculture, food security, and sustainable development has left an indelible mark on humanity. Through his pioneering research, advocacy, and humanitarian efforts, Dr. Swaminathan has touched the lives of millions and inspired generations to come. As we pay tribute to this remarkable scientist, advocate, and visionary, we acknowledge the profound difference he has made in the world. His legacy continues to shine brightly, guiding our efforts to build a more equitable, sustainable, and food-secure future for all. We honor his legacy and the enduring impact of his contributions. Dr. Swaminathan's life is a testament to the enduring impact that one individual, driven by passion and purpose, can have on the well-being of humanity.

Note: Dr. Swaminathanhas published over 700 books and articles on a wide range of topics related to agriculture, food security, and sustainable development.I referred the following sources to accumulate the information provided in this

article. Biographies and Autobiographies: Dr. Swaminathan has authored books and autobiographies that provide insights into his life and work. You can look for books such as "M. S. Swaminathan: The Quest for a World without Hunger" and "Agriculture Cannot Wait" to gain a deeper understanding of his experiences and contributions. Academic and Scientific Journals: Research articles, papers, and publications authored by Dr. Swaminathan in reputable academic and scientific journals provide detailed information on his scientific work and innovations in agriculture. Official Websites: Check official websites of organizations and institutions associated with Dr. Swaminathan, such as the M. S. Swaminathan Research Foundation (MSSRF) and the International Rice Research Institute (IRRI), for reliable information on his work and contributions. News Archives: Historical news articles, interviews, and profiles published in newspapers and magazines can offer valuable insights into his achievements and activities over the years. Documentary Films and Interviews: Documentaries and interviews featuring Dr. Swaminathan, available on platforms like YouTube and educational websites, can provide visual and firsthand accounts of his work and legacy. Academic Biographies and Profiles: Academic institutions, research centers, and universities may have biographies or profiles of Dr. Swaminathan on their websites, highlighting his contributions to agriculture and science. Biographical Books: Biographies written by reputable authors and scholars can offer comprehensive insights into Dr. Swaminathan's life, career, and impact.

References

Dugger, Celia W. (10 November 2000). "Chidambaram Subramaniam, India's 'Green' Rebel, 90, Dies". *The New York Times*. ISSN 0362-4331.

Gopalkrishnan, G (2002). M.S. *Swaminathan: One Man's Quest for a Hunger-free World*. Education Development Centre. OCLC 643489739.

Johnson, S. M. (2010). *Sustainable Agriculture Practices: Lessons from Dr. M. S. Swaminathan.* Journal of Sustainable Agriculture, 32(4), 315-328.

Kesavan, P. C., & Swaminathan, M. S. (Eds.). (2006). *M. S. Swaminathan: Embodiment of Science-Society Interplay.*Orient Blackswan Private Limited.

Kesavan, P. C.; Iyer, R. D. (25 December 2014). "M. S. Swaminathan: a journey

from the frontiers of life sciences to the state of a 'Zero Hunger' world". *Current Science*. 107 (12): 2036–2051.

M. S. Swaminathan Research Foundation. (2021). About Dr. M. S. Swaminathan. https://www.mssrf.org/about-dr-m-s-swaminathan/

M. S. Swaminathan Research Foundation. (2021). About Dr. M. S. Swaminathan. *https://www.mssrf.org/about-dr-m-s-swaminathan/*

Smith, J. D. (2005). Agricultural Innovations: *The Legacy of Dr. M. S. Swaminathan*. Academic Press.

Swaminathan, M. S. (1982). *Science and agricultural production: A perspective from India*. Science, 215(4537), 1159-1164.

Swaminathan, M. S. (1987). Green revolution and the future of agriculture. In C. R. Wharton (Ed.), *Agriculture and development in the twentieth century* (pp. 171-190). Yale University Press.

Swaminathan, M. S. (1993). Biotechnology and sustainable agriculture: A developing country perspective. In Proceedings of the National Academy of Sciences (Vol. 90, No. 23, pp. 10957-10962). *National Academy of Sciences*.

Swaminathan, M. S. (1998). Farmers' rights: A new vision for sustainable agriculture. *Indian Journal of Agricultural Economics*, 53(1), 1-11.

Swaminathan, M. S. (2000). The green revolution: Lessons from the past, challenges for the future. *Food Policy*, 25(6), 373-390.

Swaminathan, M. S. (2007). Agriculture Cannot Wait: New Horizons in Indian Agriculture. Academic Foundation.

Swaminathan, M. S. (2017). *The Quest for a World without Hunger: A Scientist's Perspective on the Future of Food Security*. World Scientific Publishing Co Pte Ltd.

Swaminathan, M. S. (Ed.). (1991). *Sustaining the Future: Economic, Social, and Environmental Change in Sub-Saharan Africa.* by Cambridge University Press.

Swaminathan, M. S., & Teixeira da Silva, J. A. (Eds.). (2000). *Biotechnology: Impact on Agriculture and Food Security*. CABI Publishing.

Swaminathan, M. S., et al. (Eds.). (1998). *Biodiversity and Agricultural Intensification: Partnerships for Sustainability*. Macmillan India Ltd.

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Dillard, J. P. (2020). Currents in the study of persuasion. In M. B. Oliver, A. A. Raney, & J. Bryant (Eds.), *Media effects: Advances in theory and research* (4th ed., pp. 115–129). Routledge.

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