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Foreword

It is with great pleasure and honour that the National Centre for Advanced Studies in Humanities and Social Sciences (NCAS) presents **Volume 14, Issue I** of the ***Sri Lanka Journal of Advanced Research Studies in Humanities and Social Sciences*** **(SLJARS)**. This issue highlights scholarly work that advances knowledge and offers critical insights into societal wellbeing through the lenses of humanities and social sciences.

As the only research institute in Sri Lanka governed by the *Universities Act No. 16 of 1978*, NCAS remains committed to promote and extend high-quality research that integrates academic rigor with societal relevance. It is the known fact that the rapid technological changes cannot overstate the undeniable values of human behaviour and needs, importance of human intellect, ethical and natural judgment, and cultural understanding. Research on human behaviour, society and cultural identities continue to play a pivotal role in addressing contemporary challenges and informing evidence-based decision-making.

The contributions featured in this volume reflect the interdisciplinary evolution of the humanities and social sciences, especially through the practices of arts and cultures, education and polity, demonstrating engagement with empirical data and methods, and policy-oriented analysis. Each article represents a meaningful scholarly contribution, whether through the exploration of historical processes, cultural interpretations, or critical examinations of present-day social issues.

SLJARS is a **peer-reviewed journal**, published biannually under a **double-blind review process**, and has been recognized by *Sri Lanka Journals Online (SLJOL)* since 2007. The journal continues to serve as a respected platform for scholarly dialogue and intellectual exchange at national and international levels.

I extend my sincere gratitude to the authors, reviewers, and the editorial team for their dedication and scholarly commitment. Their efforts ensure the continued academic integrity and relevance of the journal. I am confident that the research presented in this issue will inspire future scholarship and contribute constructively to the advancement of knowledge and society.

Senior Professor (Mrs.) Prashanthi Narangoda
Director/NCAS

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NCAS Research Journal is a bi-annual research journal of the NCAS, Colombo, Sri Lanka. It seeks to provide a platform to the academics, practitioners, policy makers and other stakeholders of various dimensions of to present their research findings and to debate on issues of mutual and common interests for the benefit of the local and global community

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Content

The Rakhigarhi System: Adaptive Pluralism and the Reinterpretation of Bronze Age Indus Urban Resilience

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Abstract

The Harappan Civilization (c. 2600–1900 BCE) represents one of the Old World's most sophisticated and expansive primary urban formations, yet its underlying socio-economic mechanics have long confounded scholars due to the absence of deciphered textual records and its seemingly decentralized political structure. The monumental scale and protracted chronology of its largest metropolitan center, Rakhigarhi, situated along the paleochannels of the Ghaggar-Hakra river system, presents a particularly formidable archaeological paradox: how did a pre-industrial urban agglomeration of such immense demographic density and organizational complexity sustain itself for over seven centuries within a volatile, semi-arid environment inherently dependent upon the capricious rhythms of the Indian Summer Monsoon? This inquiry systematically deconstructs and transcends reductive, monolithic explanations for Harappan prosperity, which have historically vacillated between hydraulic determinism and climatic catastrophe models. It proffers instead a novel, integrated theoretical paradigm predicated upon a deliberately engineered and meticulously managed economic multiplicity, herein termed *strategic economic polymorphism*. Through a forensic synthesis of high-resolution, multidisciplinary data encompassing detailed archaeobotanical and zooarchaeological assemblages, stable isotopic dietary records, high-precision paleoclimatic proxies, and cutting-edge archaeogenetic analysis this study illuminates a sophisticated, mutually-reinforcing system of dual-season agropastoral production, intensive fluvial and hinterland resource exploitation, and deeply embedded inter-regional mercantile networks that functioned as a cohesive, risk-dispersing mechanism. The central thesis posits that Rakhigarhi's enduring metropolitan stability was not the artifact of a singular, massive agricultural surplus generated from a monolithic resource base, but rather an emergent property of a meticulously curated portfolio of complementary subsistence and economic strategies,

ingeniously designed to proactively distribute risk across disparate ecological, temporal, and geographical domains. Critically, recent genomic evidence affirming the autochthonous origins of the Rakhigarhi populace irrefutably validates the endogenous, indigenous development of this advanced socio-economic configuration, situating the Harappan achievement firmly within the South Asian cultural matrix and refuting outdated diffusionist theories. The resultant "Rakhigarhi Paradigm" fundamentally recontextualizes Harappan urbanism, reimagining it as a network of robust, regionally-attuned political economies whose prosperity was a direct function of calculated diversification, proactive human niche construction, and profound economic integration, rather than a passive reliance upon fertile alluvial substrates or a monolithic, centralized state apparatus.

Keywords*:* Rakhigarhi, Harappan Political Economy, Subsistence Polymorphism, Archaeobotany, Zooarchaeology, Paleoenvironmental Reconstruction, Ancient DNA, Stable Isotope Analysis, Ghaggar-Hakra Paleochannel, Indus Trade Networks, Urban Resilience, Niche Construction, Risk Mitigation, Mature Harappan Period.

Introduction

Deconstructing the Paradox of Pre-Industrial Metropolitan Sustenance

The spectacular efflorescence, zenith, and subsequent reconfiguration of the Harappan Civilization persists as one of the most defining and resilient enigmas within Old World archaeology. It represents a foundational, autochthonous trajectory toward urban complexity whose non-literate and ostensibly decentralized character renders its internal operational mechanics profoundly opaque to the analytical frameworks typically applied to coeval Near Eastern societies, which benefit from extensive epigraphic records elucidating dynastic lineages, bureaucratic administration, and theological frameworks. For generations, scholarly endeavors to apprehend the civilization's structural logic were confounded by its undeciphered script and an archaeological record that, while exhibiting meticulously engineered urban planning, standardized weights and measures, and ubiquitous material cultural homogeneity across a vast geographical expanse, remained bereft of the illuminating textual archives royal inscriptions, economic tablets, legal codes that so vividly characterize Mesopotamian and Egyptian contexts. This lacuna has forced interpretations of Harappan socio-economics to be derived almost

exclusively from the silent, yet eloquent, testimony of material culture, from the layout of its cities to the residues of its daily meals.

Rakhigarhi, presently acknowledged as the most expansive Harappan settlement yet unearthed, constituting a vast metropolitan landscape spanning over 350 hectares across multiple mounds in present-day Haryana, India, constitutes the contemporary epicenter of this interpretive conundrum. Its immense demographic scale, estimated through projective settlement density models to have sustained a population numbering in the tens of thousands, and its remarkable chronological endurance, spanning the critical formation, maturation, and eventual localization phases of the Harappan trajectory, present a trenchant contradiction to established paradigms governing the viability of early complex societies. These paradigms often presuppose a direct and uncomplicated correlation between environmental bounty, particularly the presence of perennial, predictable river systems, and the sustainable scale of urban agglomerations. The fundamental, irreducible question this research confronts is: what sophisticated, systemic stratagems enabled this dense, socially stratified, and administratively intricate urban entity to not only establish itself but to perpetuate its functional coherence for such an extended duration within the environmentally capricious, semi-arid terrain of the northwestern subcontinent, a region inherently susceptible to the erratic oscillations of the Indian Summer Monsoon and situated on a potentially seasonal river system whose flow was subject to tectonic and climatic vagaries?

This document propounds a novel thesis, contending that the authentic font of Rakhigarhi's exceptional durability resided not solely in its monumental architecture the so-called "granaries," citadels, and ritual baths or its advanced civic engineering, such as the famous drainage systems and water-management features, but in the intrinsic, polycentric, and deeply adaptive organization of its quotidian economic existence. It was a meticulously managed, polymorphic subsistence system that masterfully conjoined profound localized ecological adaptation with expansive, inter-regional economic interdependence, thereby creating a socio-ecological formation of remarkable buffering capacity and latent resilience. It is postulated that Rakhigarhi's sustained affluence and political coherence were emergent properties of its unwavering commitment to strategic economic diversification, functioning as an intricate, multi-layered mechanism for

distributed risk that effectively insulated its substantial population from the inevitable exogenous shocks of resource scarcity, climatic variability, and potential trade disruptions. This analysis consciously transcends the historically pervasive, anachronistic depiction of a civilization statically dependent upon a narrow foundation of winter cereals like wheat and barley, offering instead an evidence-saturated reconstruction that identifies a society which acted as the conscious architect of its own socio-ecological niche. This society implemented a calculated fusion of intensive, multi-season agropastoralism, fluvial and lacustrine resource capitalization, and far-reaching mercantilism that was dynamically adjusted over generations in response to cumulative environmental knowledge. Consequently, Rakhigarhi is not merely perceived as an archaeological site, but as a critical, dynamic case study in ancient urban autarky and resilience, demonstrating how the dialectical interplay between local ingenuity, cumulative ecological knowledge, and continental-scale connectivity forged one of the ancient world's most resilient and enduring socio-economic formations, whose legacy is indelibly embedded in the subsequent agrarian and social history of the Indian subcontinent.

The Enigma of Scale: Situating Rakhigarhi within the Harappan Oikumene

The geographical siting of Rakhigarhi was not fortuitous but rather attests to an advanced, cumulative comprehension of regional ecological and economic geostrategy, reflecting a deep, place-based knowledge accrued over centuries, if not millennia, of prior settlement and intensive landscape interaction. Situated directly astride the now-ephemeral paleochannels of the Ghaggar-Hakra system a riverine corridor that, during the Mature Harappan period, functioned as a vital hydrological artery draining the Siwalik Hills and potentially fed by a stronger monsoon, supporting a lush riparian corridor the city occupied a strategic interstice. It effectively mediated interactions between the fertile alluvial plains of the Indus and its tributaries to the west, the mineral-rich precincts of the proximal Aravalli Range to the south, and the vital commercial arteries linking the pan-Harappan world with broader Middle Asian exchange networks that stretched to the Oman peninsula, Mesopotamia, and Central Asia. This investigation deliberately situates Rakhigarhi squarely within the comprehensive ‘Indus-Saraswati’ interaction sphere, explicitly

recognizing the Ghaggar-Hakra corridor as a nucleus of intense settlement clustering and profound economic dynamism, which may have even served as a central axis of the civilization's territorial organization and cultural identity, thereby challenging the primacy often accorded solely to the Indus River itself in traditional narratives of Harappan genesis.

Nonetheless, the advantages of a propitious location are, in themselves, insufficient to account for the city's astonishing urban footprint, which demonstrably eclipses that of the more frequently excavated and studied centers at Harappa and Mohenjo-daro, suggesting a unique confluence of local factors and strategic advantages that propelled its growth to pre-eminence. The fundamental paradox that continues to preoccupy archaeologists and economic historians is the persistence of such a dense, stratified, and logistically demanding urban complex, requiring constant, reliable inputs of food, water, fodder, fuel, and raw materials for its crafts and industries, within a region defined by extreme hydro-climatic volatility. Here, river flow was likely seasonal and subject to avulsion, and monsoon rains could be capricious, presenting a constant, existential threat of drought or flood that could devastate a less prepared society.

The resolution to this paradox, as meticulously demonstrated through a convergence of material evidence from multiple disciplinary vantage points, resides not in the superlative success of a single, highly optimized subsistence method, but in the finely woven, flexible, and fundamentally diversified economic base that was engineered to be greater than the sum of its parts. The Harappan elite, planners, and the populace at large did not stake their collective survival upon the unwavering success of a solitary harvest or a single resource flow; instead, they strategically cultivated a suite of redundant and complementary strategies, thereby erecting a sophisticated, multi-layered socio-ecological bulwark against unavoidable natural perturbations. These ranged from seasonal drought extremes and delayed monsoons to the potentially catastrophic, avulsive migration of river channels, which could render entire agricultural districts unproductive almost overnight. This deep-seated commitment to economic pluralism, which constitutes a deliberate, organizational distribution of risk across different ecological niches, productive seasons, and geographical zones, endowed Rakhigarhi with the crucial adaptive capacity and latent flexibility requisite for absorbing and mitigating disturbances that would have proven fatal to less versatile, more

specialized socio-political formations. It was this very polymorphic structure that cemented its role as a remarkably stable economic and cultural nexus for nearly a millennium. The inherent imperative of sustaining a metropolitan population of such scale within a high-risk environmental setting created the structural conditions that not only favored but demanded the adoption of a diversified, polymorphic economy, thereby driving continuous innovation in crop management, animal husbandry, resource procurement, and storage technologies.

Interrogating Subsistence: Transcending Civilizational Homogenization for Urban Granularity

For decades, the economic foundation and dietary practices of the Harappan civilization were delineated through an overly simplified, homogenous lens, frequently reduced to a static formula predicated upon a triumvirate of wheat, barley, and zebu pastoralism. This caricature originated in the early, large-scale excavations of major sites like Mohenjo-daro and Harappa, where recovery techniques focused on monumental structures and larger artifacts, and was perpetuated by a lack of fine-grained, systematic recovery techniques such as flotation, which is essential for recovering the small seeds of millets and other potential staples. While these staples were undeniably vital caloric components, this reductive caricature perilously obfuscates the brilliant regional and localized economic adaptations that were, in reality, the propulsive force behind the civilization's pervasive success and its intrinsic capacity for long-term adaptation to a mosaic of micro-environments, from the coastal reaches of Gujarat to the semi-arid plains of Haryana and the rugged highlands of Balochistan. The Harappan world must therefore be conceptualized not as a monolithic, uniform cultural bloc governed by a universal economic model, but as a dynamic mosaic of interconnected regional domains and peer polities, each instantiating the overarching Harappan *oikumene* the shared world of material culture, metrology, and iconography in a manner optimally tailored to its local resource base, unique environmental constraints, and historical trajectory, yet bound together by a shared material grammar and active participation in extensive, continental-scale exchange networks.

The contemporary, state-of-the-art excavations at Rakhigarhi, employing high-precision scientific methodologies such as systematic

flotation for seed recovery, soil micromorphology for understanding site formation processes and activity areas, and high-resolution radiocarbon dating to create a finely phased chronological sequence, now facilitate a decisive shift in focus from a broad, civilizational perspective to one of unprecedented urban granularity. This allows researchers to reconstruct the economic life, dietary habits, and resource procurement strategies of a specific metropolis in exceptional, household-level detail. Empirical evidence now compellingly corroborates that Rakhigarhi's cultivators were far from passive recipients of environmental conditions; rather, they were erudite, active environmental managers who implemented a shrewd, risk-mitigating poly-cropping system that was dynamically responsive to the rhythms of the monsoon and the behavior of the Ghaggar-Hakra river.

This strategy artfully synthesized traditional winter cereals (rabi season), such as wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*), which relied on residual soil moisture and winter rains, with a crucial suite of resilient, fast-growing, and profoundly drought-tolerant summer millets (kharif season) like jowar (*Sorghum bicolor*) and bajra (*Pennisetum glaucum*). These millets could be sown with the unpredictable summer rains and would mature quickly, providing a critical harvest in the late autumn. This approach epitomizes ancient agricultural risk management operating at its most sophisticated level a calculated, multi-seasonal strategy engineered to guarantee a baseline level of food security across a broad spectrum of hydro-climatic conditions.

If the winter rains failed or the river was low, the summer millets, with their different growing requirements and shorter cycle, could compensate. Conversely, a poor monsoon might be offset by a good winter harvest. This system actively forged and perpetuated a highly reliable and productive agro-ecological niche that could consistently support a large, non-agrarian urban population. The intentional introduction, propagation, and cultural integration of these non-native, drought-tolerant C4 pathway crops (millets) is not coincidental; it constitutes a profound act of environmental modification and conscious niche construction, demonstrating palpable agency, foresight, and cumulative ecological expertise that was passed down and refined over generations.

The Roadmap of Reconstruction: A Forensic, Multi-Proxy Investigative Framework

This research is conceptualized as an extensive forensic enterprise: the meticulous reconstruction of a sophisticated, vanished economic world predicated solely upon the fragmented, silent testimony of its material remains, requiring the assembly of disparate, often microscopic clues into a coherent, testable, and dynamic narrative of the past. The investigation is architected upon a robust, multi-pronged analytical framework, commencing with a critical historical hermeneutic that traces the scholarly trajectory of the Indus Civilization from its early colonial discoveries and the initial, awe-struck revelations at Harappa and Mohenjo-daro, through the processual archaeology of the mid-twentieth century that sought general laws of cultural evolution, to the current, science-driven post-processual paradigm that emphasizes human-environment interactions, agency, and resilience.

The inquiry is conceptually buttressed by sophisticated modern theoretical constructs imported and adapted from other disciplines, specifically Resilience Theory from ecology and the theory of Human Niche Construction (HNC) from evolutionary biology, which together provide a powerful, synergistic lens for understanding long-term socio-ecological dynamics over the *longue durée*. Resilience Theory, as developed by C.S. Holling, helps us understand how complex systems absorb disturbance and reorganize while undergoing change, so as to still retain essentially the same function, structure, identity, and feedbacks. The theory of Niche Construction posits that organisms, through their activities and choices, modify their own and each other's environments, thereby altering the selective pressures that act upon them; humans are the ultimate niche constructors. These frameworks furnish the essential conceptual lexicon to comprehend not merely *what* the Rakhigarhi economic system comprised in terms of resources, but, more critically, *how* and *why* it maintained its operational efficacy, stability, and adaptive capacity across centuries in the face of predictable and unpredictable challenges, allowing it to avoid a catastrophic systemic collapse for an impressive duration, and to transform gradually rather than collapse abruptly. The empirical core of the argument is constructed through a synergistic convergence of data derived from a formidable suite of advanced scientific techniques, each illuminating a different facet of this complex, polymorphic

system. This multi-proxy approach is the only methodology capable of capturing the full spectrum of Harappan economic life:

Microscopic and Assemblage Analysis: Meticulous studies of archaeobotanical remains (seeds, chaff, phytoliths, starch grains) and detailed taxonomic/taphonomic analyses of animal bone assemblages (species representation, age-at-death profiles, butchery marks) provide direct, tangible evidence for the specific plant and animal species exploited, their relative importance in the economy, and the strategies behind their use whether for traction, meat, milk, or secondary products.

Biogeochemical Profiling: The interpretation of stable isotopic signatures (Carbon-13, Nitrogen-15) encapsulated within the bioapatite of tooth enamel and the collagen of human and animal skeletal remains provides a direct, quantitative record of individual dietary intake over different periods of life. Carbon isotopes distinguish between the consumption of C3 plants (like wheat and barley) and C4 plants (like millets and sorghum), while Nitrogen isotopes indicate trophic level and the consumption of animal protein or aquatic resources, effectively reading the chemical biography of individuals and revealing dietary differences across status, gender, or neighborhood.

Geological and Paleoenvironmental Context: Stratigraphic and geochemical analysis of paleo-river sediments, coupled with regional climate proxies from speleothems (cave deposits like those at Sahiya), lake varves, and marine cores from the Arabian Sea, provides the robust environmental backdrop against which human adaptations must be understood. These proxies chart the long-term fluctuations of monsoonal intensity, river discharge, and overall aridity, allowing us to correlate periods of economic change or stability with specific environmental conditions.

Material Sourcing and Trade Analysis: Geologic provenience studies of materials like chert, carnelian, lapis lazuli, and steatite, using techniques like X-ray Fluorescence (XRF) and Neutron Activation Analysis (NAA), map the extensive exchange networks that supplied the city with non-

local goods, illustrating its economic connectivity and interdependence with other regions.

The resultant evidentiary narrative systematically elucidates the dynamic fluvial environment of the Ghaggar-Hakra, the genomic constitution and dietary patterns of the populace, the refined agro-ecological logic of the cropping system, the economic efficiency of integrated animal management, and the critical functionality of long-distance exchange networks, weaving them into a single, coherent story of a resilient urban economy. Each of these independent evidentiary threads is interwoven to undergird the concluding argument: that the "Rakhigarhi Paradigm" of subsistence a highly resilient, integrated, and flexible system fundamentally necessitates a re-evaluation of the sources of Harappan prosperity, shifting the analytical focus from passive dependence on agricultural bounty to a state of active, engineered resilience achieved through strategic economic polymorphism, profound regional integration, and the continuous, conscious construction of a sustainable socio-ecological niche.

The multi-proxy approach is indispensable, for the complexity and distributed nature of the polymorphic economy demand validation from every conceivable sector botanical, zoological, chemical, geological, and mercantile to be comprehensively apprehended and convincingly demonstrated, creating a robust, interconnected web of evidence that is resistant to disproof and points unequivocally towards a society that mastered the art of sustainable complexity in a challenging environment.

Theoretical Foundations: Resilience, Niche Construction, and the Political Economy of Diversity

To fully apprehend the Rakhigarhi system, one must move beyond mere description of its components and engage with the theoretical frameworks that explain its durability. The paradigms of Resilience Theory and Niche Construction Theory offer a powerful, complementary lens through which to view the strategic choices and long-term outcomes of Harappan economic organization.

a. Resilience Theory and the Dynamics of Socio-Ecological Systems

Resilience Theory, originally developed in ecology, conceptualizes systems not as entities seeking a static equilibrium, but as dynamic, adaptive cycles constantly undergoing phases of growth, conservation, release, and reorganization. The resilience of a system is its capacity to absorb disturbances and still retain its core function and structure. Applied to archaeology, it allows us to see ancient societies not as static entities that eventually "collapse," but as adaptive systems that constantly respond to change. A resilient system, like that of Rakhigarhi, is characterized by several key attributes: diversity (of resources, institutions, and social networks), modularity (components are connected but not so tightly that a failure in one causes a cascade of failures), and tight feedback loops (society can quickly perceive and respond to environmental change).

The volatile, semi-arid environment of the Ghaggar-Hakra basin presented constant "disturbances" droughts, floods, river channel shifts. A specialized, monolithic economy based solely on winter wheat would have had low resilience; a single prolonged drought could cause systemic failure. The polymorphic economy of Rakhigarhi, by contrast, exhibited high resilience. Its diversity of crops (C3 and C4, winter and summer), livestock (cattle, water buffalo, sheep, goat), and resource bases (agriculture, pastoralism, fishing, trade) meant that a shock to one component could be absorbed by the others. The modularity is evident in its semi-autonomous craft quarters and its integration into trade networks that were not wholly dependent on a single partner. Feedback loops were likely embedded in the cumulative, generational knowledge of farmers who could read the signs of the monsoon and adjust their planting strategies accordingly, and in the administrative structures that managed surplus and redistribution. Thus, the seven-century longevity of Rakhigarhi is not a mystery of stasis, but a testament to its high-resilience, adaptive socio-ecological system.

b. Human Niche Construction: Engineering an Agro-Pastoral-Mercantile Niche

Niche Construction Theory (NCT) provides the mechanism for *how* this resilience was achieved. It argues that organisms do not just passively

adapt to their environments through natural selection; they actively modify their surroundings, altering the selective pressures that act on them and future generations. Humans are the ultimate niche constructors, using culture and technology to create environments that suit their needs. The Harappans at Rakhigarhi were not simply adapting to the Ghaggar-Hakra landscape; they were proactively *constructing* an agro-pastoral-mercantile niche.

This niche construction took multiple, interconnected forms:

Agro-Engineering: The deliberate introduction and cultivation of drought-tolerant millets was a profound act of niche construction. By creating fields for these crops, they altered the local flora, soil chemistry, and hydrology, effectively building a more reliable food-production system that could buffer against monsoon failure. This was a cultural inheritance of knowledge and practice an inherited niche that passed adaptive advantages to subsequent generations.

Hydrological Management: While evidence for large-scale irrigation canals is sparse at Rakhigarhi compared to Mesopotamia, the presence of wells, water-reservoirs, and drainage systems indicates a sophisticated management of water resources. This modification of the hydrological niche ensured a more reliable water supply for both domestic use and small-scale irrigation.

Social and Economic Niche Construction: The development of standardized weights, measures, and ceramic types, and the maintenance of long-distance trade networks, constituted the construction of a *social and economic niche*. This niche reduced transaction costs, facilitated the predictable flow of goods and information, and created a stable environment for economic specialization and growth. The very urban plan of Rakhigarhi, with its designated areas for different activities, was a form of constructed social space that fostered economic efficiency and administrative control.

In this light, Rakhigarhi's prosperity was not a lucky accident of geography, but the result of a sustained, multi-generational project of environmental and social modification. The polymorphic economy was the engine of this niche construction, and the resulting resilience was its outcome. This theoretical perspective moves us from seeing the Harappans as victims of their environment to recognizing them as active, sophisticated shapers of their own destiny.

c. The Evidentiary Pillars of the Polymorphic Economy

The theoretical model of a resilient, niche-constructing society is only as strong as the empirical data that supports it. The following sections present a detailed synthesis of the multi-proxy evidence that collectively validates the "Rakhigarhi Paradigm" of strategic economic polymorphism.

The Archaeobotanical Record: A Symphony of C3 and C4 Cultigens

The systematic flotation of soil samples from various chronological phases and activity areas at Rakhigarhi has yielded a rich and revealing archaeobotanical assemblage that completely overturns the simplistic wheat-and-barley model. The data reveals a complex, multi-cropping agricultural strategy designed for risk mitigation and dietary breadth.

The Winter Staples (C3 Plants):

As expected, the classic winter cereals, dwarf wheat (*Triticum sphaerococcum*), bread wheat (*Triticum aestivum*), and barley (*Hordeum vulgare*), are well-represented. These were the calorie-rich foundations of the diet, likely grown on the better-watered soils closer to the Ghaggar-Hakra paleochannel, potentially utilizing some form of water management or flood-recession agriculture.

The Summer Revolution (C4 Plants):

Crucially, the evidence for summer crops is overwhelming and significant. Grains of drought-adapted millets, including jowar (*Sorghum bicolor*), bajra (*Pennisetum glaucum*), and finger millet (*Eleusine coracana*), are found in substantial quantities. Their

presence is not incidental; it is strategic. These fast-growing millets have a shorter growing season and require less water than wheat and barley. They could be planted with the arrival of the unpredictable summer monsoon, providing a harvest that filled the grain stores before the winter crop was even sown. This created a continuous annual cycle of food production, effectively doubling the agricultural bandwidth of the hinterland and providing a critical safety net.

Pulses and Other Cultigens:

The agricultural system was further diversified with a variety of pulses, such as lentil (*Lens culinaris*), chickpea (*Cicer arietinum*), and pea (*Pisum sativum*). These legumes are not only protein-rich but also fix nitrogen in the soil, enhancing fertility and allowing for more sustainable cultivation practices. Other finds, like sesame (*Sesamum indicum*) for oil and linseed (*Linum usitatissimum*), add further layers of economic and dietary complexity.

This diverse crop portfolio is the very definition of agricultural polymorphism. It buffered the population against the failure of any single crop due to pest, disease, or specific weather events. A poor wheat harvest could be offset by a good millet yield, and *vice-versa*. This was not subsistence farming; it was a calculated, surplus-generating system designed for urban sustenance.

d. The Zooarchaeological and Stable Isotope Testimony: Integrated Pastoralism and Dietary Realities

The analysis of animal bones and the biogeochemistry of human remains provides a parallel narrative of diversification and integration, revealing the crucial role of animal husbandry and the actual dietary patterns of the city's inhabitants.

The Animal Economy: The zooarchaeological assemblage at Rakhigarhi shows a managed, multi-species approach to animal resources. Cattle and water buffalo were the primary large animals, valued not only for their meat but crucially for their traction power for plowing fields and carting goods, and for their milk and dung (for fuel and fertilizer). Sheep and goat, more resilient to arid conditions, provided a reliable source of meat, wool, and hair. The

presence of a significant number of wild animal bones, including gazelle, blackbuck, and freshwater fish and turtles, indicates that hunting and fishing supplemented the diet, providing an additional, low-risk source of protein that was independent of the cultivated fields and herds.

Stable Isotope Revelations: Stable isotope analysis (δ13C and δ15N) of human skeletal remains from the Rakhigarhi cemetery provides a direct, quantitative window into the diet of the people themselves. The results are striking. They show a diet that was heavily based on C4 plants the millets complemented by C3 plants (wheat/barley) and a moderate amount of animal protein. This conclusively proves that millets were not a marginal "famine food" but a staple component of the everyday diet for a significant portion of the population. The isotopic data confirms the picture painted by the archaeobotany: the people of Rakhigarhi were consuming the products of their polymorphic agricultural system. Furthermore, the analysis can show variations between individuals, suggesting dietary differences that may correlate with social status, occupation, or ethnic identity, adding another layer of social complexity to the economic model.

This integrated system of multi-purpose pastoralism and opportunistic wild resource exploitation formed a second, critical layer of the risk-dispersal strategy. If crops failed, the herd could be culled. If disease struck the herds, wild resources and stored grain could provide a stopgap. The animal economy was not separate from the agricultural one; it was deeply intertwined, providing labor, fertilizer, and a mobile, stored food source.

e. The Paleoenvironmental Context: Thriving in a Volatile World

The polymorphic economy did not develop in a vacuum; it was a direct and intelligent response to the specific environmental conditions of the region. Paleoclimatic data from a variety of sources has now painted a detailed picture of the Harappan environment.

The Ghaggar-Hakra System: Geological studies confirm that the Ghaggar-Hakra was a major, monsoonal river system during the height of the Mature Harappan period. However, it was likely seasonal, with its flow strongly tied to the strength of the Indian Summer Monsoon. It was not a perennial, snow-fed river like the Indus. This inherent unpredictability made reliance on it for irrigation a risky proposition.

Monsoonal Fluctuations: Speleothem records from regions like the Sahiya Cave in Uttarakhand provide a high-resolution record of monsoon intensity. They show that the Mature Harappan period was not one of uniform climatic optimum. It was characterized by periods of strong monsoon interlaced with phases of significant aridity and weaker rainfall. The civilization did not flourish in spite of this volatility; its polymorphic economy allowed it to *thrive because of its capacity to handle it*.

The End of the Mature Phase: Critically, the paleoclimatic data indicates a trend towards increased aridity after c. 2000 BCE, with a weakening of the monsoon and the eventual desiccation of the Ghaggar-Hakra channels. This did not cause an immediate "collapse" of Rakhigarhi. Instead, the city's resilience allowed it to endure, but it likely triggered a process of reorganization. The economic emphasis may have shifted further towards the more arid-adapted millets and mobile pastoralism, and the population may have dispersed towards the Ganga plain, a process of "de-urbanization" rather than catastrophic collapse. The polymorphic system did not fail; it allowed for a managed, gradual transformation in the face of a profound environmental shift.

f. The Archaeogenetic and Trade Dimensions: Endogenous Development and Continental Connectivity

Two final pillars of evidence complete the picture, addressing the origins of the population and the extent of their external connections.

The Indigenous Genome: The seminal ancient DNA study of an individual from Rakhigarhi revealed a genome that is a mixture of ancient South Asian hunter-gatherer and early Iranian farmer-related ancestry, but critically, it showed *no* ancestry from Steppe pastoralists or Anatolian farmers at that time. This finding is of monumental importance. It demonstrates that the sophisticated urban society at Rakhigarhi, with its polymorphic economy, was an indigenous South Asian development. It was not the product of a colonizing or diffusing population from the west. The knowledge, strategies, and social structures that underpinned this economy were homegrown, emerging from millennia of adaptation within the subcontinent.

The Networked City: Material evidence attests to Rakhigarhi's deep integration into the pan-Harappan and international exchange system. Carnelian beads from Gujarat, lapis lazuli from Afghanistan, and shells from the coast found at the site speak of well-established trade routes. This long-distance trade represents the ultimate expression of economic polymorphism distributing risk across geographical space. A local resource failure could be compensated for by the import of goods that could be traded for food from another, more fortunate region. This connectivity was not a luxury; it was an integral component of the city's economic resilience, buffering it against purely local crises.

Synthesis: The Rakhigarhi Paradigm and its Implications for Understanding Ancient Urbanism

The convergence of evidence from archaeology, botany, zoology, chemistry, genetics, and geology presents an incontrovertible case. The sustained prosperity of Rakhigarhi was not a historical fluke but the logical outcome of a brilliantly conceived and executed socio-economic strategy. The "Rakhigarhi Paradigm" is one of strategic economic polymorphism a deliberate, managed, and integrated system of production and exchange that distributed risk across seasons, species, ecological zones, and geographical regions.

This model forces a fundamental re-evaluation of the Harappan Civilization. It moves us away from a focus on enigmatic "priest-kings" and centralized storage structures as the sole sources of power, and towards an

appreciation of a political economy that derived its stability from its flexibility and diversity. The power of the Harappan elite, while still likely real, may have been based less on coercive control of a single resource and more on the successful administration, facilitation, and perhaps ideological sanctioning of this complex, multi-faceted economy. They were the managers of resilience.

The implications of this paradigm extend far beyond the Indus Valley. It serves as a powerful case study for the global understanding of early urbanism. It demonstrates that the pathway to complexity is not monolithic. While Mesopotamian city-states relied heavily on intensive irrigation agriculture and temple/palace economies, and Egyptian civilization was tethered to the predictable Nile, the Harappans pioneered a different model a networked, resilient, and polymorphic urbanism that was arguably more adaptable and sustainable in the long term. The eventual transformation of the Mature Harappan system was not a failure but a reorganization into a new, post-urban form better suited to the changing climatic realities, a process guided by the very resilience built into its core.

In conclusion, the stones of Rakhigarhi, the seeds in its soil, the bones in its middens, and the isotopes in its skeletons all tell a consistent story. It is the story of a people who, through ingenuity and accumulated wisdom, constructed a niche of remarkable resilience. They did not simply build a city; they engineered a system, a polymorphic masterpiece of ancient socio-ecology that allowed them to flourish for centuries in the face of uncertainty, leaving an enduring legacy that would shape the subcontinent for millennia to come.

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Manifestation of Buddhist Iconography on the Evolution of Modern Musical Instruments in India: An Organological Study of stringed instruments through South Asian Buddhist Art

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Abstract:
This study examines how musical instruments are depicted in Buddhist art in South Asia and how these representations influence the design and performance practices of modern Indian musical instruments. The methodology combines a qualitative iconographic analysis of Buddhist art, focusing on sculptures, frescoes, and engravings that feature musicians and musical instruments in selected Buddhist sites where the climax of the Buddhist art is evident. Ajanta, Pitalkhora, Sanchi, Bharhut, Mathura, Amaravati, Nagarjunakonda, Gandhara (Pakistan), and Anuradhapura (Sri Lanka) are selected based on the peak. In parallel, a historical and contextual study of Indian musical instruments provides deeper insights into the evolution of their physical design and playing techniques. Evidently, ancient sculptures from Bharhut, Mathura, Gandhara, Amaravati, Nagarjunakonda, Pitalkhora, Sanchi, and Anuradhapura (Sri Lanka) and the murals and ceilings of Ajanta depict a wide variety of stringed instruments. The representations of stringed instruments in selected Buddhist artworks are categorized into two types: arched or bow-shaped design, with the neck curving from the body, fingerboard resembling that of the modern Sarod or Rabab. The study concludes that these depictions offer valuable insights into the history, structural design, playing techniques, and cultural and religious contexts of modern Indian musical instruments**.**

Key words: Buddhist Art, Iconography, Musical iconography, stringed Instruments, Indian Music

Introduction and background

Music iconography focuses on the study of the visual representation of musical subjects. Its primary materials include portraits of performers and composers, illustrations of instruments, instances of musical composition, and the use of musical images for metaphorical or allegorical purposes. It

is therefore so vital that the study of both music and the visual arts, including questions of patronage, reception history, social and intellectual history, philosophy, and aesthetics, as well as more rigorous technical matters such as organology, music theory, performance practice, and context, since they all compound together to study of historic landmarks and achievements of the artistic styles and symbolic meanings of the instruments (Ann Buckley, p.5)

From the simple, spherical mounds enshrining the relics of Gautama Buddha, the founder of Buddhism, to the emergence of monumental Stupa depicting, with exquisite fluidity and lyricism, his life and previous incarnations (Jataka stories) and scenes from every aspect of life in ancient India, Buddhist art has gone against the tenets of the principles that gave rise to it - austerity, simplicity and the principle of non-symbolic worship. Ironically and dichotomously, although the scriptures state that the historical Buddha never imposed any restrictions on the representation of figurative art, Buddhist art eventually began to depict the life that the Buddha had abandoned - dance, music, court life, and a luxurious lifestyle (Nilofar Shamim Haja, p.4).

Buddhism has a rich artistic and cultural heritage and has significantly influenced various aspects of South Asian societies, including music and musical instruments. Buddhist iconography, which includes sculptures, paintings, and other visual representations, often includes depictions of musical instruments played in religious rituals, ceremonies, and daily life. The evolution of musical instruments in India is a complex process, influenced by various cultural, religious, and social factors. Although India's classical musical traditions are often studied in isolation, the influence of religious iconography, especially Buddhist art, has been perceived by limited scholarly attention. The musical instruments depicted in ancient Buddhist art forms reveal not only the diversity of instruments used during the period but also the underlying religious and cultural philosophies that shaped their design and use. This study will focus on the iconographic representations of stringed instruments in Buddhist art. It will explore the continuity of these traditions and their influence on contemporary Indian music.

This research takes place at the locations where the peak of the Buddhist art have been occurred, namely, Ajanta, Pitalkhora, Sanchi,

Bharhut, Mathura, Amaravati, Nagarjunakonda, Gandhara (Pakistan), and Anuradhapura (Sri Lanka) and it addresses following research question.

1. What musical elements or instruments are depicted in Buddhist art across different regions?
   And how have these depictions influenced the design, aesthetics, and cultural significance of modern Indian musical instruments?

Methodology

This research mainly bestows with Erwin Panofsky's method (1892-1968) of Iconology- Iconography (Erwin Panofsky, 1972, p. 5-7)

1. Primary, or natural subject matter – pre-iconographical description
2. Secondary or conventional subject matter – iconographical analysis
3. Intrinsic meaning, symbolical values – iconological interpretation

From the Iconographic Point of view, it achieves a fusion of anthropomorphic and abstract elements that fulfill the aesthetic requirements of the literate and socio-cultural background of contemporary society (Mishra, 2015, p. 1). Iconographic studies are of two types.

(1) The descriptive study is concerned mainly with the formal and physical features of the image studied concerning the prescription corroborations available from tests'

(2) The Historical study, which considers the various factors giving rise to and contributing to the gradual evolution of the different iconographic concepts (Mishra, 2015. pp2). Thus, this study is concerned with both descriptive and historical approaches.

This qualitative research study followed the survey of literature and examination of archaeological information. The literature survey included library surveys, map studies, Tripitaka, Jataka, and scholarly studies. The archaeological examination was performed on structural (shape) evidence to identify and analyze the structure of Musical Instruments and other musical evidence in relevant locations namely, Ajanta, Pitalkhora, Sanchi, Bharhut, Mathura, Amaravati, Nagarjunakonda, Gandhara (Pakistan), and Anuradhapura (Sri Lanka).

Objectives of the Study

This study aims to explore the reflection of Buddhist iconography on the evolution of modern musical instruments in India, particularly through an organic analysis of South Asian Buddhist art. In addition, this research aims to examine the Role of Musical Instruments in Early Buddhist Art, Explore the Regional similarities in Buddhist Musical Traditions across South Asia, and Examine the Interaction between Buddhist Iconography and the Design of Musical Instruments.

Literature review

Music in Buddhist Literature

The Buddhist literature like Tripitaka, and Jataka stories, provide abundant of evidence about music. The birth stories of Buddha, called Jataka were assumed to be compiled between the 3rd – 2nd Centuries BCE., exists in various versions, depending on the particular cultural context spread over South Asia, some of which are linked to music. As revealed in the Jataka Stories, the Prince Siddharatha who later became the Lord Buddha namely Gautama, was consistently immersed in music. As a young prince, he was confined to three palaces, as his father King Suddhodana wanted him to become the Universal King *(Chakravarthi),* where he was surrounded by all the luxuries that accompanied by sensuous female musicians and danseurs.

> *'passed the time with the noble music of singing women.. . with tambourines whose frames were bound with gold and which sounded softly beneath the strokes of women's fingers, and with dances that rivalled those of the beautiful Apsarases. There the women delighted him with their soft voices, charming blandishments, playful intoxications...' (*Johnston, p.13)

The *Sona Sutta* in the *Anguttara Nikaya* uses the analogy of tuning a harp (veena) to explain the Buddha's philosophy of the middle path. Since Sona was a veena player, the Buddha taught him about the middle path through the method of tuning the instrument, illustrating the balance required in life(Sona sutta-Bikkhu Sujato, AN.6.55). The dialogue between the Buddha and Sona goes as follows:

> *"What do you think, Soṇa? When you were still a layman, weren't you a good player of the arched harp?"*
> *"Yes, sir."*
> *"When your harp's strings were tuned too tight, was it resonant and playable?" "No, sir."*
> *"When your harp's strings were tuned too slack, was it resonant and playable?" "No, sir."*
> *"But when your harp's strings were tuned neither too tight nor too slack, but fixed at an even tension, was it resonant and playable?"*
> *"Yes, sir."*
> *"In the same way, Soṇa, when energy is too forceful it leads to restlessness. When energy is too slack it leads to laziness. So, Soṇa, you should focus on energy and serenity, find a balance of the faculties, and learn the pattern of this situation*" (Sona sutta-Bikkhu Sujato, AN.6.55).

The *Sakka Panha Sutta* in the *Digha Nikaya* tells the story of Panchasikha, the divine musician of King Sakka, who visited the Buddha. Panchasikha *took his lyre of red vilva-wood* (AN.6.5: Sona Sutta; *verse II*) played his veena and sang, sharing his music with the Buddha during their encounter (AN.6.5: Sona Sutta; *verse V*). The significance is that Panchacika has alluded the name of the Lord Buddha, Dhamma and the Bhikkus and was able to control his voice and the strings simultaneously so that he was able to please the audience. The elbow conversation between Panchasika and the Buddha proves to that

> "From here it will be neither too far nor too near for the Bhagavā to hear the song," and he stood aside. Standing aside, Pañcasikha, the young Gandhabba, let his lyre of red vilva-wood be heard and a song alluding to the Buddha, the Dhamma, to Arahants, and to love.
>
> The song being over, the Bhagavā addressed Pañcasikha, the young Gandhabba, "The sound of your strings, Pañcasikha, harmonizes with that of your song, and the sound of your song with that of your strings; but, verily, Pañcasikha, your strings neither go beyond your song, nor does your song go beyond your strings. But when, Pañcasikha, did you compose these stanzas alluding to the Buddha, the Dhamma, Arahants and to love?"

Similarly, in Jataka No. 243, the Guttila Jataka, it is narrated that the Buddha had once lived as a renowned musician, playing the veena (arched harp) at the court of Benares. According to the story, the Veena he played had seven strings, as described in the text (BO LAWERGREN, p.228).

The first chapter of the *Lankavatara Sutta* is titled 'Ravanadhyesana.' It begins by recounting how King Ravana, along with his retinue, visited the Buddha and performed on musical instrument *Veena* (lute) (Lankavatara Sutta, 2002. Dharmasiri, Gunapala, (ed.), p.69).

The empirical sources as mentioned above, reveal that music plays a significant role in Buddhist literature, particularly in the depiction of the Buddha's life and teachings. Various texts, such as the Tripitaka, Jataka stories, and Suttas, intertwine music with spiritual lessons, showcasing how the Buddha's experiences with music from his early life as a prince to his use of musical analogies helped convey philosophical concepts like mind balance and the middle path.

Pioneers of the study

Bo Lawergren's 1994 paper, *Buddha as a Musician: An Illustration of a Jataka Story*, published in *Artibus Asiae*, explores the role of music in the life of the Buddha and his previous lives as depicted in the Jataka tales. The paper provides a survey of various Buddhist literatures, highlighting the connection between the Buddha and music, especially in his past lives. However, it does not delve into visual representations or offer detailed descriptions of musical instruments. The seven-stringed veena described in Buddhist literature closely aligns with Bharata's *Chitra veena*, as presented by Dr. Thakur Jaidev Singh in 1960. While Singh notes this correlation, he does not provide further details to substantiate his claim, nor does he discuss the specific shape of the veena. Swami Prajnanananda, in his works *A History of Indian Music* (1963) and *A Historical Study of Indian Music* (1981), examines the historical context of Indian musical instruments, including references to the Pitalkora Veena engravings. However, Prajnanananda does not focus on the shape of the veena or its resemblance to the veena concepts found in Buddhist literature. In *Ajanta Part I* (1930), G. Yazdani provides a comprehensive study of the Jataka tales and the related paintings in the Ajanta caves. His

detailed descriptions of the artwork offer musical evidence, with several depictions of musicians and instruments in the paintings, thereby linking music to Buddhist teachings and iconography. Peter Stewart, in his 2024 paper *Gandharan Arts and the Classical World*, includes depictions of music in Gandharan art. Although Stewart presents visual representations of musical themes, music is not the central focus of his work, and he does not explore the musical evidence in depth. Tauqeer Ahmad's research paper titled *Musical Instruments as Depicted in Reliefs of Gandhara Art* (2013) specifically examines musical instruments in Gandharan art. Ahmad's study provides a detailed analysis of the musical depictions and instruments, offering insight into how music was represented in Gandhara's Buddhist art.

The above review curtails the existing studies where no comprehensive analyze has been undertaken reflecting the Buddhist iconography on the evolution of musical instruments in India through an organological lens. By focusing on South Asian Buddhist art, this research could explore how ancient musical instruments, as depicted in Buddhist iconography, have evolved into their modern forms, shedding light on the cultural and artistic continuity across centuries.

Results and discussion:

Prince Siddhartha was a musician and played the harp (veena?). Evidence supporting this is found in the archaeological site of Loriyan Tangai **(fig.01)**, dating back to the 2nd century C.E. This picture shows a person seated on a bench or chair, holding a harp on their lap. With their right hand, they pluck the strings, while their left hand makes contact with them. The same style of instrument depiction and playing techniques can also be found in the Ajanta Caves **(fig.2&3)**, Amaravati **(fig. 4)**,Nagarjunakonda **(fig.5)** and Gandhara **(fig.6 &7)** where similar representations of the instrument and its playing method are shown**.**

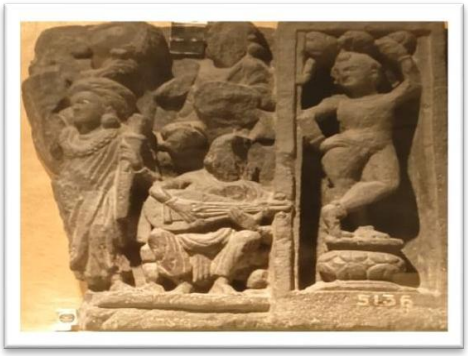

Fig.1

Fig.2

Fig.3

Fig.4

Fig.5

Fig.6

Fig.7

Fig.8

The playing techniques depicted here are similar to those used in the modern Indian Sarod **(fig.8)** and Kashmiri Rabab **(fig.9&10)**, with the instrument positioned in a way that closely resembles their setup.

Fig.9

Fig.10

The stringed instruments depicted in Buddhist art at sites i.e. Pitakhora Caves, Anuradhapura (Sri Lanka), Bharhut, Mathura, Sanchi, and

certain features from Gandhara resemble the bow- shaped harp. The bow-shaped harp, along with its plectrums, has been found in several sculptures from Cave No.4, Pitalkhora caves. There are three such sculptures: two depicting male figures **(Fig.11&12),** and the third portraying a female figure **(Fig.13).** In Fig. 11, the male figure holds a harp against his left shoulder, while in Fig. 12, the male figure positions the harp between his right and left hands, plucking the strings with his left hand. Notably, the male figure in Fig.12 holds the plectrum with his left hand and is adorned with bracelets on his left wrist and a double-robed garland around his neck. The female figure in Fig. 13 is playing a harp, which rests on her lap. She plucks a string with her right hand, holding the plectrum (Kona) between her thumb and forefinger.

Fig.11

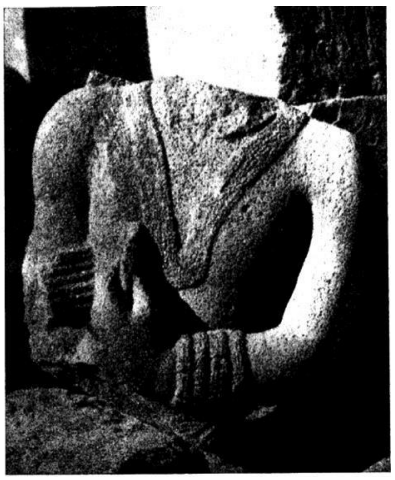

Fig.12

Fig.13

Fig.14

According to the engraving of a harp found at Lohaprasada, Anuradhapura (Sri Lanka), the harp features an elliptical body. Its shape is bow-like, being semi-curved, similar to a bow **(Fig.14)**

Similar bow-shaped harps are depicted on the Sanchi Stupa **(Fig.15&16)** Bharut stupa **(Fig.17)** and Matura **(Fig.18).** These representations show resemblance to the modern Indian harp and swarmandal. Additionally, this type of harp bears similarities to the South Indian instrument, the Yaal (or yaaz); a variant of harp with gut strings that stretch from a curved ebony neck to a boat-shaped resonator.

Fig.15

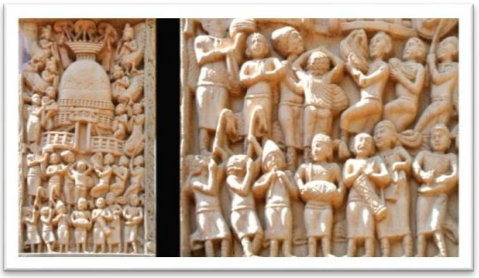

Fig.16

Fig.17

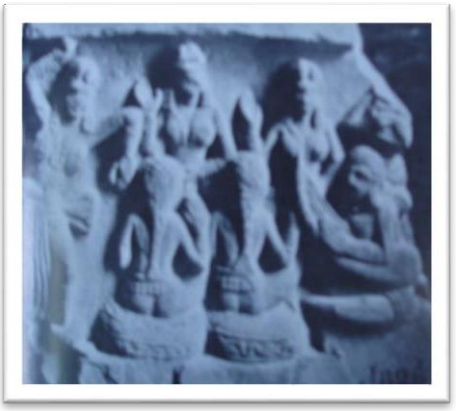

Fig.18

Conclusion

The study of Buddhist iconography and its reflection on the evolution of modern musical instruments in India reveals a fascinating interplay between art, culture, and technology. The examination of

South Asian Buddhist art has shown how symbolic representations and religious narratives, particularly those related to Buddhist teachings and practices, have influenced the design and development of stringed instruments throughout history. From the early depictions of divine figures holding instruments to the more intricate, functional designs of contemporary instruments. The transformation of musical tools also reflects the broader cultural and spiritual shifts within Indian society.

This study further highlights the organological characteristics and the significant role that the Buddhist iconography played in shaping the aesthetics and functionality of stringed instruments, integrating artistic expression with sound production. Buddhist symbols, motifs, and philosophical ideals were not only reflected in the physical appearance of instruments but also in the way music was envisioned as a vehicle for spiritual and meditative experience. The continuous evolution of these instruments demonstrates the adaptability of Indian musical traditions, illustrating how they have incorporated influences from religion, art, and cultural exchange.

In conclusion, the fusion of Buddhist iconography with the evolution of musical instruments in India underscores the complex relationship between art forms and material culture. The legacy of Buddhist art, through its visual and symbolic influence on music, continues to enrich the cultural tapestry of South Asia, serving as a testament to the enduring connection between spiritual beliefs and artistic innovation.

Table of Figures

01. Gautama Buddha playing on a harp (veena?), Lorian Tangai-Pakistan: schist stone (National museum, Calcutta)

02. A Kinnara is playing a string Instrument (Kachhapi Vina?), depicted in Padmapani (also known as the “Beautiful Bodhisattva”: before enlightenment Buddha was known as Bodhisattva) panel, Cave No.1, Ajanta caves

03. The Kinnara with the Lute or Vina is depicted behind the figure of Padmapani in cave No.1. (Similar figure can be seen in a stone sculpture in cave No.4, Ajanta caves).

04. Harp player, Amaravati (National museum, Calcutta).

5. Harp Player, Nagarjunakonda, National museum, Calcutta

6. **Chakhil-i-Ghoundi Stupa**: a stone slab depicts Prince Siddhartha enjoying worldly life where we have representation of the drum, flute and the harp; Peshawar museum Suchandra Ghosh, p.48

7. Man playing a veena. By Smith, Vincent Arthur, 1848-1920 - Book: "A history of fine art in India and Ceylon, from the earliest times to the present day", page 117. (a scene from the life of Gautama Buddha, and a man playing the vina, from the Yusufzai district near Peshawar. Greco Buddhist (Gandhara School), Pakistan, 1st to 3rd century.)

8. **Ustad Ali Akbar Khan in a concert | courtesy: Raghu Rai; https://enewsroom.in/ali-akbar-khan-sarod-player-musician- cinema/**

9. **Kashmir's 13-Year-Old Rabab Player Wins Bal Puraskar Award; https://kashmirlife.net/kashmirs-13-year-old-rabab-player-wins-bal-puraskar-award-339235/**

10. **Kashmiri boy inspiring youth to learn traditional musical instrument Rabab (https://www.aninews.in/news/national/general-news/kashmiri-artist-inspires-youth-to-learn-traditional-instrument-of-rabab20210 6271 51227/**

11. 12 & 13. Harp Players from Pitalkhora, Cave no.4, A History of Indian Music by Swami Prajnananda (1963), p.129-130

14. Harp Players from Anuradhapura Buddhist site, captured by author.

15. Harp player in the right corner: Temptation of the Buddha with Mara and his daughters and the demons of Mara fleeing Sanchi Stupa 1 Northern Gateway. Jhon Marshall p.55

16. Gangulybiswarup - Wikipedia Commons File:Foreigners Worshiping Stupa - East Face - West Pillar - North Gateway - Stupa 1 - Sanchi Hill 2013-02-21 4287.JPG Reformated photograph and highlighted desired portion.

17. Harp playe, Bharut. National museum Calcutta, captured by author.

18. Harp player women, Matura, Nilofar Shamim Haja; DakshinaChitra, p.73, https://www.academia.edu/1085303/ Celebration_of_Life_A_study_of_sculptural_an d_mural_depictions_of_Dance _and_Music_in_Buddhist_Art_of_India

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The Survival of The Fittest: Deconstructing Man-Made Beliefs in Yashpal's /khəccər ɔ:r a:dmi:/ (Mule and the Man)

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Abstract

This paper examines Yashpal's short story /khəccər ɔ:r a:dmi:/ (Mule and the Man) as a powerful critique of man-made religious beliefs and their disruptive impact on the natural order. Through an intricate interplay of themes including The Survival of the Fittest, economic inequality, and human dogmatism, Yashpal unravels how traditional beliefs can often diverge from natural instincts, leading to consequences that ultimately expose the emptiness of these convictions. The narrative, centered on a mule and a man stranded in severe conditions, highlights the clash between humanity's blind faith and the animal's innate survival instincts, presenting nature as both resilient and unforgiving. The study delves into Yashpal's deft integration of Darwinian principles, demonstrating how survival relies on adaptation and alignment with nature rather than adherence to irrational convictions. Additionally, the story portrays economic inequality as a force that reinforces superstition, with individuals often drawn to dogmatic solutions for material gain or comfort. By employing a rigorous literary analysis, this paper reveals how Yashpal uses storytelling as a medium for societal critique, challenging entrenched beliefs and underscoring the need for a more rational, symbiotic relationship with the natural world. The findings affirm Yashpal's commitment to social justice through literature, emphasizing that literature serves not only as reflection but as a call for intellectual discernment and adaptation in the face of changing environmental and social landscapes.

Keywords: Yashpal, short stories, mule and man, Darwinian principle in literature

Introduction

Yashpal (1903-1976), an influential figure in Hindi literature, stands out as a progressive writer deeply engaged with social issues, using his works to

confront prevalent dogmas and injustices. Known for his revolutionary zeal and unyielding commitment to societal reform, Yashpal's writings often explore themes of class struggle, economic inequality, and the oppressive nature of traditional beliefs. In his short story /khəccər ɔ:r a:dmi:/ (Mule and the Man), Yashpal crafts a narrative that serves as a poignant critique of religious superstition and its detrimental impact on human behavior and the natural world in a comparative way. Set against the backdrop of a harsh, unforgiving environment, the story depicts a man and a mule stranded and struggling for survival, exposing the inherent conflict between human dogma and primal survival instincts.

The story's central theme 'The Survival of the Fittest' challenges deeply rooted, man-made religious beliefs, demonstrating how such convictions can hinder one's ability to adapt to natural demands. The stranded mule, representing the innate will to survive, operates according to instincts rather than superstitious beliefs, in stark contrast to the man, who clings to faith and irrationality in a dire situation. Yashpal uses this juxtaposition to highlight how religious dogmas, when applied to life's practical challenges, can blind individuals to the reality of their own needs and surroundings. The mule's instincts symbolize a natural resilience and wisdom that remains unclouded by external ideologies, underscoring a powerful message: survival often depends not on adherence to dogmatic beliefs but on adapting to the natural world.

By examining the mule's pragmatic responses against the man's superstitious inclinations, Yashpal not only critiques the naivety and destructiveness of rigid beliefs but also questions their broader impact on society. The story underscores how superstitious thinking disrupts the natural order, stifling human instincts and, consequently, survival itself. In doing so, Yashpal raises questions about the relevance of tradition in modern life and the importance of rational thought in the face of adversity. Through this narrative, Yashpal's literary vision transcends simple storytelling to address deeper societal issues, reinforcing his role as a pioneer in the progressive literary movement in Hindi literature.

Literature Review

Yashpal's literary contributions emerged in the early 20th century, a period of significant socio-political upheaval in India marked by the struggle

for independence and a concurrent rise of progressive ideologies. As part of the /nəyi: kəha:ni:/ movement (1954-1963) (New Story movement) in Hindi literature, Yashpal's work was instrumental in challenging societal norms, particularly targeting religious orthodoxy and entrenched superstitions that hindered India's social progress. Unlike many writers of his time, who emphasized themes of patriotism or romanticism, Yashpal embraced a distinctly realist approach that focused on social critique. Scholars recognize Yashpal as a pioneering voice who used his writing to question traditional power structures and advocate for rational thought and equality. His characters often find themselves caught between societal expectations and a natural, instinctual drive, highlighting the tensions between social norms and the organic order.

Existing academic analyses of Yashpal's work emphasize his critique of religious orthodoxy, which he perceived as a primary factor inhibiting individual and societal growth. Researchers have noted how Yashpal's narratives consistently dismantle the sacred veneer surrounding religious dogma, exposing its often irrational, oppressive nature. His stories challenge the notion that religious beliefs are absolute, encouraging readers to question their validity in practical, survival contexts. Yashpal's /khəccər ɔ:r a:dmi:/ (Mule and the Man) is one of several works in which he juxtaposes human characters with animals to underscore the folly of adhering to superstitions, highlighting that survival often depends on instincts rather than rigid beliefs. Scholars also argue that Yashpal's portrayal of animals, like the mule in this story, serves as a literary device to emphasize natural order and survival instincts, elements that human characters, bound by religious orthodoxy, often lack.

Yashpal's themes resonate with Darwinian Evolutionary Theory, particularly the concept of 'survival of the fittest,' which he uses to critique societal structures that prioritize rigid beliefs over adaptive, rational responses to challenges. Literary critiques have drawn parallels between Yashpal's work and Darwinian principles, suggesting that his characters embody the conflict between natural survival instincts and socially constructed limitations. This intersection of literature and Darwinian thought has been explored in numerous studies, where Yashpal's work is seen as a call for adaptability and rationalism over blind adherence to tradition. His critique of superstition and societal norms reflects a broader discontent with the repressive elements of

Indian society, situating Yashpal not only as a literary icon but as a catalyst for social change in modern Hindi literature.

Methodology

This paper employs a multidisciplinary approach, combining literary analysis with theoretical perspectives on evolution and survival, to explore Yashpal's /khəccər ɔ:r a:dmi:/ (Mule and the Man). This analysis seeks to uncover how Yashpal uses narrative structures, character symbolism, and themes to critique societal norms and religious dogma. By examining Yashpal's characters and their interactions with both human and animal elements, the study demonstrates how survival instincts challenge the validity of superstitious beliefs and religious orthodoxy, aligning with Darwinian principles of 'survival of the fittest.'

The interpretive methods used in this analysis are primarily rooted in close reading and thematic analysis. Close reading allows for an in-depth examination of language, dialogue, and interactions between characters, which reveal the narrative's underlying critique of superstition. Through this lens, we analyze the protagonist's relationship with the mule as a reflection of humanity's inherent conflict between adhering to societal beliefs and embracing natural instincts. Additionally, literary techniques like symbolism and metaphor are dissected to expose how Yashpal uses the mule a symbol of survival and instinct to question religious dogma, portraying it as a man-made construct that disrupts the natural order.

This paper also incorporates theoretical perspectives from Darwinian Evolutionary Theory to frame Yashpal's commentary on survival. The concept of 'survival of the fittest' provides a framework for understanding the characters' actions and choices, particularly the protagonist's realization that rigid beliefs are incompatible with the demands of real-world survival. Drawing on these evolutionary perspectives, the study interprets the mule's behavior as emblematic of adaptive responses to life-threatening situations, a stark contrast to the human tendency to rely on prescribed beliefs. This contrast is analyzed through Yashpal's narrative structure, which juxtaposes instinct with superstition to reveal their implications on survival.

Finally, the study integrates socio-cultural perspectives to contextualize Yashpal's critique within broader Indian society, where religious orthodoxy often intersects with social norms. This context allows for a deeper

understanding of how Yashpal's characters embody both individual and collective struggles, challenging readers to reassess the role of belief systems in a rapidly changing world. Through these interpretive methods, the analysis reveals Yashpal's literary strategies in deconstructing the narratives around superstition, inviting a re-evaluation of the relationship between natural survival instincts and socially constructed beliefs.

Analysis and Discussion

The rugged setting of the Lahaul Valley, with its harsh weather and treacherous terrain, plays a critical role in Yashpal's /khəccər ɔ:r a:dmi:/ (The Mule and the Man), highlighting the story's central theme of survival. This unforgiving environment forces characters to confront primal instincts, where adaptability becomes essential. The struggle of the survey team and the devotee of Vishnu (who is one of members of the team) against these elements vividly illustrates the consequences of failing to align with natural instincts. The environmental backdrop functions as a mirror for the internal conflicts of the characters, emphasizing the stark contrast between blind adherence to beliefs and the adaptability required for survival.

The mule emerges as a powerful symbol of resilience and nature's unyielding will to survive. Its actions, such as resorting to cannibalism in extreme circumstances, underscore an instinctive alignment with nature's principles. In contrast, the devotee of Vishnu represents humanity's blind faith in cultural conditioning and religious beliefs. Her refusal to remove wet clothing or drink life-saving brandy actions dictated by her adherence to religious customs highlights a tragic inability to prioritize survival. This rigid behavior, juxtaposed with the mule's pragmatic instincts, critiques the limitations of dogma in the face of life-threatening circumstances.

The narrative's climax illustrates the conflict between religious beliefs and natural instincts. The devotee of Vishnu's tragic death, resulting from her unwavering commitment to ritual purity, exemplifies the dangers of ignoring the natural order. In contrast, the mule's survival serves as a stark reminder of the importance of adaptability and self-preservation. Through this dichotomy, Yashpal questions the validity of man-made myths that contradict the demands of survival, suggesting that blind faith often leads to catastrophic outcomes.

The story incorporates Darwin's concept of "Survival of the Fittest" as a critique of humanity's detachment from nature. The mule's ability to adapt

to extreme conditions aligns with Darwinian principles, while the devotee of Vishnu's rigid behavior demonstrates the consequences of non-adaptive tendencies. Her rejection of practical survival measures, driven by her faith, underscores the dangers of cultural conditioning that inhibits rational decision-making. Yashpal uses this contrast to illustrate the critical need for aligning human behavior with natural instincts.

Furthermore, Yashpal critiques the societal structures that perpetuate superstitions, linking them to economic exploitation and ignorance. Religious beliefs, as seen in the devotee of Vishnu's actions, often overshadow rationality, leaving individuals vulnerable in the face of real-world challenges. The narrative suggests that these beliefs are not just personal but are deeply entrenched in a societal framework that prioritizes faith over practical survival strategies.

The themes of survival and the human condition are woven throughout the story. The fragility of human life is starkly depicted through the dire circumstances faced by the survey team and the devotee of Vishnu. Their inability to adapt contrasts sharply with the mule's instinct-driven survival. The mule's actions, while unsettling, reflect the ruthless realities of natural selection, emphasizing the importance of aligning with nature's principles for survival. The contrast between the mule and the devotee of Vishnu serves as a broader metaphor for society's detachment from natural instincts. The mule's adaptability enables its survival, while the woman's devotion to outdated customs leads to her demise.

In essence, /khəccər ɔ:r a:dmi:/ (The Mule and the Man) critiques the dangers of blind faith and highlights the necessity of rationality and adaptability in the face of nature's challenges. By intertwining narrative, symbolism, and Darwinian Theory, Yashpal creates a powerful commentary on humanity's disconnection from the natural world. The story's tragic climax underscores the consequences of prioritizing dogma over pragmatic action, advocating for a balanced approach that respects both natural laws and rational thought.

Conclusion

In conclusion, *khəccər ɔ:r a:dmi:* (*The Mule and the Man*) emerges as a deeply reflective and socially charged narrative that transcends the boundaries of a simple tale about survival in harsh conditions. Through the powerful

juxtaposition of the mule's instinctive wisdom and the Brahmin woman's unwavering commitment to religious orthodoxy, Yashpal exposes the inherent danger of elevating dogma above life itself. The natural environment in the story is not merely a setting but an active, indifferent force that demands adaptability. Against this relentless backdrop, the characters' choices acquire symbolic weight, revealing how rigid belief systems can render human beings vulnerable in moments that require practical judgment and flexibility.

Yashpal's critique operates on multiple levels religious, social, and philosophical. By presenting the mule as a creature guided purely by instinct and self-preservation, he subtly invokes evolutionary principles, suggesting that survival favors those who can adjust to their surroundings. In contrast, the human characters, particularly the devotee of Vishnu, become emblematic of a society shackled by inherited customs and unexamined traditions. Her refusal to drink brandy for warmth or to remove her wet clothes, even in life-threatening conditions, illustrates the tragic consequences of allowing ritual purity to outweigh the fundamental instinct to survive. Through this contrast, Yashpal underscores the irony that the so-called "rational" human is often less adaptable than an animal.

Moreover, the story critiques the societal structures that perpetuate such rigid ideologies. Religious orthodoxy, as portrayed here, is not simply a matter of personal faith but a system reinforced by cultural expectations and social conditioning. Yashpal suggests that these structures often serve to maintain control and preserve outdated hierarchies, even at the cost of human welfare. The woman's suffering, therefore, symbolizes not just individual stubbornness but the broader human tendency to cling to beliefs that provide identity and moral certainty, even when they conflict with empirical reality.

At a deeper allegorical level, *The Mule and the Man* reflects the broader human condition. It questions whether civilization, with all its rituals and moral codes, has distanced humanity from the primal wisdom necessary for survival. Yashpal does not advocate for the abandonment of culture or faith; rather, he calls for discernment a harmonious balance between spiritual values and rational thought. His message resonates as a plea for intellectual awakening, urging individuals to examine whether their beliefs empower them or endanger them.

Ultimately, the story serves as a timeless reminder that adaptability is not a betrayal of tradition but a prerequisite for survival and progress. Yashpal

affirms that true strength lies in the ability to evolve, to question inherited assumptions, and to align one's actions with the realities of the natural world. Through vivid imagery, sharp characterization, and penetrating social commentary, he transforms a seemingly simple narrative into a profound meditation on faith, reason, and human resilience. In doing so, he reinforces literature's enduring role as a mirror to society challenging complacency, exposing contradictions, and inspiring the courage to embrace change.

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A Cost-Effective Post-Production Workflow and Equipment Chain for Independent Filmmakers

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Abstract

This study investigates a low-cost post-production workflow and equipment chain that meets the financial constraints of the Sri Lankan film industry while maintaining industry standard visual quality. Post-production represents a significant amount of the production costs, often challenging independent and student filmmakers and other low-budget productions. The research identifies current post-production systems, evaluates their costs and standards, and explores human audio-visual perception to identify an affordable alternative. The proposed system incorporates a cost-effective combination of hardware and software optimized for efficient editing, color grading and creating DCI-recommended outputs. The workflow emphasizes streamlined processes including proxy-based offline editing, high-resolution confirmation, and final delivery to expected quality. The system and workflow were validated through the audio-visual content and a comparative analysis with two alternative versions. Focus group feedback assessed technical parameters such as brightness, contrast, color accuracy and emotional impact. The results show that the proposed workflow outperformed its counterparts by providing high-quality outputs within tangible constraints and budget constraints. The study concludes that the proposed workflow offers a practical solution for the film industry in Sri Lanka, balancing affordability with visual satisfaction. However, given the rapid evolution of post-production technology and artificial intelligence, continuous adaptability is essential to ensure long-term relevance and sustainability.

***Keywords**:* Post-production technology, audio-visual perception, cost-effective Post-production.

Introduction

In the film production process, post-production plays crucial role in shaping a film's final output. It is a multifaceted process that includes editing, sound

design, color correction, visual effects (VFX) and mastering. For independent filmmakers, the post-production phase can often be a significant challenge, involving significant financial and technological investments (Bordwell & Thompson, 2004). However, digital technologies and innovations in post-production software and hardware have led to the democratization of filmmaking tools, allowing independent filmmakers access to high-quality post-production facilities at lower costs. Despite this, the challenge of managing high production costs remains, especially in emerging film industries such as Sri Lanka (Perren, 2012). The purpose of this study is to explore how independent filmmakers can use innovative post-production workflows and equipment chains to reduce costs while maintaining industry standards.

The rapid evolution of post-production technology has transformed traditional workflows. In the past, cutting physical film strips in film editing was a tedious and time-consuming process. With the advent of digital editing technologies, the entire process has become more streamlined and cost-effective (Dancyger, 2011). Modern digital editing tools such as Avid Media Composer, Final Cut Pro, and Adobe Premiere have become the industry standard, giving filmmakers more flexibility in their workflows and reducing the need for expensive physical media (Brown, 2016). Moreover, the rise of cloud computing and storage solutions has made it easier for independent filmmakers to access powerful software remotely, thereby reducing the need for expensive on-site infrastructure (Gibson, 1966). These technological advances have not only made post-production more affordable but have also allowed filmmakers to maintain a high level of creativity and quality in their work.

However, despite these innovations, high post-production costs plague many independent filmmakers, especially in countries like Sri Lanka where budgets are often limited. According to Bordwell and Thompson (2004), post-production typically represents a significant portion of a film's total budget, which can be a daunting reality for small-scale productions. Furthermore, the increasing complexity of post-production tasks, such as 3D rendering, color grading, and advanced sound mixing, require specialized expertise and equipment that further increases costs (Holman, 2010). The need for high-end technology such as Dolby Atmos for sound design and specialized visual effects software makes it more difficult for independent filmmakers to meet

professional standards without overspending (Jackson, 2014).

To address these challenges, this study seeks to identify cost-effective alternatives to traditional post-production workflows. A critical component of this research will be to evaluate current post-production practices in Sri Lanka and assess how new, affordable solution can be integrated into existing workflows without compromising quality.

The research question addressed in this study is whether alternative production techniques can significantly reduce production costs without compromising the viewing experience. High post-production costs are particularly burden for the Sri Lankan film industry, sometimes limiting creative capability and narrowing the access to advanced technology. Facing this challenge, the research attempted to balance cost-effectiveness of the post production aspect with audience satisfaction.

To achieve this, the study focused on several objectives: to identify the current post-production equipment and technology in Sri Lanka, the standards and associated costs, and to find out the audience's basic cognitive ability in understanding audio-visual content. The aim was to validate the finished output with a technical team using a strict fixed control system, propose and test alternative solution for film post-production. This comprehensive approach ensured that the proposed solutions were both practical and aligned with industry and audience expectations.

The theoretical frame of this research is based on two main theories: Human Perception and Image Quality Model and Media Richness Theory. The Human Perception and Image Quality Model explores the limits and capabilities of human visual perception with an emphasis on how audio-visual outputs are experienced and evaluated by audiences. This model ensures that the proposed post-production workflow aligns with the perceived constraints, delivering content that maintains high quality without exceeding unnecessary technical specifications. Media richness theory, on the other hand, focuses on the effectiveness of communication through different media formats, highlighting the importance of clarity, immediacy, and richness in conveying information. Together, these theories provide a robust framework for optimizing the balance between quality, cost and audience engagement in audio-visual content creation.

In summary, while advances in technology have made post-production more accessible, independent filmmakers still face significant challenges in

managing costs. This research will examine the intersection of post-production technology, cost reduction, and workflow optimization, ultimately proposing a model that can assist filmmakers in navigating post-production complexities while maintaining high quality standards.

Literature Review

Film Post-Production Technology

The history of film post-production is intrinsically linked to the broader technological advancements within cinema. Initially, the post-production process involved manual techniques, which were time-consuming and labour-intensive. Early post-production primarily consisted of cutting and splicing physical film stock, a practice pioneered by editors like Edwin S. Porter and his innovations in editing and narrative structure (Crafton, 1999). This early form of post-production was vital in shaping narrative cinema, and its development marked a significant shift from the rudimentary days of filmmaking to a more refined process.

In the early days of cinema, the post-production process was rudimentary. Filmmakers physically edited the film stock by cutting and splicing it to create the desired narrative flow. According to Bordwell and Thompson (2004), this technique of film editing remained the standard until the mid-20th century. With the advent of more sophisticated technologies, filmmakers began to experiment with sound and color, adding another layer of complexity to post-production (Bordwell & Thompson, 2004).

Early Film Post-Production

In the early 1900s, the use of editing machines such as the Moviola, a hand-cranked editing tool, allowed editors to work with film stock more efficiently. These early devices were critical to the development of the film industry, enabling editors to splice and reassemble scenes. Early film editing focused heavily on the practical needs of the filmmaker, ensuring that footage could be pieced together to form a coherent narrative (Reisz & Millar, 2010). This process remained fully manual until the digital revolution, which transformed the method of editing.

Linwood G. Dunn's innovations in film editing technology during the early 20th century revolutionized the industry. Dunn's work in developing the first optical printers and his advancements in film development (VFX)

techniques helped to streamline post-production workflows (Gomery, 2005). These developments were pivotal, providing filmmakers with greater flexibility and precision in editing, sound synchronization, and color correction.

Edwin S. Porter's early experiments with editing and storytelling in cinema, particularly his work with the "Mapport" editing technique, were critical in establishing the grammar of cinematic storytelling. Porter's contributions to the development of editing conventions and the synchronization of film and sound set the stage for the more advanced technologies that would follow (Musser, 1991). His innovations marked a shift toward the use of editing as a tool for shaping narratives rather than just technical adjustments.

With the development of sound technology in the 1920s and 1930s, film editing technology evolved to accommodate the synchronization of sound and image. This era saw the emergence of more sophisticated editing machines that could handle both film stock and sound tape. The integration of sound into cinema brought about a shift in the way post-production processes were conceived, requiring new approaches to editing, mixing, and dubbing (Gomery, 2005).

Introduction of Digital Technology for Editing

The introduction of digital editing in the late 20th century fundamentally changed the post-production landscape. The move from analog to digital editing provided filmmakers with greater flexibility, speed, and precision (Dancyger, 2011). Digital non-linear editing (NLE) systems, such as Avid Media Composer and Adobe Premiere Pro, revolutionized the editing process by allowing filmmakers to cut, paste, and rearrange scenes on a computer screen without the need for physical film (Brindle, 2014). This advancement eliminated many of the constraints imposed by traditional film editing and opened up new creative possibilities.

As digital editing systems became more widely adopted, filmmakers began to integrate multiple media sources, such as digital video, computer-generated imagery (CGI), and traditional film footage, into a cohesive post-production workflow. This shift to intermedia workflows has allowed for the seamless blending of different formats, leading to more sophisticated visual effects and higher production values in modern films (Goulekas, 2001).

Negative plate engraving, which was once an essential part of film production, gradually became obsolete as digital tools took over the role of combining and manipulating film elements.

The integration of sound into cinema is one of the most significant technological advancements in film history. Initially, films were silent, and sound was added later in the post-production process. With the advent of synchronized sound technology, filmmakers could now combine speech, music, and sound effects in ways that significantly enhanced the cinematic experience (Gomery, 2005). The introduction of multi-track sound systems and the eventual development of digital sound mixing technologies, such as Dolby Atmos, further elevated the role of sound in post-production (Jackson, 2014). These advancements enabled the creation of more immersive audio-visual experiences.

Color processing in film has also evolved significantly over the years. Early color films were created using techniques like hand-tinting and stenciling, but these were labor-intensive and expensive processes (Rickitt, 2007). The introduction of Technicolor in the 1930s marked a major leap forward in color processing technology, offering filmmakers the ability to produce vibrant, full-color films (Belton, 1992). Over time, the process was refined, and new techniques, such as digital color grading, replaced older methods.

The development of color mixing technologies, including the digital manipulation of color during post-production, has been one of the most important advancements in modern filmmaking. Digital color grading software, such as DaVinci Resolve, allows filmmakers to make precise adjustments to color tones, saturation, and contrast, giving them greater control over the visual aesthetic of their films (Hullfish, 2013). This level of control has made color correction a crucial aspect of the post-production process, helping to achieve the desired look and mood of a film.

In the digital age, the range of technologies available for post-production has expanded beyond editing and sound design to include advanced visual effects (VFX), color grading, and 3D rendering. The use of digital tools to enhance visuals and sound has become standard practice in the industry, with technologies like CGI and motion capture enabling filmmakers to create immersive worlds and characters (Goulekas, 2001).

In modern post-production, broadcasting and the incubation of content play crucial roles in the distribution and preparation of films for wide release. The process of broadcasting involves the conversion of films into formats suitable for television, streaming, or cinema. This step is integral to ensuring that the final product reaches its intended audience. Incubation, on the other hand, refers to the testing and feedback phase, where test audiences are used to gauge the effectiveness of the post-production decisions, particularly in terms of pacing, sound, and visual appeal.

Digital Post-Production Workflow

Digital post-production workflows have revolutionized how films are made. The DCI (Digital Cinema Initiatives) standard is one such milestone, which ensures that digital films meet the technical standards for theatrical exhibition (Perren, 2012). Modern filmmakers use various digital tools in tandem to create seamless post-production workflows, from initial editing through to final mastering. These workflows involve collaboration across different departments, including editing, color grading, sound design, and VFX, all of which rely heavily on digital technologies for efficiency and quality.

The DCI standard has played a pivotal role in the adoption of digital cinema by major studios and independent filmmakers alike. It ensures that digital films are compatible with projection systems worldwide and helps streamline the distribution of films across theaters and digital platforms. For independent filmmakers, the DCI standard offers a pathway to high-quality cinema presentation at a fraction of the cost of traditional film stock (Bordwell & Thompson, 2004).

Modern sound mixing technologies, such as Dolby Atmos, have raised the bar for audio-visual experiences. Dolby Atmos allows sound to move freely around the audience, creating a more immersive experience than traditional surround sound systems (Jackson, 2014). This technology has become standard in high-budget films and has begun to permeate independent filmmaking, offering filmmakers the tools to create professional-quality soundscapes on smaller budgets.

Post-Production Technology and Cost

The evolution of post-production technology has also brought significant changes to the cost structure of filmmaking. While early filmmaking required expensive film stock and elaborate equipment, the advent of digital technologies has reduced these costs substantially (Dancyger, 2011). However, as the complexity of post-production tasks increases, the cost of high-end equipment and software remains a significant factor for filmmakers, particularly those working with limited budgets (Holman, 2010).

The costs associated with modern post-production technologies are a critical concern for filmmakers, especially in developing markets. High-end software and hardware, such as advanced color grading tools and 3D rendering systems, come with steep price tags, which can be prohibitive for independent filmmakers working on low budgets (Goulekas, 2001). Despite the affordability of some tools, the cumulative cost of digital post-production can still place a significant burden on filmmakers.

In high-budget productions, the cost of post-production often exceeds other stages of filmmaking. Case studies of major films show that a substantial portion of the budget is allocated to post-production tasks such as editing, sound mixing, and visual effects (Brownlow, 1979). These costs are often absorbed by the production company, which has access to advanced technology and a large team of specialists.

Despite the high costs associated with post-production, this phase remains the most creative and transformative stage of filmmaking. It is during post-production that filmmakers can refine their vision, enhance performances, and fully realize the artistic potential of the film. As Brownlow (1979) argues, post-production is the phase where the "raw material" of the film is sculpted into a finished work of art.

Global Trends in Low-Cost Post-Production

In recent years, the global film industry has witnessed significant shifts in post-production practices. These changes have been largely influenced by technological advancements, economic pressures, and the increasing accessibility of digital tools. Independent filmmakers, particularly those operating within constrained budgets, have been quick to adopt innovative approaches to achieve professional results without incurring high costs.

One of the most notable trends in low-cost post-production is the democratization of technology. High-quality editing software such as DaVinci Resolve, Adobe Premiere Pro, and Final Cut Pro X are now available at affordable prices or even for free in some cases. These tools offer a suite of advanced features, including color correction, sound editing, and visual effects integration, which were once reserved for high-budget productions (Goulekas, 2001). Furthermore, cloud-based platforms like Frame.io and Adobe Creative Cloud enable collaborative workflows, allowing teams from across the globe to work together seamlessly.

Another emerging trend is the use of artificial intelligence (AI) and machine learning in post-production. AI tools such as Adobe's Sensei and Runway ML are increasingly being utilized for automated editing, noise reduction, and even generating special effects. These technologies reduce the time and labor traditionally required in post-production, enabling filmmakers to focus on creative decisions rather than technical challenges (Xyzparis.xyz, 2023). Additionally, AI-powered tools are being used to upscale low-resolution footage, further expanding the possibilities for filmmakers working with limited resources.

The adoption of open-source and alternative software is also gaining traction. Blender, an open-source 3D animation and compositing tool, has become a popular choice for independent filmmakers and small studios due to its robust features and lack of licensing costs. Similarly, Audacity is widely used for audio editing in low-budget projects. The open-source community fosters a collaborative ecosystem where filmmakers can access tutorials, plugins, and support to enhance their workflows (Alexis Van Hurkman, 2014). Hardware advancements have also played a crucial role in low-cost post-production trends. Modern computing devices, including laptops and compact desktop setups, now have the processing power required to handle high-definition video editing and rendering. External GPU (eGPU) solutions further enhance processing capabilities, allowing budget-conscious creators to work with 4K or even 8K footage without investing in expensive workstations (Brindle, 2014).

In the sound domain, innovations like Dolby Atmos provide immersive audio capabilities at increasingly accessible price points. Affordable tools such as iZotope RX enable detailed audio cleaning and mixing, which were traditionally done in high-cost studios (Jackson, 2014). Sound editing,

previously a separate and expensive process, can now be integrated into the overall post-production workflow using comprehensive digital tools.

Global outsourcing is another trend shaping low-cost post-production. Filmmakers in countries with high production costs increasingly collaborate with professionals in regions where post-production services are more affordable. For example, countries like India, the Philippines, and Eastern Europe have emerged as hubs for cost-effective post-production, offering skilled labor for editing, VFX, and sound design at competitive rates. This trend is facilitated by high-speed internet and cloud-based file-sharing platforms (Perren, 2012).

Lastly, the rise of remote working has transformed how post-production teams operate. The COVID-19 pandemic accelerated the shift to remote workflows, pushing the industry to adapt quickly. Tools like Zoom, Slack, and collaborative editing platforms are now staples of the filmmaking process. These technologies allow filmmakers to save on physical studio space and travel expenses, making low-cost production models more viable (Xyzparis.xyz, 2023).

The convergence of these trends illustrates a promising future for filmmakers working within financial constraints. As technology continues to evolve, the accessibility of professional-grade tools and workflows will only increase, empowering creators worldwide to produce high-quality content on limited budgets. These advancements also highlight the importance of adaptability and innovation in navigating the dynamic landscape of global film industry.

Methods and Methodology

The methodology for this research aimed to evaluate the post-production technology used in Sri Lanka, and to develop a low-cost alternative post-production workflow that maintains a enough-quality audio-visual output within the limits of human audio-visual perception.

The study is rooted in constructivism, which emphasizes that knowledge is actively constructed through interactions and experiences. This approach aligns with the goal of understanding and improving post-production practices by directly engaging with the tools, workflows, and outcomes within real-world contexts.

The research adopted an inductive approach, focusing on deriving insights from specific observations and experiences to form broader conclusions. By analyzing the technical processes and their outcomes, the study aimed to construct an optimized, cost-effective post-production workflow based on empirical data.

A qualitative research method was employed to provide an in-depth exploration of the complexities of post-production practices. This method allowed for a detailed analysis of the workflows, tools, and outcomes, considering both technical and perceptual factors.

The study utilized a case study strategy to analyze post-production practices within the Sri Lankan context. The case study approach provided a detailed examination of the identified workflow and equipment chain, offering insights into the practical challenges and potential improvements.

To validate the proposed low-cost post-production workflow and equipment chain, an audio-visual (AV) content piece was created. This content was developed using the identified workflow and tools, adhering to the quality standards determined during the research process.

The created content was tested with a focus group to assess its effectiveness in delivering quality audio-visual output which can be entertain. The focus group consisted of carefully selected individuals who represented potential audience members.

The AV content was shown to the focus group in a controlled environment, ensuring that all participants experienced the same technical and perceptual conditions.

1. **Questionnaire Feedback**
   After viewing the content, the focus group participants were provided with a structured questionnaire. The questionnaire was designed to capture their feedback on various aspects of the AV content, including Colour, Brightness, Contrast, Image clarity, and overall impact.

2. **Discussion Sessions**
   Following the completion of the questionnaire, participants engaged in a guided discussion to elaborate on their feedback. These discussions provided valuable qualitative data, revealing deeper insights into the strengths and limitations of the proposed workflow.

Thematic analysis was used to analyse the feedback gathered from the focus group. This method involved in identifying recurring themes and patterns in the data, which were then used to evaluate the effectiveness of the proposed low-cost post-production solution. The analysis helped determine whether the workflow met the desired quality standards and identified areas for further improvement.

In summary, this methodology combined constructivist philosophy, an inductive approach, qualitative research, and thematic analysis to explore and validate a cost-effective post-production workflow. The creation and testing of AV content ensured that the findings were grounded in practical outcomes, contributing to the development of a practical and viable alternative for the Sri Lankan film industry's post-production needs.

Results and Discussion

Audio Visual Perception and assessment of Image Quality

The foundation of film technology is deeply rooted in human audio-visual perception, particularly phenomena like persistence of vision and the phi phenomenon. Persistence of vision, first described by Peter Mark Roget, is the optical illusion where the human eye retains an image for a fraction of a second after it disappears, allowing for the seamless perception of motion in rapidly displayed frames (Bennington and Gay, 2006). Complementing this is the phi phenomenon, identified by Wertheimer (1912), which explains how the brain perceives continuous motion when viewing a series of static images in rapid succession.

Optical illusions occur when the brain misinterprets visual information, often leading to a distorted perception of reality. These illusions can affect how viewers perceive image quality, particularly in film and media. For instance, illusions such as the "Müller-Lyer" effect, where two lines of equal length appear different due to the surrounding arrows, demonstrate how contextual cues can alter the perception of spatial relationships. Similarly, the "brightness contrast illusion" can cause the brain to perceive objects as brighter or darker depending on their surrounding light, even when they are the same. These phenomena affect how viewers experience images in films, as the brain may process visual elements differently based on perceived contrast, depth, or movement, thus influencing the overall perceived quality of the image (Gregory, 1997; Palmer, 1999). In film post-production,

understanding these illusions is crucial for color grading and visual effects, ensuring that the intended visual message is accurately communicated to the audience.

Technology and Cost of Post production in Sri Lankan Film Industry

The technology budget for post-production in Sri Lanka varies widely depending on the scale of the production and the specific tools used by the post-production team. Through interviews with five technicians and observing their post-production systems, it became clear that industry-standard software and high-performance hardware are essential to achieving the desired quality of the final output. The technologies employed in the post-production workflows include Avid, DaVinci Resolve, and Adobe Premiere Pro, which are widely recognized for their advanced editing and color-grading capabilities.

Avid Media Composer is a professional non-linear editing (NLE) software that is frequently used in larger film productions. It provides powerful media management features and supports complex editing workflows, making it a preferred choice for editors working on feature films and television series. DaVinci Resolve, primarily known for its color grading functionality, is also widely used for editing and post-production in the Sri Lankan industry. Its advanced color grading features enable filmmakers to achieve cinematic color correction, giving their films a polished, professional look. Adobe Premiere Pro, which is also used by some technicians, is known for its flexibility and integration with other Adobe Creative Cloud tools, making it a popular choice for smaller-scale productions.

The technicians observed in this study also rely on high-performance workstations to handle the demanding computational tasks required for film editing, color grading, and visual effects work. The most commonly used machines include high-capacity Windows-based workstations and Apple Mac Pro workstations. These systems are equipped with powerful processors, large amounts of RAM, and graphics cards designed to handle the processing power required for professional post-production. Additionally, efficient storage solutions are integral to the workflow, as post-production often involves handling large video files that need to be accessed and edited in real time. Many technicians use RAID (Redundant Array of Independent Disks) storage systems, which provide high-speed data transfer and redundancy to protect

against data loss.

Based on the interviews and observations, the total budget for post-production technology in Sri Lanka ranges from 9.5 lakhs to 15 lakhs Sri Lankan rupees. The variation in budget is mainly due to the scale and complexity of the production, as well as the specific hardware and software configurations chosen. The higher-end systems, such as those using Avid Media Composer and DaVinci Resolve with recommended workstation computers and storage solutions, are typically found in larger, more commercial projects that require greater processing power and storage capacity. On the other hand, smaller, independent productions may rely on more affordable software like Adobe Premiere Pro and less powerful workstations, which bring down the overall cost of post-production.

These costs represent a significant portion of the overall production budget, particularly for independent filmmakers working with limited resources. While these industry-standard tools and systems are essential for achieving high-quality results, the financial constraints of independent filmmakers in Sri Lanka highlight the need for more cost-effective solutions. In the face of rising technology costs, it is increasingly important for filmmakers to explore alternative post-production workflows that maintain a balance between quality and affordability, allowing them to achieve expected output without exceeding the budget.

Focus Group Feedback Analysis

The focus group provided valuable data into the technical and experiential aspects of the content produced using the proposed low-cost post-production workflow and equipment chain. The analysis revealed strong evidence supporting the feasibility of this approach while identifying areas for improvement. Three primary parameters image quality, content experience, and emotional impact were evaluated and compared across three different versions of the same content (A, B, and C), where "A" represented the content created using the proposed system.

Image Quality

The feedback on image quality emphasized key elements such as brightness, contrast, sharpness, and color accuracy. Among the three versions, content "A" received the highest preference, demonstrating superior sharpness

and resolution. Participants noted that the brightness and contrast levels in "A" were balanced, ensuring clarity without overexposure or loss of detail. The color accuracy was highlighted as a strength, as the proposed workflow incorporated LUT locking and color smoothing processes, effectively minimizing discrepancies and ensuring consistent reproduction. While participants acknowledged some minor limitations in achieving ultra-high resolution outputs, these were within acceptable perceptual limits and did not interfere with the viewing experience.

Content Experience

Feedback on overall content experience was mixed but leaned toward positive responses for "A." Participants described the content as engaging and immersive, with effective synchronization between audio and visual elements. By contrast, versions "B" and "C," created using alternative workflows, were noted to have inconsistent image quality and less engaging narratives. Suggestions from the focus group included further refinement of raw footage during production to enhance the integration of post-production effects. These insights highlight the importance of maintaining a balance between technical quality and creative storytelling to sustain viewer engagement.

Emotional Impact

The emotional impact of the content was a critical factor in the evaluation. Content "A" evoked stronger emotional reactions compared to the other versions, attributed to its clearer and sharper images. Participants reported that the high technical quality heightened their cognitive and emotional connection to the narrative, reinforcing the importance of technical excellence in influencing audience perception. In contrast, technical weaknesses in versions "B" and "C" detracted from the immersive experience and reduced the overall emotional impact.

Conclusion and Remarks

This study investigated the development of a low-cost post-production workflow and equipment chain tailored for the Sri Lankan film industry. The aim was to address the high costs associated with traditional post-production processes while ensuring the quality of audio-visual outputs met professional standards. Through analysis of current practices and feedback from focus

group evaluations, the proposed system was found to be both cost-effective and practical.

The proposed system configuration balances affordability with performance. It features a workstation powered by an 8-core Xeon processor and 32 GB of RAM, enabling smooth multitasking and efficient handling of complex editing tasks. Dual 1 TB SSD drives provide ample storage and high-speed media management, while an Nvidia GeForce GPU with 8 GB VRAM ensures robust graphics processing and accurate color output. The system also incorporates high-quality IPS monitors for precise color calibration

The workflow is designed to optimize efficiency at every stage of post-production. It begins with proxy generation in DaVinci Resolve, allowing offline editing on lower-spec systems. Once editing is finalized, the workflow transitions to full HD or 2K resolution for color grading, leveraging the system's hardware to achieve accurate and visually appealing results. The final stage involves upscaling the edited content and creating a Digital Cinema Package (DCP) using DCP-o-Matic, ensuring compliance with cinema projection standards. This streamlined workflow minimizes costs while maintaining technical excellence.

Feedback from the focus group evaluations confirmed the effectiveness of the proposed system and workflow. The content produced using this configuration consistently outperformed alternatives in parameters such as image sharpness, color accuracy, and overall emotional engagement. Participants highlighted the system's ability to deliver high-quality outputs while acknowledging the importance of strong raw footage and creative storytelling to enhance the final product.

In conclusion, this study demonstrates that a cost-effective post-production workflow can significantly benefit the Sri Lankan film industry, enabling filmmakers to achieve professional results without incurring prohibitive expenses. By adopting the proposed system and workflow, independent filmmakers and low-budget productions can overcome financial constraints while maintaining high standards of quality. Future work should focus on further refining raw footage preparation and increasing awareness of technical standards to maximize the workflow's potential for industry-wide adoption.

In the context of rapid technological advancements and increasing integration of artificial intelligence (AI) in the film industry, ensuring the long-

term relevance of these findings presents a significant challenge. While the proposed workflow is effective and accessible today, evolving technologies may require ongoing updates to maintain its viability. Therefore, this study's recommendations should be viewed as a flexible foundation rather than a fixed solution, encouraging filmmakers to adapt and integrate emerging technologies to sustain their competitiveness and creative potential in the local industry.

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Portuguese imprint in Sri Lankan Art and Culture: Historical and Aesthetic expedition

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Abstract

The appearance of the Portuguese in Sri Lanka (Ceylon) makes a significant turning point in the history of the island. Simply, it marked the end of medieval period in Sri Lankan polity, especially the ruling by a kingship, and the beginning of modern era in Sri Lanka. When we look in to the matter from a deeper sense, it is apparent that their arrival enabled transform the Sri Lankan society from its Indian, or more precisely the Asian mould, and gave it a unique western identity that lasted for about five centuries under colonial powers vested by three consecutive power unions namely: Portuguese (1505-1658), Dutch (1658-1796) and the British (1796-1948). Of which, the inspiration of Portuguese is immense due to its everlasting physiognomies embedded in Sri Lankan culture and society to date. Their inspiration is evident in almost every aspect of Sri Lankan culture: language, religion, socio-cultural affairs, dress patterns, food, art and architecture, music, dance, etc., Thus, it appears so important to have an in-depth study to identify and examine the influences/ inspirations of Portuguese that caused a significant transcendence of Sri Lanka's culture and other major aspects to date.

The study expects carrying out a major literature survey from Sri Lanka and overseas, with a particular focus on evidence found from Portugal: in government and private/ individual archives, libraries, galleries and parlours, which are under the custody of Portuguese government with their special permission, and a field study from Sri Lanka and in Portugal to map and detail the similarities, identities, and remarkable contributions and intercourse between two countries in terms of restoring the cultural values of the civil community. The excavated data, and evidence will be published in the form of complete volume covering all the areas and will also be uploaded into the relevant

academic and research databases with the permission of the relevant authorities. New findings will be published in accredited Research Conferences and journals.

Keywords: Portuguese in Sri Lanka, Portuguese Creole, Colonial architecture, Fortresses in Sri Lanka, Sinhalese lingua dialects

Pioneering work on the subject

It is apparent that many a scholars have examined and analyzed the facts and evidence to embrace the Portuguese imprint in the country from different perspectives, whereas its influence on Asian cultural transformation has also been discussed at varying degrees by scholars at home and overseas. Among the pioneering studies, those carried out by Shihan de Silva Jayasuriya (1996-2008) is significant in which she has discussed the influence of Portuguese Creole in detail. John Holm (1994) examines the influence of Portuguese in a similar context in which she discusses the significance of Pidgins and Creoles with special reference to Sri Lanka. C.R. de Silva (1972, 1987, 1994, 2001 & 2002) studies about the Portuguese influence in Sri Lanka from various perspectives in that he examines the common features of Portuguese imprint in Sri Lanka and South Asia with special reference to Maldives. K.M. de Silva (1981) in his "A History of Sri Lanka" paid much attention to study about the significant turning points of the polity of Sri Lanka in that the legendary role played by the Portuguese has been analyzed from a broader perspective. Apart from major studies by Sri Lankan scholars some overseas scholars i.e. W. Fox (1819), J. Ferguson (1903), S. Ghana Prakasar (1919), Hugh Nevill (1904), John Holm (1988), and many of the scholars have examined the Portuguese influence from various perspectives. The latest study is seen in the work by Hugo C Cardoso,., et al. (2019) in "Documenting modern Sri Lanka Portuguese – Scholar Space" by putting more attention on language space accommodated by Portuguese Creole in Sri Lanka. It was realized through all these readings, the scholars have paid more attention on the language, and they have discussed the other socio-cultural elements as part of the establishment of language in the Sri Lankan society.

In my view, the Portuguese involvement in Sri Lankan culture

and society is broader than what we have evaluated to date, its amalgamation is vital in shaping and reshaping Sri Lanka's Art & Architecture, dance and music that are deep rooted to date in Sri Lankan culture. Even though centuries have passed after the Portuguese invasion of the country as a colony, their inspiration is rather a package of new elements in all its aspects which could not be exterminated by her successors: Dutch and British rulers. Thus, its appears more important to have an onsite examination and evaluation with the Portuguese culture and its affinities with regard to the contemporary Sri Lankan socio cultural behaviour and restore them for the future references and further studies as well.

Introduction

Sri Lanka, located in the southern tip of the Indian Ocean, formerly known as Ceylon, Serendib, Tabrobane, Thabmbapanni etc., throughout its history, experienced a variety of cultural influences, mainly because it became the natural focal point at the southernmost part of the sea routes that connected Asia with the Mediterranean. Sailors from Greece, Rome, China, Persia and many of the Southeast Asian countries i.e. Cambodia, Indonesia (Java, Sumathra, Bali) and Indian sailors and merchants have visited the island for many a purposes, of which gem and jewelry, spices, and natural beauty is significant. Nevertheless, they left their cultural heritage in varying degrees in the island through various channels: marriage, religious institutions, language, arts and crafts, music and dance, architecture etc.,

The year 1505, turns a new chapter in the history of Sri Lanka with significant steps taken in the polity, economy and society, and a major volume of cultural influence with the landing of a fleet of Portuguese headed by Don Lourenço de Almeida when they were randomly gusted into the island at Galle, the southern coastal tip of the island.[1] They were sailing from around Maldives as a result of a pursuit made against ships belonging to Moorish and Arab traders, and finally rescued themselves in the island Serendib. This incident is considered the first European appearance in the country with a different

[1]http://www.galleheritage.gov.lk/en/the-portuguese-period/, accessed: 01/06/2022

behavior, advanced military equipment i.e. guns, and allied military weapons. It is apparent that the arrival of the Portuguese prevented the Island from becoming an Indian province. With the naming of the island as Ceilão, Sri Lanka gained a unique identity, imposing a considerable amount of influence on the country's culture nearly five centuries since 1505. We agree, all Portuguese influence was not beneficial with regard to its identity and the sustainability of the country, its positive aspects have contributed to develop a diverse economic, social and cultural domain through which traditional aspects were restored and promoted by the ordinary society where the Portuguese administration never forced restrictions.

The naval captain Almeida having received a friendly hand by the king of Kotte, Vira Parakrama Bahu, was permitted to implement commercial avenues the island, and as a result established formal contact with the king of Kotte. Not only that, in 1518 they were permitted to build a fort at Colombo and were given trading concessions.[2] The particular transformation is described in the Sinhalese chronicle Rajavaliya as follows;

> "At that time, in the year 1522 of our Lord Jesus Christ, there came a ship to the harbor of Colombo from the Portuguese settlement in Jambudvipa…there in our harbor of Colombo a race of people fair of skin and comely withal. They don jackets of iron and hats of iron: they rest not a minute in one place: they walk here and there…they eat hunks of white stone (bread) and drink blood (wine): and give two or three pieces of gold and silver for one fish or one lime. The report of their cannon is louder than thunder when it bursts upon the rock of Yugandhara: their cannon balls fly for a gawwa and shatter fortress of granite."[3]

Portuguese visitors also had the opportunity to rule the country when Prince Dharmapala was enthroned as the successor of King Buvaneka Bahu with all the patronage given for his grandson Prince Dharmapala,

[2] Encyclopedia Britannia, The Portuguese in Sri Lanka (1505–1658)

[3] Rajavaliya: A Historical Narrative of Sinhalese Kings from Vijaya to Wimaladharmasuriya II ed, B. Gunasekara, 1900. Colombo, George J.A. Skeen, Government Printer, Ceylon p.73

who was even more dependent on Portuguese support. An agreement between Bhuvanaika Bahu and the king of Portuguese granted to receive a tribute of cinnamon. Further, the Prince was educated at the Roman Catholic Church under the patronage of the members of the Franciscan order, and he was converted to a Christian in 1556.[4] From then onwards the Portuguese ruled the island except the hill country,[5] by enabling a system of services with the aim of securing the essential produce of the island, especially the cinnamon and elephants. The existing caste system was also secured by the Portuguese in terms of facilitating the needs of the new rule. While Salagama caste was originally serving for Cinnamon industry, the non-Salagamas, i.e. Karawa, Hunu, and Padu castes were newly engaged in peeling of cinnamon by Portuguese rulers.[6]

It is to be mentioned that Portuguese were the first administrators to maintain the Land Register (Tombo) in order to maintain the land and people in each and every village they were ruling, [7] 'and the payment in land to officials also was continued and was extended to Portuguese officials as well.'[8]

New beginning of Sri Lankan culture

When Portuguese arrived in the island of Ceylon, they did not have a proper understanding of its native culture: their religion, culture, norms and customs etc., The best option for them to introduce their own pattern of polity, economy and a culture, utilizing their power and strength. Whether the new beginning was alien to the existing population was a question though, it must have created ground for conflicts between the rulers and the civilians, also creating hardships in

[4] Perera, C. Gaston. "THE FIRST EVANGELICAL MISSION OF THE FRANCISCANS TO CEYLON." Journal of the Royal Asiatic Society of Sri Lanka 53 (2007): 153–202. http://www.jstor.org/stable/23731204.

[5] De Silva, K.M. 1981. A History of Sri Lanka, Berkley and Los Angeles, University of California Press, pp. 113- 132

[6] -ibid- p. 179

[7] Paranavithana, Karunadasa Dias,2007. The Portuguese Tombos as a Source of Sixteenth-Seventeenth Century Sri Lankan History," Re-Exploring the Links History and Constructed Histories between Portugal and Sri Lanka. Ed. Jorge Flores, Maritime Asia 18, Wiesbaden, Otto Harrassowitz, pp. 63-67

[8] Silva, K.M., 1981. pp.177- 178

daily life. We need to accept that the Portuguese introduced a feudal society where the system was administered by employers and people were employed in several positions to obtain the services. They were either daily paid or monthly paid depending on the services rendered to the government. While they were governing the island, the main profitable income of the Portuguese was Cinnamon and elephants, thus, the services were more accrued towards these products. In addition, they promoted the produce of pepper and betel nuts (areca nuts) since it gave a profitable harvest upon the Ceylonese weather. Apparently, the new administration created a new beginning of Sri Lankan culture, economy and culture as briefly mentioned below;

Language

It is imperative that Portuguese served as a lingua franca in Sri Lanka nearly for three hundred years. Even to date, the Burgher community of 0.3% of the population covering both Portuguese burghers and the later appeared Dutch Burghers, have made a significant impact on Sri Lankan language. To date, we Sri Lankans use a quite a large number of words borrowed/ inspired from those belonged to Portuguese (Table 01). Apparently, it has led to the evolution of a new language, "Sri Lanka Portuguese Creole."[9] The interaction of the Portuguese and the islanders led to the evolution of a new language, Portuguese Creole. It helped flourishing as a link language between the 16th and mid-19th centuries and continues to be spoken today (there is no written form) by an extremely small percentage of the population.[10]

It is interesting to note that the miscegenation of the Portuguese-Sri Lankan marriage resulted in the growth and expansion of bilingual community that was proficient in both Creole and Sinhala/Tamil.[11]

[9] De Silva, Shehan & Jayasuriya, Shihan de S. 2008. The Portuguese in the East: A Cultural History of a Maritime Trading Empire: Volume 11 of International Library of Colonial History , Bloomsbury Academic, New York. P.113

[10] Cardoso, Hugo C., et al. 2019, Documenting modern Sri Lanka Portuguese – Scholar Space, Language Documentation & Conservation Special Publication No. 19, Documentation and Maintenance, of Contact Languages from South Asia to East Asia. Mario Pinharanda-Nunes & Hugo C. Cardoso Ed., p.7 https://scholarspace.manoa.hawaii.edu › bitstream: Accessed 03/07/2022

[11] Jayasuriya Shihan de Silva. The Portuguese Cultural Imprint on Sri Lanka. In: Lusotopie, n°7, 2000. Lusophonies asiatiques, Asiatiques en lusophonies. P. 253. (pp.

Words borrowed/ inspired from Portuguese Language

Person names	City names	Object names
Almeda/ Almeida	Batticaloa (Batecalou)	almariya (wardrobe)
Alwis (Alves)	Chilaw	annasi (pineapple)
Aponsu	Colombo	baldiya (bucket)
Cabraal	Milagiriya (milagre)	bankuwa (bench)
Corea (Correia)	Negombo	bonikka (doll)
Costa	Putlam	bottama (button),
Croos (Cruz),	San Sebastian Hill	gova (cabbage)
De Abrew (Abreu)	St. Joseph	kabuk (laterite, a building
De Mel (Melo)		material)
De Saram (Serra)		kalisama (trousers)
De Silva (Da Silva)		kamisaya (shirt)
De Soysa		kussiya (kitchen)
De Zoysa Dias		lensuwa (handkerchief)
De Fonseka		masaya (month)
Fonseka (Fonseca),		mesaya (table)
Fernando		narang (orange)
Fernandes		nona (lady)
Gomes or Gomis		paan (bread)
Livera		pinturaya (picture)
Mendis (Mendes)		rodaya (wheel)
Nonis		rosa (pink)
Perera (Pereira)		saban (soap)
Peiris o		salada (salad)
Pieris		sapattuwa (shoe)
Peres		simenti (cement)
Pinto		sumanaya (week)
Rodrigo		toppiya (hat)
(Rodrigues) Salgado		tuwaya (towel)
Sigera		viduruwa (glass)
Silva/ de Silva		
Suwaris		
Thabrew/ de Abrew Thisera		
Vaas (Vaz)		

Table 01: Words adapted from Portuguese Creole to the Sinhalese vocabulary

253-259). www.persee.fr/doc/luso_1257- 0273_2000_num_7_1_1374: Accessed 08/07/2022: Boxer, C.R. 1961, Four Centuries of Portuguese Expansion 1415-1825:

Furthermore, the Portuguese influence within Sri Lankan society is even more prominent in Portuguese Burgher communities and Afro- Lankan communities within the Island which formed a new language dialect "Sri Lankan Portuguese."[12] And to witness to date some of the names of the cities, persons and objects are still identified by Portuguese terms. Most Burgher people have preserved Western customs of which their language in that their surnames are retained with pride.

To date, speakers of Portuguese Creole are generally members of the Burgher community (descendants of the Portuguese and Dutch) who reside in Batticaloa and Trincomalee.[13] In addition it is spoken by the Kaffir community (Bantu slaves brought to the Island by the Portuguese and later by the Dutch and British), in Puttlam.[14] Portuguese Creole consists of words from Portuguese, Sinhala, Tamil, and even Dutch and English.[15] It is considered to be the most diverse creole dialect in Asia because of its vitality and the influence of its vocabulary on the Sinhala language. The Portuguese Burghers were more mixed, following Catholicism and speaking a Portuguese creole language, and due to its vibrant usage and adaptability to the social demands, Portuguese Creole continued to be used by the Dutch Burghers families too, as the informal language until the end of the 19th century.[16]

Religion/ Roman Catholicism.

The introduction of the Christianity is seen with the arrival of Portuguese to the island. Being the main form of Christianity in Sri Lanka to date, it was first introduced through the particular intercourse with Portuguese missionaries. Whereas the Portuguese influence was marked by intense Roman Catholic missionary activity, Portuguese

[12] A Succinct Survey, Johannesburg, Witwatersrand University Press, p.102

[13] -ibid-p. 254

[14] Holm, John, 1994 (Reprint), Pidgins and Creoles Vol. II- Resurvey, New

[15] York: Hunter College and the Graduate Center, City University of New York. Pp. 288-289

[16] Pathmanadan, S., 2006 "The Portuguese in North East Sri Lanka (1543-1658): An Assessment of Impressions Recorded in Tamil Chronicles and Poems," Maritime Asia 18, Re-Exploring the links: History and Constructed Histories between Portugal and Sri Lanka, ed. GJorge Manuel Flores, Wiesbaden, Harrassowitz. p.31

established Catholic religious teaching centers by Franciscan priests since 1542.[17] They seem to have been more responsible with regard to the education. Since the Jesuit priests were well versed in teaching, they have engaged in teaching in the Northern areas. However, Catholic clergy was more active in transforming the traditional system of education in the country: from temples, or pirivenas to the formal schools and educational institutes. It is the fact that they established several schools in Jaffna Peninsula while giving some opportunities for the communities in other areas as well. With the publicity they gained by establishing a school in Colombo, following schools were established in different areas in the country;

1. St. Aloysius College, Galle and Rathnapura
2. St. Michael's College, Batticaloa
3. St. Servatius' College, Matara
4. St. Joseph's College, Trincomallee
5. St. Mary's College, Kegalle[18]

With the arrival of the Dominican and Augustinian priests, different tasks were assigned to each school.[19]

Most important with regard to the polity of this country is the education provided to Prince Dharmapala, grandson of King Buvaneka Bahu under the Franciscan Priests, and his conversion to Catholic resulting many members of the Sinhalese royal inheritance to follow the same. Particular coronation resulted in transferring of Buddhist orthodoxy in kingship towards Christianity, more precisely Catholicism. It is informed that the Prince Dharmapala or Don Juan Dharmapala, endowed missionary orders lavishly, often from the properties of Buddhist and Hindu temples. The particular movement helped Portuguese to promote Christianity. "Members of the landed aristocracy embraced Christianity and took Portuguese surnames at baptism."[20]

[17]Ihemere, Kelechukwu, U., ed., 2014 Language Contact: A Multidimensional Perspective, United Kingdom: Cambridge Scholars Publishing, p. 209

[18] McGilvray, Dennis B. 1982. "Dutch Burghers and Portuguese Mechanics: Eurasian Ethnicity in Sri Lanka." Comparative Studies in Society and History 24, No.2 (1982): p.250 (235–63). http://www.jstor.org/stable/178584. Accessed: 10/07/2022 [19] https://catholiceducation.lk/history-of-catholic-education/ Accessed: 05/07/2022

[20] House of the Archbishops, Arrival of Jesuit Fathers in Sri Lanka:

While the priests of Franciscan order were responsible for education, they established parish schools in villages and educated them not only for the sake of education, by converting them as Christians too. "Many coastal communities underwent mass conversion, particularly Jaffna, Mannar, and the fishing communities north of Colombo. Catholic churches with schools attached to them served Catholic communities all over the country. The Portuguese language spread extensively, and the upper classes quickly gained proficiency in it."[21]

It is so significant that the Portuguese were more successful in retaining their converts than the Dutch missionaries who tried to spread Protestantism after the Portuguese left the island. This is reflected in the census report of Sri Lanka where the Catholic community represented 6.2% of the total population where the Christianity was endowed by 1.4%. There is no seen community of Protestants according to the latest census reports.[22]

Portuguese in Administration

It is to be noted that the Portuguese were the first to introduce a system of record keeping in local administration. They introduced a registry of lands in the country in terms of calculating the earnings and profits of the crops, harvest of their cultivation from the lands they acquired. 'They compiled a tombo, or land register, to provide a detailed statement of landholding, crops grown, tax obligations, and nature of ownership.'[23] The purpose of maintaining the records was to manage and monitor the earnings and profits of the areas under their control, and the particular mechanism helped immensely in later administrative procedures to continue the same practice in a modified and customized manner. It was more or less continued by later occupied Dutch and British rulers of the island, despite some of them were destroyed. It is to be noted that the Portuguese administration, and the practice is continued in the country even to date. The government position of land registrar, and the Land

https://catholiceducation.lk/arrival-of-jesuit- fathers-in-sri-lanka/

[21] https://www.britannica.com/place/Sri-Lanka/The-Portuguese-in-Sri-Lanka-1505-1658

[22] Census Report- 2012. Department of Census and Statistics, Ministry of Policy Implementation, Economic, Child, Youth Affairs and Cultural Affairs, ISBN: 978-955-577-940-1.p.147

[23] Paranavithana, Karunadasa Dias, 2006. pp.63-78

Registries in the country is hailed from the system of Tombo.

A different approach in local administration was also captured by Portuguese descendants in the country during the colonial period due to their educational background. Since the Catholic priests took the responsibility of educating the local community with a different objective, they were taught in the English medium. When, the colonials were taking control of the country, these Portuguese descended, English educated community were on top priority list and were employed in higher positions in the local government offices. They were in different ranks from civil servants, administrators, bankers, teachers, court registrars and other jobs. To date, we see that some of the highly paid jobs are reserved by the Portuguese descendants in the country.

Portuguese Art and Architecture

Portuguese once took the rule over several regions in the country, brought their government officials, soldiers, technicians, crafts people from time to time. They married Sri Lankans and initiated the construction of houses, churches, fortifications, and several other buildings that necessarily portrayed the Portuguese architectural inspiration. The masons, carpenters, plumbers, and other local crafts people along with the Portuguese craftsmen, religious value, and/or measures that have been taken to maintain the fullest security in the respective construction work. Use of rubble stones, and the Pise de Terre (rammed earth), use of terracotta floor bricks, half round tiles, etc., were part of the Portuguese influence on architecture.[24] Below given is a brief description of built architecture inherited by Portuguese to Sri Lanka.

a. Catholic Churches (Chapel)

When the Portuguese introduced Catholicism in the country, they established the Catholic churches (Chapels) all over the island, especially in the maritime areas. Some of them have been re-constructed and

[24] De Vos, Ashley, 2002. Saman Kelegama and Roshan Madawela ed., Dutch Architecture, Dutch Colonial Architecture, Dutch Period Architecture or Architecture of Dual Parentage?', in 400 Years of Dutch – Sri Lanka Relations 1602 – 2002, (Colombo, Institute Policy Studies of Sri Lanka pp.399-438.

effected as Dutch Reformed Churches i.e. All Saints Anglican Church in Galle, Church of Our Lady in Vaddukkoday in Jaffna. To date, Sri Lanka is embraced with several nationally recognized Portuguese churches which are also identified and preserved as archaeological monuments in the country. It is evident that Portuguese introduced a distinctive tradition of architecture which was gradually incorporated in to the Sri Lankan architecture i.e. the inner gardens, facades, arches and arcades which were new to the Sri Lankan masonry.

Fortresses

There are 13 major fortresses around the island with distinctive architectural scape exclusively built by Portuguese to provide the utmost security to the island they conquered. They were all individual arrangements depending on the natural landscape to fulfil the need and the circumstances. The evidence remains to date in Galle (Fig. 01 & 02), Kalutara, Matara, Pooneryn, Jaffna, Batticaloa, Kytes and Delft Island, Mannar, Menikkadawara, Negombo, Ratnapura, Ruwanwella, and Hanwella, where all were identified as Dutch fortresses once Dutchers captured the island over Portuguese.

Fig. 01: Marine Entrance of Galle Fort with Dutch Emblam on top

Fig. 02: Main Entrance of Galle Fort

However, to date, some of these fortresses are in a dilapidated stage. The fortresses in main cities i.e. Colombo, Galle, Matara, Kalutara, Poneryn, Jaffna etc., are well maintained by the local government and the foreign aid exclusively sent forth from both Portugal and Holland to preserve and maintain them.[25]

It is not exaggerating, each of these fortresses portrays its own architectural scape depending on the geographical contours of the place. While sea fortresses like Galle, Matara (Fig. 03 & 04), Colombo, Jaffna (Fig.04), were forced to provide extra care from sea fare threats, the landside fortresses were prepared as barriers to reach the Portuguese mind centers.

Fig. 03: Matara Fortress (Star Fortress)

[25] https://whc.unesco.org/en/list/451/

Fig. 04: Matara Fortress- Main Entrance

Houses

Houses made under Portuguese influence were so typical that they were built upon a built platform. The houses had a colonnaded open verandah, portico, interior garden with several rooms facing it, two way doors and windows with niches on the walls to provide light and ventilation to the inside of the house. Gabled roofs were introduced with clay made roof tiles.

Fig. 05 Portuguese built colonial house converted into maritime museum-Galle Fort

Such characteristics obviously helped demarcating the social hierarchy of Portuguese- Sri Lankan families (Fig. 05 & 06).

Fig. 06 Streets and shops inside the Galle Fort. UNESCO World Heritage Site

Buddhist Art and Architecture

Above all, the Portuguese were able to influence the Buddhist art in the country, especially absorbed the newly introduced Portuguese elements transforming its original form and structure to a westernized structure. Aforementioned façade, decorated pillars in the interior of the image house, arches and gables were gradually evolved, and built by the local craftsmen under the instructions of Portuguese masonry. The stucco designs on the churches, were the precursor to the elaborate designs which adorned the facades of Buddhist temples. The early European facade temples were probably created along the coast which had absorbed European cultural traits; gradually the style penetrated interior parts of the island. There are also instances where actual churches have been converted into Buddhist temples i.e. Balapitiya Pushparamaya

Raja Maha Vihara in Galle District (Fig. 07)

Fig. 07 BalapitiyaPushparama Raja Maha Viharaya https://www.agefotostock.com/age/en/Stock- Images/temple-sri-pushparama.html[26]

Further, the Bell Tower which has become an integral part of Sri Lankan Buddhist temples was also introduced by Portuguese, though they are not associated with Portuguese Church Art (Fig. 08 & 09).

Fig. 08 Gateway (Thorana) at Kathaluwa Buddhist Temple, Galle

Fig. 09 Gateway (Thorana) with Bell Tower, Sunandaramaya, Buddhist Temple, Ambalangoda

[26] Image Code: IBR- 3829736Photographer:MartinMoxter/imageBROKERCollection, Shooting date: 03/04/2013

Incorporation of European figures into the Buddhist temple paintings is another inspiration received from Portuguese. Of them, the European winged angel is significant. Though the concept of angel is not alien to Buddhist art, Christian style angel with wings became popular in Sri Lankan Buddhist art during the period of Portuguese. These were created by local craftsmen who copied these figures from sketches, books or other portable art material. However, those figures were evolved with typical iconography which emerged a combination of Sri Lankan-Portuguese art conquest in Buddhist paintings i.e. Mirissa Veheragalle Samudragiri temple, Kathaluwa ancient Raja Maha Vihara. Moreover, the grape vines, maple leaf, and several fauna and flora of European style was introduced to Buddhist paintings by the Portuguese.

The most significant characteristics of Buddhist painting during this period is the incorporation of Portuguese style clothes in to the paintings. In many scenes minor details were merged in to the traditional dress of Sri Lankan woman or a man whereas some paintings were entirely representing the Portuguese dress patterns. i.e. Purvarama Temple, Kathaluwa (Fig. 10)

Fig. 10 Frescoes at the Purvarama Vihara, Kataluwa (1886)

Portuguese cuisine and Sri Lankan Spices

Portuguese introduced many food, flavours and sweetmeat to the Sri Lankan culture. One of the major introductions is the red chilies which is a must in Sri Lankan curry making to date. In every Sri Lankan kitchen, chilly and pepper is an essential spice in preparing fish, meat, or any other hot and spicy curry. Similarly, the use of Cummins, dill seeds and cinnamon were popularized in the Sri Lankan cuisine by the Portuguese. Until then, pepper was the only hot mix in Sri Lankan cookery practice. [27]

Bread and sweetmeat

Along with that they also introduced bread to the Sri Lankan food. According to Rajawaliya, people identified bread as "hunks of white stone." They introduced various kinds of bread and cakes i.e. love cake, bolo fiado or bolo folhado, a layer cake filled with cashew. Nonetheless, Boruwa (made with semolina (Rulang) or sago seeds), Oil cake, Milk toffee, musket, cookies, and fuguete are prominent sweetmeat in Sri Lanka even today. Bolo Fiado (Layered Pastry Cake), and "Sinasir" (a rice pancake with coconut and spices) show the blend of local and Portuguese culinary traditions.[28]

Rice and vegetables

The Portuguese introduction to Sri Lanka significantly influenced the island's cuisine, bringing new ingredients, cooking techniques, and dishes. Some of the notable cuisines and culinary elements introduced by the Portuguese include Chili and Spices, which became a staple in Sri Lankan cooking, replacing or supplementing traditional spices.[29] They also introduced vinegar in cooking, leading to the creation of dishes i.e. marinated meats, and fish and most of the pickles. Bitter Gourd and Other Vegetables: Certain vegetables like bitter gourd and tomatoes were introduced or popularized through Portuguese influence, becoming

[27] De Silva, 1981. pp.90-127
[28] De Silva, K.M.1993, A History of Sri Lanka. University of California Press, 116-120
[29] -ibid-p. 123.

integral to local cuisine .

Dress and costume

Under the Portuguese rule, Sri Lanka was influenced by a new trend of clothing i.e. maxi and *pinapo* frock became so popular in the country. They were the first to introduce the *Cabaya* or coat to males, *Juan hatte* (a jacket with long sleeves) for women, *saya* (skirt), *kabakurruttu* (a short, long sleeved cotton jacket edged at the side with dainty pillow lace), shoes and sandals, etc., all of which have now become a part of Sri Lankan culture and considered Sri Lankan rather than European.[30] Illustrations in Portuguese and Dutch descriptions of the Island in the 16th and 17th centuries reveal that the Sinhalese soldier's dress was of Portuguese influence. There is an engraving from Description of Malabar and Ceylon (1672) by the Dutchman Philip Baldaeus that depicts the reception of his fellow-countryman, explorer Joris van Spilbergen, by King Vimaladharmasuriya I. The king's guards are shown wearing a Portuguese-type helmet, white jacket and kilt (Fig. 11).

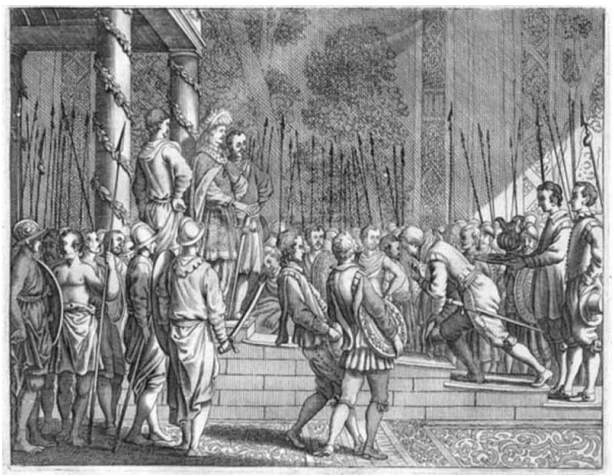

Fig.11 Explorer Joris van Spilbergen received by King Vimaladharmasuriya I. King's guards with Portuguese helmet[31]

It is significant that the later arrived Dutch and British colonizers

[30] Wimalaratne, K.D.G., 2002. Cultural Impact of the Dutch Rule in Sri Lanka' in 400 Years of Dutch – Sri Lanka Relations 1602- 2002, Saman Kelegama and Roshan Madawela ed., (Colombo, Institute of Policy Studies, pp.543

[31] Baldaeus, Philip (1672) Descriptions of M a l a b a r and Ceylon,

continued the same tradition that they wore Portuguese costume, complete with hat and shoes.

Music and dance

One of the biggest revolutions in Sri Lankan culture is seen in its music as a result of the arrival of Portuguese. They not only revitalized the traditional Sri Lankan music, but their contribution reformed its original form with typical customs and norms into the existing values too. They introduced the so-called western instruments i.e. ukulele and the guitar, viola and violin (western), also the musical forms such as the baila, which was originally popular in the community of Portuguese traders and their Kaffir slaves.[32] With its particular rhythmic beat 6/8 time, baila music has established its own identity in Sri Lankan society even today: in musical entertainments/performances, festivals and celebrations i.e. weddings, birthdays and special gatherings. To date, Sri Lanka boasts of renowned musicians whose nick names have the prefix *'Baila.'* i.e. Baila Bastian. There is a popular baila song composed of him that goes as Lankawata baila gena Wally Bastian-Baila valin Rata hollapu baila Bastian. (Wally Bastian, the one who brought baila to Ceylon: the one who shook the country by singing baila).[33] It is apparent that the baila created a particular musical tradition in the country, perhaps due to its new music melodies, the fast tempo, comical lyrics, new instruments, and always entertained by dance. As Radhakrishnan states: The dances include "quadrille dancing known as láánsas (lancers), which is maintained in Batticaloa as a highly valued albeit more esoteric form.[34] Silva argues that music of 16th-century Portugal, has found its way into mainstream popular Sinhalese music in such a way that it has been instrumental in bridging the cultural gap between Sri Lankans and the Portuguese.[35]

[32] Jackson, pp. 73-76

[33] Please refer to the you tube link: https://youtu.be/n_pgmrbZCfQ

[34] Radhakrishnan, Mahesh, 2021. "Shake it and Dance": Portuguese Identity and the Performance of Káffrinha, The Asia Pacific Journal of Anthropology, Taylor & Francis. P. 13 (1-29) Stable URL: https://www.tandfonline.com/doi/full/10.1080/14442213.2021.1922496 : Accessed 25/06/2022

[35] Jayasuriya, Shihan De Silva. 2009. "Tracing socio-cultural roots of the Portuguese influence in

Technical/ Mechanical skills by Portuguese

The majority of the Portuguese descendants are craftsmen in that we find eminent black smiths, key smiths, leather product makers, master carpenters, tailors, printers, painters and mechanics. They are capable of creating many practically, and aesthetically sound equipment ranging from heavy duty machines to kitchen knives, beyond capabilities of these black- smiths. Till recent times, the only owners of printing presses in Batticaloa District in the island were the Portuguese and Dutch descent Burghers.[36] Even in the Printing press managed by the Catholic clergy, the master printers and binders were all of Portuguese origin.[37]

Apart from that, Beeralu-Lacemaking which began as a domestic pastime of Burgher women, is now a part of Sinhalese culture too. The Beeralu lace is an iconic industry in south Ceylon, where it generates high income to the craftsman, also an instrumental wearing representing the social status, especially of Sri Lankan women.[38] The typical technique, the designs and the clothing is unique to the industry and has become an iconic of the social hierarchy in the country for a period (Fig. 12).

Sri Lanka," Special Guest Lecture on "The Portuguese impact on the socio-culture of Sri Lanka" at the Bandaranaika International Diplomatic Training Institute, 6/02/2019: https://bidti.lk/tracing-socio-cultural-roots-of-the- portuguese-influence-in-sri-lanka/ Accessed 01/07/2022

[36] McGilvray, Denis B., Jorge Flores ed. 2007. The Portuguese Burghers of Eastern Sri Lanka in the wake of Civil War and the Tunami, Re- Exploring the Links: History and Constructed Histories between Portugal and Sri Lanka, Harassowitz, Wiesbaden, p. 329

[37] De Silva R.K., & Beumer, W.G.M. 1988. Illustrations and Views of Dutch Ceylon1602- 1796, Leiden, E.J. Brill. P.115

[38] https://www.ceylondigest.com/traditional-beeralu-lace-a-vital-factor-of-sri-lankan-heritage/: https://www.pinterest.com/pin/beeralu-lace-industry--297096906649566732/:

Fig. 12 The incorporation of Beeralu designs from Home Decoration to Bridal Dressing in Sri Lankan society

Traditional Games

Foot Ball is the Traditional game of the Portuguese Burghers. In Sri Lanka, it is the Portuguese Burghers who introduced the game of football and to date football is considered one of the nationally recognized games, which is played from school to club level, at the District, Province, and National level and also in international tournaments. Football is very common and the Eastern Province is well known for the game of football too.

Conclusions

The foregoing data, evidence, and analysis clearly demonstrate that the arrival of the Portuguese marked a decisive watershed in the historical trajectory of the island, reshaping its structures in ways that extended far beyond immediate political domination. Their presence did not merely alter administrative or commercial systems; rather, it initiated a multidimensional transformation that penetrated deeply into the social fabric, value systems, and symbolic life of the society. Through sustained interaction with local communities, the Portuguese introduced new institutional patterns, belief systems, and aesthetic expressions that gradually fused with indigenous traditions. This process was neither superficial nor temporary. Instead, it constituted a profound cultural

encounter in which external influences were localized, adapted, and eventually naturalized within the island's evolving civilizational framework.

One of the most enduring consequences of this encounter was the establishment of a distinct cultural layer that continues to be visible in multiple domains of Sri Lankan life. The introduction and consolidation of Christianity alongside the long-standing predominance of Buddhism illustrates the lasting religious pluralism that emerged from this period. Similarly, architectural forms, artistic motifs, musical traditions, performative practices, and linguistic elements associated with Portuguese influence became embedded within local cultural expressions, ultimately forming part of the composite heritage of the island. Such features did not remain confined to colonial enclaves but diffused across social strata, demonstrating how external cultural impulses can be assimilated into indigenous contexts and reinterpreted over time.

Even after the Portuguese were displaced by the Dutch in 1658, the cultural imprints they had established proved resilient. Subsequent colonial powers, despite possessing their own administrative agendas and cultural orientations, neither fully eradicated nor substantially diluted these earlier influences. This endurance suggests that by the time political control shifted, Portuguese-introduced practices and institutions had already become integral to everyday life and social identity among the inhabitants. In effect, these elements had ceased to be perceived as foreign impositions and had instead been internalized as components of local tradition. The observation made by João de Barros in 1540 aptly anticipates this phenomenon, emphasizing that while material symbols of imperial presence may decay, intangible legacies such as religion, customs, and language possess a far greater capacity for survival across generations.

Therefore, the Portuguese episode in the island's history must be understood not simply as a phase of colonial occupation but as a formative cultural epoch whose effects outlived its political authority. Their legacy illustrates how early encounters in the age of maritime expansion could engender enduring civilizational exchanges, shaping identities and social practices long after the original agents of change had departed. In this sense, the Portuguese contribution represents a foundational layer in the

historical evolution of Sri Lankan society, underscoring the broader principle that cultural transformations, once rooted in lived experience, often transcend the temporal limits of empire and become permanent features of a nation's heritage.

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Biomechanical Analysis of Wrist Movements in Sabaragamuwa Traditional Dance.

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Abstract

Sabaragamuwa traditional dance, originating from Sabaragamuwa Province, demonstrates distinctive expressive hand gestures characterized by fluid and circular wrist movements. This study investigates the biomechanical principles underlying wrist movements in Sabaragamuwa dance, focusing on muscular involvement, joint mechanics, and movement coordination. A mixed-method research design was employed, integrating primary data collected through literature surveys, empirical reports, and field observations and semi-structured interviews with dancers and instructors, alongside secondary data derived from academic literature and relevant theoretical sources. Motion patterns were analyzed using kinematic and kinetic frameworks to identify joint angles and muscular activation patterns. The findings reveal that wrist flexion, extension, medial deviation, and lateral deviation are the dominant movement patterns. Flexion and extension movements of the wrist joint performed within the sagittal plane, around a coronal axis that passes through the wrist joint. Medial and lateral deviations of the wrist occur within the coronal plane, around a sagittal axis. Circumduction of the wrist joint is achieved through a sequential combination of movements. It begins with extension of approximately 60°, followed by lateral deviation (radial abduction) of up to 25°, medial deviation (ulnar adduction) of up to 40°, and finally flexion of approximately 80°. These movements were achieved through coordinated activation of forearm flexors and extensors, particularly the flexor carpi radialis, flexor carpi ulnaris, extensor carpi radialis, and extensor carpi ulnaris. Forearm rotational stability is supported by the pronator teres and supinator muscles. The results indicate that controlled muscular co-contraction is essential for maintaining fluidity and aesthetic precision while minimizing strain. The study concludes that Sabaragamuwa wrist movements reflect an efficient

biomechanical system that balances artistic expression with functional joint mechanics, contributing to dance science literature and providing practical implications for performance optimization and injury prevention.

Keywords: Sabaragamuwa dance, Biomechanics, Wrist movement, Dance kinesiology

Introduction

Dance is a universal form of human expression that combines artistic creativity with structured physical movement. It exists across cultures and historical periods, serving social, ritualistic, and performance purposes. From classical traditions such as *Ballet, Lating dance, Contemporary Dance to Asian forms like Bharatanatyam, Kathak,Kathakali,Mnipuri* dance requires coordination, rhythm, strength, flexibility, and neuromuscular control.

Sri Lankan traditional dance represents a rich cultural heritage rooted in ritual, religion, and community practice. The three main classical traditions Kandyan dance, Low Country dance and Sabaragamuwa dance developed in different regions of Sri Lanka and are closely associated with temple ceremonies, healing rituals, and royal court performances. Kandyan dance, originating from the hill country, is characterized by vigorous jumps, spins, and expressive gestures, while Low Country dance is traditionally linked with ritual healing ceremonies (thovil). Sabaragamuwa dance is known for its graceful movements and strong rhythmic patterns.

Although research has been conducted on Sri Lankan dance, studies specifically related to its biomechanics are very limited. Research on Kandyan dance and semiotics has been conducted by Sudeesh Mantillake, while Lakshman Manchanayake has examined the mathematical structures of Kandyan dance. Additionally, studies on Bharata Natyam and Kandyan dance have been carried out by S. Bhananath and Dr. V. Gopinath. Aravinda Ravibahu and Kuruppu Bandara have analyzed the movements of Sabaragamuwa dance according to Hrdlička's theory. However, no research has been found regarding the biomechanics of Sabaragamuwa dance. Therefore, this study has been conducted by the researcher to address this research gap.

Sri Lankan traditional dance demands high levels of coordination, flexibility, balance, and muscular strength. The movements involve complex footwork, dynamic torso control, and expressive hand gestures, reflecting both artistic creativity and biomechanical efficiency. According to cultural and performance studies, these dance forms preserve indigenous knowledge systems while also

requiring systematic physical training for performance excellence (De Zoete, 1957; Reed, 2010).

Human movement has been examined as a structured and systematic phenomenon (Greene, 2010). Within this broader analytical framework, dance movement occupies a distinct position, transcending quotidian physical activity to function as an embodied form of expressive communication (Krasnow, 2015). Through the body as a medium of non-verbal discourse, dancers construct and transmit meaning to audiences, transforming movement into a semiotic and aesthetic practice (Green, 2010). Thus, dance is not merely kinetic activity but a complex integration of physical technique, expressive intention, and communicative function (Krasnow, 2015).

Despite the increase in scholarships offered, the expansion of theoretical discourse in areas such as performance studies and movement analysis, particularly within the Sri Lankan context, has paid poor attention to the internal biomechanical processes that underpin movement execution (Bronner, Ojofeitimi, & Rose, 2008). Practical engagement within the field of dance indicates that many dancers prioritize the external, formal, and stylistic dimensions of movement while insufficiently attending to the internal physiological and biomechanical processes that enable efficient execution (Shultz & Houglum, 2010). This imbalance between aesthetic output and internal bodily awareness has prompted the development of Dance Science as a specialized interdisciplinary field (Krasnow, 2015).

The aforementioned imbalance presents both artistic and pedagogical challenges. Without a systematic understanding of the coordinated functioning of the muscular and skeletal systems, dancers may achieve visual accuracy while lacking biomechanical efficiency (Hamill, Knutzen, & Derrick, 2015). Such disjunction not only constrains expressive clarity and technical refinement but also increases vulnerability to both acute and chronic injuries arising from improper alignment, muscular imbalance, or repetitive strain (Bronner, Ojofeitimi, & Rose, 2008).

Accordingly, this study seeks to examine the relationship between internal biomechanical awareness and movement execution within indigenous dance practice (Cohen & Ranganathan, 2011). By integrating principles of movement science with performance theory, the research aims to articulate a framework through which dancers may cultivate embodied precision, technical sustainability, and injury prevention while preserving aesthetic authenticity (Krasnow, 2015).

A lack of awareness of internal body mechanics may restrict expressive refinement and increase the risk of injury due to misalignment, muscular imbalance, or repetitive strain. Consequently, a systematic understanding of the coordinated functioning of the musculoskeletal system is essential for sustainable dance practice.

Dance Science integrates knowledge from exercise physiology, dance physiology, and kinesiology to examine the scientific principles underlying human movement in dance contexts. These disciplines collectively address how muscular, skeletal, and neuromuscular systems function in the production, regulation, and sustainability of movement. Krasnow (2015) characterizes Dance Science as a relatively recent development that gained clearer institutional and academic recognition toward the late twentieth century.

The emergence of Dance Science was influenced by earlier advancements in related scientific domains, including sports science, sports medicine, biomechanics, exercise physiology, nutrition, and psychology. The formal scientific investigation of human movement began to consolidate around the mid-twentieth century (Luttgens & Wells, 1971). These developments laid the theoretical and methodological foundation for applying movement science principles specifically to dance training and performance.

The genesis of this study is rooted in a personal experience of musculoskeletal discomfort encountered during a practical engagement at a traditional dance performance. This experience prompted a critical re-evaluation of prevailing approaches to the study and training of traditional dance forms. While substantial scholarly and pedagogical emphasized information on the external, aesthetic, and stylistic dimensions of performance, comparatively information on internal biomechanical mechanisms that underpin and regulate these movements were almost non-existent. Consequently, a significant gap came to light between performative practice and scientific anatomical awareness.

As scholarly interest expanded, greater attention was directed toward understanding the physiological demands of dance and the importance of injury prevention, conditioning, and biomechanical efficiency. Consequently, scientific knowledge has become increasingly integrated into pedagogical models and professional dance practice, contributing to enhanced technical sustainability and performer well-being.

Dance as an artistic discipline refines and systematizes codified movement vocabularies through established aesthetic and technical principles. While traditional dance training emphasizes the preservation and transmission of stylistic conventions, Dance Science provides a scientific

framework for analyzing the underlying biomechanical and physiological foundations of these codified forms. In this sense, artistic practice and scientific inquiry function as complementary domains: the former cultivates performative excellence, while the latter elucidates the structural and functional mechanisms that enable such excellence.

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Objective

The primary objective of this research is to conduct a detailed biomechanical analysis of movements in Sabaragamuwa dance, with particular emphasis on joint articulation and muscular activation pattern. Accordingly, the present study seeks to direct scholarly attention toward the biomechanical principles embedded within classical dance practice.

Limitations of the study

For the purpose of conceptual clarity and analytical depth, the scope of this study is limited to the traditional Sabaragamuwa dance tradition. Within this stylistic framework, particular emphasis is placed on examining how both external movement form and internal bodily mechanics: especially the coordinated functioning of the musculoskeletal system that interacts to produce refined and controlled execution. By investigating the integration of internal movement dynamics with external aesthetic structure, this study aims to contribute to a more scientifically informed understanding of Sabaragamu classical dance.

Research Question

In particular, the internal biomechanical dynamics of Sabaragamuwa traditional dance remain underexplored within academic discourse. A comprehensive review of existing literature indicates the absence of systematic research examining the coordinated functioning of the skeletal and muscular systems in generating and sustaining Sabaragamuwa dance movements. Addressing this lacuna (Bronner, Ojofeitimi, & Rose, 2008) the present study is structured around the central research question: *How do the osteological and myological components of the human body interact biomechanically to facilitate the internal movement patterns characteristic of the Sabaragamuwa dance tradition?*

Materials and Methodology

A Sri Lankan professional Sabaragamuwa dancer from the Rathnapura District was analyzed for one of the characteristic upper-limb movement patterns, namely the "wrist rotation movement" of Sabaragamuwa dance. The following biomechanical features were examined: the sequential array of wrist joint movements, the plane of joint movement, the axis of joint movement, and the range of motion of the joint. The study adopted a mixed-method research design, incorporating both qualitative and quantitative approaches (Wu et al., 2005). Data were gathered through systematic field observations, video-based motion analysis, semi-structured interviews with practitioners, and anatomical movement mapping (Krasnow, 2015). Quantitative elements included joint movement measurements, while qualitative data were subjected to thematic and interpretative analysis (Green, 2010). The triangulation of these methods ensured analytical rigor and strengthened the validity of the findings (Robertson et al., 2014).

Results

This study identified the biomechanical features involved in the wrist during movements. Wrist motion occurs primarily between the distal radius and the proximal carpal row, consisting of the scaphoid, lunate and triquetrum. In Sabaragamuwa dance, wrist joint movements start with extension of the wrist. Then there is a maximum radial deviation of the joint followed by

forearm supination. After this hand goes to maximum ulnar deviation followed by flexion with forearm pronation.

Extension is primarily executed by the extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris as prime movers (Figure 1). The synergists include the extensor digitorum, extensor digiti minimi, extensor indicis, and extensor pollicis longus muscle. The antagonistic muscles are the flexor carpi radialis and flexor carpi ulnaris. In this extension movement by the joint allows 60^0 of extension.

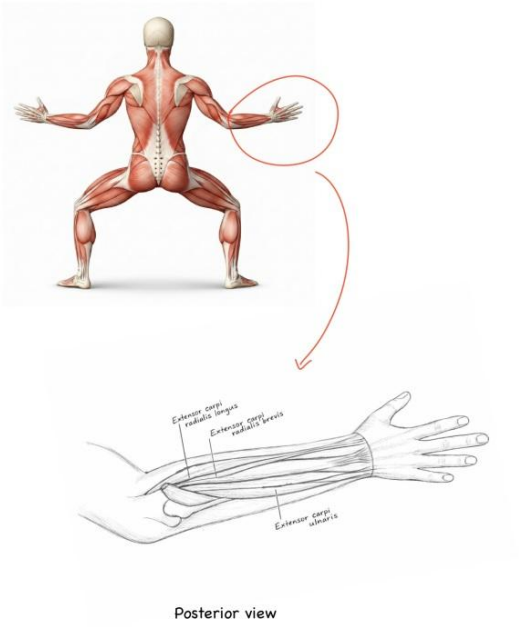

Figure 1. Prime movers of the posterior compartment of forearm

Radial deviation mainly occurs at the midcarpal joint and is produced by the extensor carpi radialis longus, extensor carpi radialis brevis, and flexor carpi radialis as prime movers. The abductor pollicis longus acts as a synergist, while the extensor carpi ulnaris and flexor carpi ulnaris function as antagonists.

Supination of the forearm involves the outward rotation that turns the palm upward. The supinator muscle and biceps brachii serve as the prime movers. The antagonists in supination are the pronator quadratus and pronator teres, which counteract the outward rotation and return the forearm to pronation.

Ulnar deviation primarily occurs at the wrist joint and is generated by the flexor carpi ulnaris and extensor carpi ulnaris as prime movers. Synergistic muscles include the flexor digitorum profundus, flexor digitorum superficialis, extensor digitorum, and extensor digiti minimi. The antagonists are the extensor carpi radialis longus, flexor carpi radialis, and extensor carpi radialis brevis. The wrist abducts up to 25°, whereas it adducts up to 40° (Figure 2).

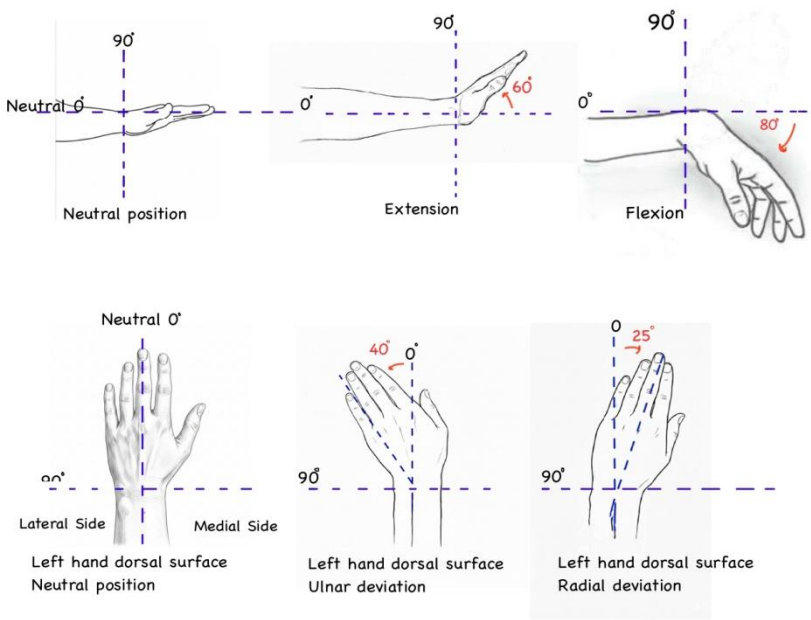

Figure 2. Range of motion of wrist; Upper raw -flexion and extension, Lower raw- ulnar deviation and radial deviation.

Flexion is primarily performed by the flexor carpi radialis and flexor carpi ulnaris as prime movers (Figure 3). The synergistic muscles assisting this movement include the flexor digitorum superficialis, flexor digitorum profundus, flexor pollicis longus, and palmaris longus muscle. The

antagonistic muscles are the extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris.

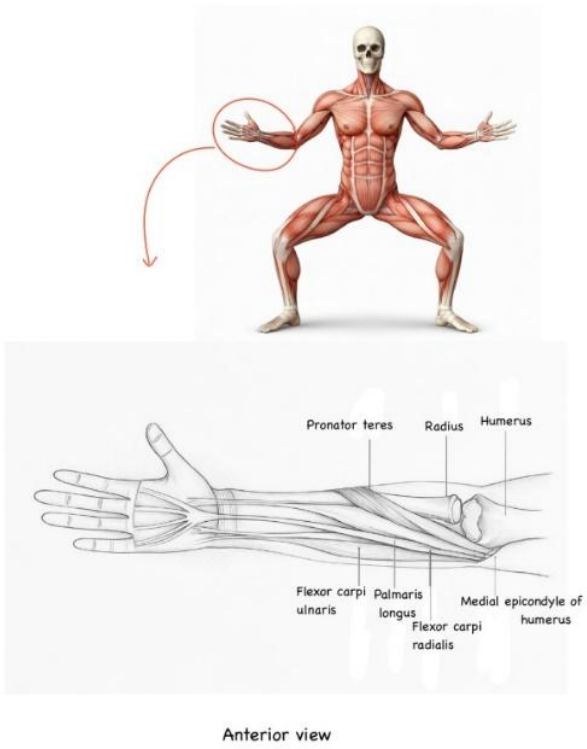

Figure 3. Prime movers of the anterior compartment of forearm.

Pronation of the forearm refers to the inward rotation that turns the palm downward. The prime mover for this action is the pronator quadratus, a deep muscle near the wrist that provides the primary force for pronation. The pronator teres acts as a synergist, assisting in the movement. The antagonists opposing this motion are the supinator and the biceps.

Discussion

The biomechanical assessment of wrist movements in Sabaragamuwa dance highlights the complexity and coordination required for expressive hand gestures. The sequence of movements beginning with wrist extension,

progressing through radial deviation, supination, ulnar deviation, flexion, and finally pronation, demonstrates how dancers rely on a finely tuned interplay of prime movers, synergists, and antagonists. Each stage of motion recruits specific muscle groups, ensuring both stability and fluidity. The rotational actions not only expand the expressive range of the wrist but also demand precise coordination between agonists and antagonists to maintain rhythm and grace. Overall, the findings reveal that Sabaragamuwa dance integrates a full spectrum of wrist biomechanics, transforming anatomical function into aesthetic artistry.

Conclusion

In Sabaragamuwa dance, the fundamental hand gesture referred to as the "wrist rotation movement" was subjected to anatomical analysis. This examination identified six distinct types of wrist movements associated with the execution of this dance pattern. It begins with extension of approximately 60°, followed by lateral deviation (radial abduction) of up to 25° with forearm supination, medial deviation (ulnar adduction) of up to 40°, flexion of approximately 80° and forearm pronation. During wrist flexion, the muscles located in the anterior compartment of the forearm are primarily activated. During wrist extension, the muscles of the posterior compartment of the forearm are mainly involved. Radial deviation is produced by muscles situated on the lateral side of the forearm, while ulnar deviation is generated by the muscles on the medial side of the forearm. The coordinated activation of these muscle groups enables smooth and continuous circumduction movement characteristic of this traditional dance gesture.

Importantly, there has been no prior scientific research analyzing dance biomechanics in the Sri Lankan context. Thus, this study represents the first systematic biomechanical investigation of wrist movements in Sabaragamuwa dance, marking a turning point in the dance research arena. By bridging anatomical science with traditional performance, it establishes a foundation for future interdisciplinary studies and elevates Sri Lankan dance into the global discourse on movement analysis.

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